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the balance are made clear, and this is as true of such matters as professional freedom and loyalty as it is of voluntary action or the limitations which political parties must accept in a democratic State. Discussion, he reiterates, is the vital process of the life of any organized community, and those actions which abolish discussion destroy also the common life.

There could not well be a better corrective to some of the thinking and actions that in the past decade have so impoverished public life and threatened the integrity of our institutions, scientific and technical as well as others. These wise words on the importance of timing, and Sir Ernest's appreciation of the value of the voluntary agencies in respect of variety and spontaneity, are accompanied by full appreciation of the need for organized political parties in order that parliamentary government may function. He sets these, however, in the context of the society which the State should serve, and he invokes his principles of liberty, of equality—as distinct from uniformity—and of fraternity, not as isolated themes, but to be reconciled with each other and set in the context of a dynamic view of justice, joining and fitting together principles as well as persons. Here may well be found that stimulus to the creative thought about institutions which should help us to ask and to answer those vital questions about power and responsibility—the extent of the activities of the State, the reconciliation of State activity with enterprise and initiative, the desirable extent of equality of income, property or opportunity and the means for achieving them with least detriment to spiritual values—to which Lord Radcliffe also directs us. Above all, it should set us to that task of the general understanding and revaluation of character, ideas and institutions, as well as of thinking, which alone can avert the greatest danger to which Lord Radcliffe points, namely, the danger of losing our character, which is often superb, and being left with our institutions, which are sometimes inept. At the least, both Sir Ernest Barker and Lord Radcliffe make manifest the richness and greatness of our heritage and the relevance to our present problems of the aphorisms of Mill, Bagehot, Matthew Arnold and many others.

MATHEMATICAL SOCIOLOGY?

Mathematical Biology of Social Behavior

By Nicolas Rashevsky. Pp. xii+256. (Chicago: University of Chicago Press; London: Cambridge University Press, 1951.) 37*s*. 6*d*. net.

IT is claimed on the dust jacket of this book that "[it] comes as a challenge to quantitative social science. In great part the quantitative work of the social scientists has been of a purely empirical nature: measurable quantities were measured, and their quantitative relations described. While this approach unquestionably aids our knowledge of social facts, it does not provide a way to discover which relations are expressive of deeper realities and which are merely incidental. Professor Rashevsky proceeds otherwise. He starts with postulates concerning the behaviour and interaction of individuals among themselves and with their environment. . . . The 'large' social phenomena (emergence of classes, urbanization, social change, revolution) then emerge as *derived* mathematical formulations. . . . Hence a new dimension is added to social research".

Prof. N. Rashevsky, who holds the chair of mathematical biology in the University of Chicago, has written extensively on mathematical biophysics and is the author of a mathematical theory explaining mathematically certain physiological phenomena of the central nervous system. I am not competent to judge the value and significance of that work; but Prof. Rashevsky evidently believes that his discoveries in that field have an important bearing on the social sciences. The present volume therefore starts with a summary of some of his results and proceeds in a series of chapters to consider some of the "'large' social phenomena". The general procedure is to lay down certain postulates about human behaviour or about the association between certain variables, and then to draw conclusions from these postulates using mathematical methods of argument.

It is difficult to see what is gained by this approach. Prof. Rashevsky almost appears to believe that the use of mathematical methods in argument is an end in itself, for in his foreword he pleads as a point in his own favour that "the author actually uses mathematics everywhere, and does not merely talk about using it". Now it need scarcely be said that, in certain circumstances, mathematics may be helpful in making argument exact and in being conducive to clarity of thought. But if the results of mathematical manipulations claim to be of use in the explanation of phenomena observed in the real world, they should be verifiable empirically. It is not enough to claim that certain relations could be verified ***in principle***, as is done on several occasions in this book, particularly as the problem of measurement in the social sciences presents serious difficulties of its own.

Two results may be quoted in illustration. On p. 69 it is stated "that if the distribution of any innate ability which may affect social status is uniform, the social status will be distributed non-uniformly, as long as either one or both of the following conditions hold: the social status affects the probability of social encounters, or the probability of an individual's travelling a certain social distance is a function of that distance". This appears to assume in the first instance that social status is in some way influenced by innate ability, an assumption which is not immediately obvious and which in many societies may well be false. Moreover, social status itself is not defined; it is merely stated that the units measuring it will be chosen so that the measure lies within a certain interval. Social distance is apparently the difference between two social statuses and seems by implication to be treated as a continuous variable. Nowhere does Prof. Rashevsky consider whether it is really possible to regard social status as a unidimensional variable—that appears to be regarded as self-evident; nor does he show any signs of being aware of the difficulties that have been encountered in attempting to make this term more precise. His conclusion, which undoubtedly is a logical consequence of his assumptions, is quite unverifiable, and his assumptions are far from being universally true.

Again, we read on p. 231 that "if in any country the inequality $U(\bar{x},a,\beta,\varphi_0) > H$ becomes satisfied and if the condition of political restrictions is satisfied, then a revolution will occur and will not be prevented by jailing either eleven or eleven hundred communists". Three of the parameters entering into the inequality are what Rashevsky calls "psychobiological" ones; and although he claims that their averages and distribution function can *in principle* be determined experimentally, he does not enlarge on this statement, which seems to be unfounded. Thus φ_0 is a threshold above which an individual will be willing to apply force to improve his social conditions. It is not clear how the average value of this threshold can be obtained, nor even in what units it is measured. For all its air of mathematical precision, when the conclusion is shorn of its mathematical trappings it seems to mean that, if in a society there are sufficiently many people who are willing to apply a sufficient degree of force to improve their social conditions, a revolution will occur. In this form, the conclusion is not very profound and scarcely novel.

I do not think it is unfair to quote these two examples as representative, and I believe that, even though some of the results are not inherently unreasonable, the usefulness of the mathematical treatment is strictly limited. Social theorists who wish to explain what Prof. Rashevsky calls the "'large' social phenomena" can attempt to do so without the elaborate mathematical apparatus adduced here. Empirical sociologists, on the other hand, will at present have to content themselves with measuring what is measurable, thus adding slowly and laboriously to our still woefully inadequate knowledge of social facts, and in trying to improve their techniques of measurement. This may be rather pedestrian in comparison with an explanation of the "deeper realities", but is likely to be more fruitful in the long run.

E. GREBENIK

TREATISE ON INDUSTRIAL CHEMISTRY

Traité de chimie industrielle

Par Paul Baud. Quatrième édition, revue et complétée. Tome 1: Grande industrie chimique; problème de l'eau. Pp. ix+865. 5000 francs. Tome 2: Métalloides et métaux. Pp. vii+1053. 5800 francs. Tome 3: Industries organiques. Pp. vii+1148. 6800 francs. (Paris: Masson et Cie., 1951.)

M. PAUL BAUD has undertaken a stupendous task in writing, apparently unaided by any collaboration, these three volumes—a task to be measured not solely by the number of pages of closely printed matter but also by the highly diversified nature of the contents.

In Vol. 1 the production of common salt, the mineral acids, ammonia and other products based on nitrogen, the alkalis, fertilizers—natural and synthetic—receive very full treatment, and this volume closes with a chapter on water, its treatment for industrial uses and the production of potable water. Attention is focused on the many sources of contamination which can affect river water through trade effluents. The menace of river pollution is now well appreciated in most countries of western Europe and the United States because of its bearing on the problem of ensuring pure water supplies for drinking purposes.

About half this volume is taken up by consideration of solid fuels—wood, torbanite, lignite and coal, and their various distillation products. Low-temperature carbonization of coal and similar materials, the hydrogenation of coal—here some account is given of the Imperial Chemical Industries process at Billingham—and the high-temperature carbonization of coal for the production of coke and gas are well described, as likewise the German processes for utilizing brown coal, and shale retorting as practised in Scotland, Estonia and France.

The petroleum industry is considered very fully, attention being directed to the geology and distribution of the oil-bearing strata, the character of the different classes of natural petroleum now being won, followed by an account of the treatment of the crude oil and the various methods of refining adapted to the composition and character of the oil produced, in various parts of the world. Adsorption, thermal cracking and its rationale, with a brief description of the principal methods of cracking employed and the products resulting therefrom, receive adequate, if not always very full, treatment. Modern methods of refining are outlined, although, in describing the solvent method of treating wax-base oils, there is no mention of the use of furfural, now well established in the United States and Great Britain. Much attention has been paid to describing the Fischer–Tropsch and similar processes. This section of the book gives a full account of recent work on polymerization, dehydrogenation, isomerization and alkylation, all of importance in the development of any chemical industry having as its raw material hydrocarbons of the petroleum industry. Petrol, kerosene, white oil, paraffin wax, petroleum jelly, asphalt and pitch are described with full attention to properties and uses.

Vol. 2 embraces in its scope hydrogen, the halogens, the liquefaction of gases; oxygen, sulphur, phosphorus and their compounds; and industries based on silicon and carbon. In the part devoted to metals, the metallurgy of iron and steel is the longest and fullest section in the whole work and is well done, and particular note is made of the many types of high-duty steel alloys. But less space is devoted to a consideration of precious metals, the rare-earth metals and radioactive elements. Throughout this volume not much space is afforded to description of the salts of the various metals.

As is inevitable in a work of such scope, some chapters are far too brief and sketchy. The French have long been pre-eminent in the manufacture of fine soaps and perfumes, and it might have been expected that these two industries would have merited more detailed treatment in Vol. 3 than has been accorded them. But the chapters dealing with the industries based on cellulose, starch and sugar are well done, as likewise those on ethyl alcohol and on the fats and waxes. Dyestuffs, plastics and the rubber industries—natural and synthetic—and pharmaceuticals receive adequate treatment. But in the account of penicillin, no mention is made of the pioneering work of Fleming—a surprising omission.

As this is a work on industrial chemistry, its value would be enhanced by including in the appropriate places some up-to-date statistics showing production of raw materials and chemical products of world-wide importance. For example, it would be of great value to have some indication of present-day production of coal, coke, petroleum, the principal fatty oils and oil seeds, rubber and rosin, together with statistics showing world production of iron ore, steel, the principal metals and such important basic chemicals as common salt, natural and synthetic nitrates, caustic soda and sulphuric acid. The theoretical considerations underlying manufacturing processes are generally well treated, due attention being paid to physicochemical, thermochemical and thermodynamic relations—in many instances ably illustrated by appropriate diagrams.

There is much in these important volumes that the reviewer has not examined in detail, but even a cursory glance would reveal one outstanding defect —and it is indeed a serious one—a complete absence of documentation: there is not even a brief bibliography at the end of any chapter. Throughout these three thousand pages, though the names of investigators and of those prominent in chemical research and technology are mentioned in their appropriate places and with dates in many instances, chapter by chapter, nowhere is there a reference to any of their published papers or patents. It is hoped that the author may remedy this defect in any future edition. The addition of an author index would also be welcome: it might serve, during its compilation, to ensure more care in the spelling of proper names: some place names and authors' names, notably British and some American ones, are mis-spelled.

The volumes are copiously illustrated by nearly six hundred clear line-drawings, amply and carefully lettered, which greatly facilitate the reading of the text. It is a pleasure to record how well the volumes are printed and bound; despite the fact that the price to British readers will seem very high, the amount of matter available is of great value, though there is little information about developments of date later than 1947. H. M. LANGTON

EMBRYOLOGY AND EVOLUTION

Embryos and Ancestors

By G. R. de Beer. (Monographs on Animal Biology.) Revised edition. Pp. xii+160. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 15s. net.

OTHER than standard texts, there are few biological books that have enjoyed so long and fruitful a life as Dr. G. R. de Beer's "Embryos and Ancestors". It first appeared in 1930 under the title of "Embryology and Evolution", and ten years later, in expanded form, under its new title. The present volume is thus the third embellishment of Dr. de Beer's theme—that variation in the order and rate of appearance of structures in successive ontogenies (heterochrony) can have a considerable influence on phylogeny. Some new passages have been added to the original fifteen chapters of the book, and a smaller number of old ones deleted. There are four new chapters, of which the first three (on the evolution of the cœlenterates, on embryology and taxonomy, and on embryology and homology) are based on articles which Dr. de Beer has already published. The fourth, on the germ layers, is new.

Dr. de Beer cautions his reader that "it is characteristic of a slogan that it tends to be accepted uncritically and to die hard". Hence, he writes, schoolboys still incorrectly learn that during its life-history an animal "climbs up its family tree". His argument with the recapitulationists is, however, on a narrow issue; and, in his view, there would be no reason to disagree with them if only they "would abandon the assertion that that which is repeated is always the adult condition". Aware, therefore, that small matters can become the cause of much misunderstanding, he points out in his preface that, when he writes that pædomorphosis (by which he means the appearance or retention, in the adult stage of the ontogeny of a 'descendant', of a structure characteristic of the young stage of an ancestral animal) "has resulted in this, that, or the other", he is merely saving time and space—and not implying the operation of some peculiar process. Schoolboys and their masters do not, however, always read prefaces. There is, therefore, a danger that the view that major evolutionary changes are due to the operation of something called pædomorphosis, a thesis which Dr. de Beer expounds, may, in spite of his warning, also become a new slogan.

Nevertheless, this book will continue to serve the very useful purpose of introducing the student to an argument that not only has a long history but also practically a vocabulary of its own. Dr. de Beer writes with imagination, and what he provides launches the reader into an interesting and exciting field of biological thought. S. ZUCKERMAN

ANALYSIS BY DIFFUSION

Microdiffusion Analysis and Volumetric Error

By Prof. Edward J. Conway. Third revised edition. Pp. xxiv+391. (London: Crosby Lockwood and Son, Ltd., 1950.) 25s. net.

CONWAY'S influence on analytical chemistry has been twofold; it is a matter of temperament which one considers the more important. To some, in whose breasts the craft spirit still flutters, Conway's applications of his own elegant concept of microtitration in the Conway unit with the Conway burette are a permanent source of pleasure, whether in using or even in just contemplating them. The methods of micro-diffusion analysis have had, and are still having, a widening application; the main, if not the only, limitation to their usefulness is that the analysand must take part in the production of a diffusible compound that can be absorbed by a reagent in a closed system and that the change resulting from this absorption can be accurately measured. Examples of reactive substances measured in the Conway diffusion unit are ammonia, from Kjeldahl digestion or urea hydrolysis, alcohol in blood, carbon dioxide from sugar fermentation or carbonates and bicarbonates in body fluids, and a number of other substances not easily to be separated or isolated in small amounts with the precision required especially in biochemical analysis.

This third edition of what has now become an essential part of most analysts' libraries includes a number of new applications, for estimating carbon monoxide, lactic, acetic or other volatile fatty acids and chloroform in blood, as well as a modification of Winnick's method for alcohol in blood.

In spite of the combined æsthetic and practical appeals of the method, it has still not replaced all others for certain analyses in which its advantages seem overwhelming. Thus its use for routine estimations of urea, especially in places where potent vegetable sources of urease are easily available, make all other procedures deserve to become obsolete: it is at least as precise and as accurate as the best of them and is much less demanding of labour, that is, of time and attention. Yet only recently a biochemical journal published still another version of a micromethod, involving distillation after alkaline hydrolysis: the author probably never even considered, let alone tried out, the micro-diffusion technique.

It is in the science rather than in the art of volumetric analysis that Conway has made his other outstanding contribution to the practice of analytical chemistry, namely, in the study of error in volumetric titration, to which the book owes the second part of its title. It is the subject of some 115 pages—nearly one-third of the whole. In the opening eight chapters of the book there are 85 pages devoted to a discussion of the apparatus and principles used in micro-diffusion analysis; there also the author has much of value to say on various sources of error that still may go unrecognized.

Discussions of methodology thus occupy a large share of Conway's book—large, anyhow, relative to the space that analysts would have thought appropriate, say, twenty-five years ago. The influence of Conway on almost every branch of analytical chemistry is a tribute to the fundamental importance of—and the unseverable connexion between—his theory and practice; there are few authors that can have produced such wide effects with so few words in so short a time. The book's 376 pages (excluding references and index) appear modest indeed when compared with the great tomes (at correspondingly great prices) under which the scientist's shelves to-day increasingly groan. Maybe this is in part because the book first appeared only thirteen years ago and has not yet had time to swell unduly. More likely, it seems to me, it is an expression of the rare combination of modesty, logicality and singleness of purpose that caused the author originally to say no more and no less than was absolutely necessary, and to stick to that admirable procedure in both subsequent editions.

The production, printing, paper and binding of the book, its freedom from errors, the clarity of illustrations and graphs, all show an anxiety on the publisher's part to co-operate in the continued success of one of the outstanding scientific monographs of our day.

A. L. BACHARACH

FACTS AND SPECULATIONS ABOUT PROTEINS

Chemistry and Biology of Proteins

By Prof. Felix Haurowitz. Pp. xii+374. (New York: Academic Press, Inc., 1950.) 5.50 dollars.

THE appearance of a new text-book dealing with proteins is bound to be an occasion of great interest to students, teachers and research workers. Each previous effort to deal with this large field has been unsatisfactory in one respect or several, although, taken together, the existing text-books gave a useful synopsis of the literature down to about 1940. Prof. F. Haurowitz's book was written with graduate students in mind. Such students require from a text-book a connected account of a subject, with key references to monographs and reviews. This they will find. For specialists, too, there is a real mine of references here that will be useful to them, even if they can expect nothing of a comprehensive nature; and there are not many serious errors of substance.

Prof. Haurowitz shows, as those who have followed his experimental work will expect, a real feeling for the obligate relationship of the physical and chemical properties of proteins with their biological functions; the plan of the book reflects this feeling in an original way. After a short section on practical methods for extracting and handling proteins, the evidence is set forth on which modern ideas on the structure of proteins are based. Here an enormous amount of painstaking work by organic chemists is treated very cursorily; there is no reference to the discovery and structural elucidation of the amino-acids, nor to the synthesis and natural occurrence of peptides. On the other hand, much of the physical chemistry is given at considerable length. This is a pity, because previous text-books have shown a similar bias. This factual material is then reconsidered in a discussion on internal structure of globular proteins. The occurrence, properties and biological functions of the various proteins are then surveyed under the following heads: albumins, globulins and other soluble proteins; insoluble proteins (scleroproteins); conjugated proteins; proteins with enzymatic properties; proteins with hormone activity; role of proteins in immunological reactions; and toxins (toxic proteins). A short section is interpolated on the combination of proteins with other substances.

The next section deals with the supply of amino-acids for protein biosynthesis. Here, perhaps, more evidence would have been acceptable that free amino-acids are actual physiological building-stones for proteins. One feels, also, that too much emphasis, for a broadly biological work of this character, has here been placed on animals, to the exclusion of other organisms that are much more adept at synthesizing amino-acids and consequently of greater interest from this point of view.

The final section, on protein synthesis, is, as Prof. Haurowitz says, speculative. He is doubtful whether nucleic acids can have sufficient specificity to be critically determinant in reproduction. Here many will be with him; cytologists have always been uncritical in claiming importance for those substances that are easy to demonstrate. Prof. Haurowitz suggests that nucleic acids act as stretching agents for holding proteins oriented in a two-dimensional arrangement. Identical two-dimensional protein structures are synthesized on such templates, and then undergo three-dimensional folding which is determined by a variety of other cellular constituents. I find it much harder to picture a 'positive' protein template laying down on itself an identical series of amino-acid residues, as Prof. Haurowitz postulates, than to imagine successive positive–negative–positive interaction of a number of complementary structures as in photography and newspaper printing. Here, at least, we have good analogies from the study of immunology, while in analogy to the positive–positive complementarity Prof. Haurowitz quotes only such events as the crystallization of pure amino-acids from solutions of mixed amino-acids, events which are unusual in the experience of many workers. My feeling is that, as usual in biology, much current speculation will turn out to be gross oversimplification. To treat the 'template' idea as axiomatic is to overrun existing knowledge; it is by no means yet proved that amino-acids are built directly into large protein-like molecules without passing through a complicated series of intermediate stages.

Taking it as a whole, students will find this book a stimulating supplement to previous text-books, and research workers in all the fields that are concerned with proteins will find in it new and interesting ideas and references.

R. L. M. SYNGE

MYXOMATOSIS IN AUSTRALIA

A STEP TOWARDS THE BIOLOGICAL CONTROL OF THE RABBIT

By F. N. RATCLIFFE, K. MYERS, B. V. FENNESSY and J. H. CALABY

Wildlife Survey Section, Commonwealth Scientific and Industrial Research Organization, Canberra, Australia

A REMARKABLY interesting epizootic of the virus disease, myxomatosis, has developed during the past fifteen months in the wild rabbit population of south-eastern Australia[1]. Resulting from the natural spread, on a vast scale, of a deliberately introduced infection, we believe it to be an event without precedent, and the first indication of a pathogen working in the population of a mammal pest in a way that holds promise of achieving a degree of biological control.

After its appearance among laboratory rabbits in South America at the end of last century, and its description by Sanarelli[2], myxomatosis attracted considerable attention from research workers in both the New and the Old World. The mystery of its origin and epidemiology was not cleared up until 1942, however, when Dr. H. B. Aragão[3] showed that the reservoir of the disease was the native Brazilian "rabbit" (a species of *Sylvilagus*), that in this natural host of the virus the infection ran a mild and rather prolonged course, and that it was transmitted in the field by mosquitoes.

It was Dr. Aragão[4] who first suggested that myxomatosis might help to control the rabbit (*Oryctolagus cuniculus*) in Australia. The New South Wales Department of Agriculture obtained virus from him in 1926; and the results of the ensuing laboratory studies were reported by White[5]. The investigations carried out under the ægis of the Council for Scientific and Industrial Research (now the Commonwealth Scientific and Industrial Research Organization) were initiated at Cambridge in 1933 by Sir Charles Martin[6], and continued in Australia by Dr. L. B. Bull and his associates. One of their first concerns was the confirmation of the already fairly clear indication that the virus would be safe to liberate in the field. The virus is, of course, highly pathogenic to both the wild and domesticated forms of the European rabbit, the infection being almost invariably lethal. In contrast, all the common domesticated animals, representatives of the native fauna (mostly marsupials) and the introduced hare (*Lepus europaeus*) were found[7] to be refractory.

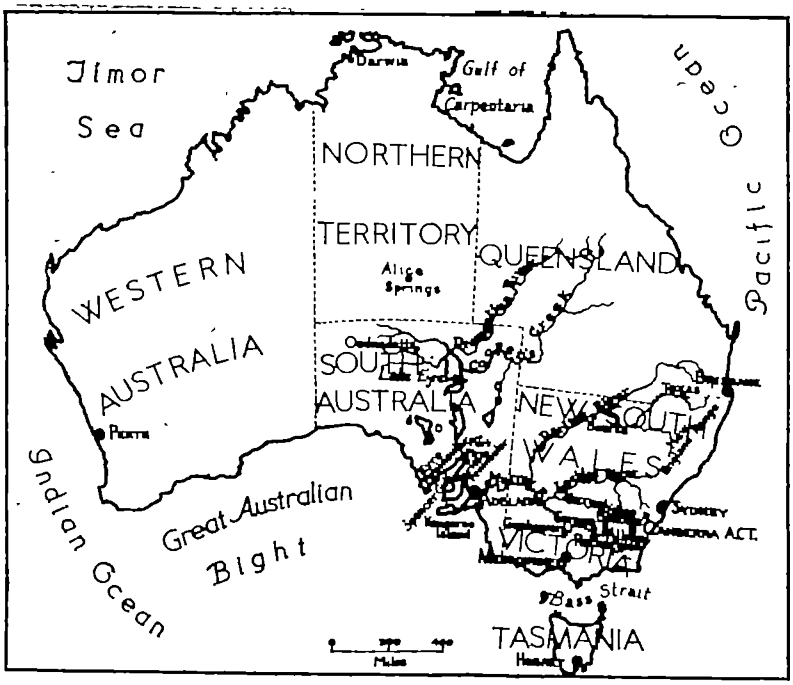
The results of the main Australian investigations have, unfortunately, only been published in summarized form[8]. At the time, it was not known that myxomatosis was essentially an insect-borne disease; but Aragão[9] had discovered that the cat flea (*Ctenocephalides felis*) could transmit the infection, and it was suspected by the Australian workers that insect vectors might assist the spread of myxomatosis in the field. Transmission by the insects considered most likely to be potential vectors in Australia (the stickfast flea, *Echidnophaga myrmecobii*, and mosquitoes) was therefore made the subject of special study in the laboratory. The flea and four species of mosquito were shown to be capable of acting as vectors. The investigations were concluded with a series of field trials, which had to be carried out in isolated localities in the semi-arid pastoral belt—fortunately the favoured habitat of *E. myrmecobii*. The results indicated that the flea transmitted myxomatosis under natural conditions, though its efficiency as a vector was limited by its restricted mobility. They also revealed the interesting fact that foxes, presumably by selective predation on lethargic infected rabbits, could prevent the establishment and spread of the disease. Although spread of the infection from one warren colony to another had occurred in an earlier experiment (carried out in a ninety-acre enclosure), there was no evidence of this taking place in any of the field trials in which the disease was established in unconfined rabbit populations.

A very serious rabbit situation developed in Australia in the years immediately following the War, and the newly established Wildlife Survey Section of the Commonwealth Scientific and Industrial Research Organization decided to re-examine the practical possibilities of myxomatosis. Following the lead of the earlier work, we planned first to carry out field trials in, among other places, areas where mosquitoes were likely to be prevalent. Between May and November 1950 seven liberations of the virus were made on five sites in the Murray Valley, four being in the Albury–Corowa area and one (the site of the earliest liberation) about a hundred miles downstream near the small town of Gunbower, Victoria.

The detail of the history of these trials is not relevant to subsequent events. All were disappointing in that, except in a portion of one of the experimental areas, the disease had no noticeable effect on the rabbit populations. Every site was kept under observation until the infection appeared to have died out, or at any rate had reached so low a level that weeks separated the sighting of sick individuals. By December, observations were concentrated on the two sites where the last (October and November) virus liberations had been made, one in the alpine foothills north-east of Albury, the other near Rutherglen in Victoria.

During the first week in December, myxomatosis flared up on the Balldale test site near Corowa, situated about seven miles north of the river in New South Wales. Almost at once reports began to come in of the appearance of the disease in other places, some on the Murray main stream, some on the northern tributaries. One of the earliest (December) outbreaks, disclosed in later surveys by a colleague, J. Brereton, was on the Darling River nearly four hundred miles from Corowa. There were other almost as surprising, but perhaps less well authenticated, early records.

The widespread dispersal of the virus, which with intensive local spread produced the remarkable epizootic that developed in the next two or three months, cannot be fully and satisfactorily explained, and probably never will be. One thing we believe to be beyond question: the spread of the disease was a reflexion of the movement of infected insects, almost certainly mosquitoes. The relative importance in the general mobility of the vector population of long and short flights, and perhaps the passive carriage on high-level winds, must remain a matter of conjecture. There is presumptive evidence, however, that long flights (or passive transport) were sometimes involved. Nothing else could very well explain the isolated outbreaks that occurred along the southern



margin of the epidemic area, for example, in the dry north-west of Victoria, and, in South Australia, at various points in the Adelaide Hills district, one on Yorke Peninsula, one near Port Pirie at the top of Spencer's Gulf, and one each on the east and west coasts of Eyre's Peninsula. These outbreaks were separated by distances of up to fifty miles. Even more isolated was the one discovered in September 1951 near Alice Springs in Central Australia.

An analysis of the December outbreak records points to the existence of an area, or areas, of disease activity, providing a source of infected insects, prior to the Balldale flare-up. We have failed to obtain direct evidence of such activity; and thus we can only record the possibility that one or more of our earlier and apparently abortive virus liberations may have contributed in some way to what might be termed the embryonic stage of the epizootic.

After the New Year, the epizootic gathered momentum rapidly. By mid-February 1951 myxomatosis had appeared in practically all parts of the huge area that was to be affected before the advent of winter, and the peak of the epizootic had passed in most districts. A feature of this phase that impressed observers was the speed with which the disease swept through local rabbit populations. When high mortalities (of the order of 90 per cent or better) occurred, they were as a rule achieved within 3–4 weeks of the date on which the infection was first noted in the population.

By the end of March a state of general quiescence had been reached; and on the results of our own and colleagues' surveys, and reports received through co-operating State Departments, it was possible to map the epizootic with reasonable accuracy. The most obvious feature of the resulting picture was the close association of the disease with rivers, creeks, irrigation systems and swamps, a clear indication of the paramount importance of water-breeding vectors. (We found that on Beadle's[16] vegetation map of the Western Division of New South Wales, the distribution of flood-zone plant associations delimited with remarkable accuracy the areas in which high rabbit mortalities had been achieved.) Outbreaks of the disease that had occurred in the 'dry' country had as a rule been transient and of low intensity.

The 'myxomatosis map' for the 1950–51 summer is completely dominated by the Murray–Darling system, along most branches of which the disease had spread. The distance, as the crow flies, between the Murray mouth in South Australia and the farthest point on the system reached by the epizootic (the Texas district on the Queensland – New South Wales border) is 860 miles. When one takes into account the coastal areas of New South Wales and Victoria (where State-organized campaigns of virus distribution succeeded in establishing the disease), the outbreaks in south-west Queensland and north-east South Australia extending around Lake Eyre to an area south of Oodnadatta, and the westward spread of the Eyre's Peninsula outbreak already referred to, we find myxomatosis dispersed over an area nearly a thousand miles from south to north, and some 1,100 miles from east to west. The collection of adequate and satisfactory data from so vast a territory presents very obvious difficulties; and the surveys which we, and colleagues in the Organization, have carried out over the greater part of it during the past year have of necessity often been rather superficial.

The marked differences in the performance of myxomatosis in different parts of the Murray–Darling system can be explained by the nature of the season. 1950 was a year of average or sub-average rainfall in Victoria; whereas the north-eastern half of New South Wales and most of Queensland received record-breaking precipitations, resulting in flooding on an almost unprecedented scale in the northern part of the epizootic area. The last flood rains occurred in November 1950; but their effects in the form of abundant surface water lingered for at least a couple of months.

Along the Murray main stream useful 'controlling' kills were confined to a very narrow strip, often only a few hundred yards wide (and usually corresponding closely to the *Eucalyptus camaldulensis* zone), except where irrigation complicated the picture. The same applied, in general along the Murrumbidgee. On the Lachlan, farther north, the high-mortality belt was wider, and we found river-fronting grazing properties tens of thousands of acres in area that had been swept virtually from fence to fence by the epizootic. It was, however, in the region lying east and north-east of Bourke on the Darling, with its dendritic development of tributary streams tapping the ranges of New England and south-eastern Queensland, that the most spectacular results were met with. Here the disease became emancipated, as it were, from the waterways as they appear on the map, and the epizootic developed areally. In places it was possible to drive for a day or more through country that had previously been swarming with rabbits and see only isolated survivors.

Two other features of this first phase of the epizootic deserve mention. In general, hills set a limit to the natural eastward spread, the disease rarely penetrating up the rivers beyond the points where they emerged on to the plains. Then there was evidence of the seasonal decrease in vector activity freezing, one might say, the epizootic at a stage when chance effects were still apparent. Areas of eminently favourable country, including substantial stretches of Murray frontage, were by-passed or only feebly invaded by the disease, the active advance of which was rather suddenly curtailed in certain places.

The results of the first, large-scale, impact of the myxoma virus on the wild rabbit population of Australia indicated that the disease would be of material assistance to man in his efforts to deal with the country's most serious animal pest, but also that it might have severe ecological limitations. Epizootics of myxomatosis could only be expected to occur where rabbits co-existed with the right types of insects in adequate abundance; while a usefully high mortality seemed likely to depend on vector densities that would be exceptional in many rabbit-infested areas. It was obvious that no sound assessment of the practical potentialities of myxomatosis could be made, nor could anyone decide how and to what extent the virus could be helped in action, until we knew a great deal more about the insects on which its performance depended.

When we started on our field experiments with myxomatosis, it was known that two species of fleas[6,7] and about half a dozen species of mosquitoes[8,9] could transmit the infection. Shortly after the epizootic got under way a colleague, R. Mykytowycz[11], demonstrated that the common and widely distributed *Culex annulirostris*, and also a species of *Simulium*, played a vector part on the Murray River flats; and later he showed, by laboratory experiments, that the rabbit louse (*Hæmodipsus ventricosus*) and a mite (*Cheletiella parasitivorax*) could act as vectors. The obvious conclusion (which was supported by the results of a laboratory study by Fenner, Day and Woodroofe[12]) was that transmission was mechanical, and that any blood-sucking arthropod that fed on more than one host individual during its lifetime was a potential myxomatosis vector. The relative efficiency of a vector species, and the importance of the role it would take in the epidemiology of the disease, would depend on its ecology and habits, including its mobility, the strength of its preference for the rabbit as a source of a blood meal, and the length of the period of its abundance.

It was clear that the scope of the vector field studies called for was extremely wide. Moreover, the Wildlife Survey Section was handicapped by the fact that practically no relevant information on the potential vector fauna was available—the mosquitoes had been well covered taxonomically, and that was virtually all that one could say.

During the 1950–51 summer it was possible to correlate the performance of myxomatosis in the Murray Valley with the distribution and activity of *Culex annulirostris*; and it seemed safe to conclude that this mosquito, which we found had a strong tendency to remain confined to timber cover close to its breeding-places, had been the principal vector in that area. Heavy rain in mid-February over part of the region produced dense populations of aedine mosquitoes, mainly *Aedes theobaldi* and *A. sagax*. (We planned to pay particular attention to these and other members of the genus that are opportunist exploiters of temporary surface water, and seemed to possess powers of dispersal above the ordinary; for they, among mosquitoes, offered the greatest hope of being able to spread myxomatosis widely and rapidly in country away from rivers and permanent swamps.) Some localized heightening of disease activity, with a spread beyond its earlier confines, pointed to transmission by these species. In view of our later observations, however, and the possibility that some more cryptic species might have been at work, the value of any deduction made at the time as to the vector efficiency of *Aedes theobaldi* and/or *sagax* is questionable.

The second (1951 winter) phase of the epizootic developed almost imperceptibly from the quiescence of autumn. Except in parts of southern Victoria, where a few sharp localized outbreaks occurred that might have been the result of winter mosquito activity (apparently a recognized feature of the coastal belt), this phase was typified by a widespread smouldering of the infection, much of it at such a low level of intensity that it almost escaped notice. In a few places an appreciable mortality was ultimately attained. There were very few winter sightings of sick rabbits in Queensland.

Though the reverse of spectacular, the behaviour of myxomatosis during the winter months was of great interest, and of equally great significance epidemiologically in that it provided a demonstration of the ability of the virus to persist, perhaps indefinitely, in the rabbit population.

Winter activity tended to follow one of two patterns and developed, to our surprise, almost exclusively in areas that had not been reached by the disease during the summer epizootic. (Thus surviving rabbit populations on river frontages, even if substantial, were rarely affected.) Some of the outbreaks were localized around swamps, hillside seepages, etc., suggesting that they had been initiated by wandering mosquitoes 'homing' to water. Others, more diffuse as a rule, showed a marked association with patches of tussock grasses and more particularly saffron thistles (*Carthamus lanatus*).

We were unable to obtain any indication of the identity of the vector or vectors responsible for winter transmission. Except for confirmation of the persistence and activity of mosquitoes (chiefly *Aedes camptorhynchus*) in parts of the Victorian coastal belt, our collections and observations in the outbreak areas were fruitless. We rather suspect that future investigations will reveal that the winter vectors of myxomatosis are ectoparasites.

The third (spring and 1951–52 summer) phase of the epizootic is still in progress at the time of writing. The abnormality of the season has made it, in one respect, disappointing. The lateness and partial failure of the monsoon left a substantial part of the epizootic area in the grip of a severe drought until close on the end of the summer, so we have not been able to obtain the information we had hoped for from Queensland and northern New South Wales.

In the extreme south, along the Victorian coast, the disease appeared on a number of offshore islands early in the spring, and some of the highest mortalities yet recorded were achieved. The species that seems most likely on our present knowledge to have played the main vector part in these outbreaks and in the early activity that developed in parts of coastal South Australia is *Aedes camptorhynchus*, the dominant mosquito of the region and a breeder by choice in brackish swamps.

As our surveys of mosquito breeding grounds had led us to expect, the season opened in the Murray Valley with a widespread emergence of *Aedes sagax* and *theobaldi*. The wave of abundance of these two species was not correlated with any marked general increase in disease activity, such as we were waiting for; and it may be said that a clear indication of the inefficiency of *A. sagax* and *A. theobaldi* as myxomatosis vectors in the field was one of the two most important things to come out of the season's observations—the other being the subsequent demonstration of the vector role of *Anopheles annulipes*.

The surroundings of a lake halfway between the Murray and Murrumbidgee Rivers, selected by one of us (K. M.) as a special study area, provided the stage for a sequence of events that miniatured the large-scale developments which occurred from late November on. The infection was artificially established and maintained in the dense local rabbit population throughout the period of abundance and dominance of Aedines, during which the situation remained static. A dramatic change occurred, however, when *Anopheles annulipes* (accompanied, in lesser numbers, by an unnamed but now well-known species of *Culex*) began to be prevalent; and a very active epizootic was soon under way.

It had been observed that *Aedes sagax* and *theobaldi* attacked stock (especially cattle) in marked preference to rabbits, which might well be the key to their inefficiency as vectors. The fact that *A. annulipes* was feeding on infected rabbits was established by inoculating suspensions of random-caught insects into healthy animals; and some interesting and significant observations were made on its habits. First, it was found to harbour during the daytime in rabbit warrens, as did the *Culex*. (Later, we obtained evidence in another locality that suggested penetration for a considerable distance underground.) Then it was noted that when the rabbits in one section of the area had been virtually exterminated, and the warrens fell into disuse, Anophelines appeared in increasing numbers in the burrows on a well-populated sandhill not far away, where the disease spread quickly. Similar behaviour was observed on other study areas.

The main summer epizootic developed over a vast, roughly crescent-shaped area, extending from the mouth of the Murray in South Australia eastward and then northward, inland of the Great Divide. It covered a substantial part of Victoria (including the south-west coast) and the southern two-thirds of the broad belt of undulating country lying between the mountains and the plains in New South Wales; while there were scattered outbreaks in the highland valleys along its eastern margin. In some regions, notably the Murray Valley, the epizootic built on, and extended, the effects of the previous summer's activity; but for the most part it developed in country that had not been reached by the disease during the first phase of its spread. It is difficult to estimate the relative importance of natural and artificial dissemination of the virus in preparing the way for the second summer epizootic. Winter and spring sightings of sick rabbits had been reported in many, if not most, parts of the affected area; but the State-sponsored inoculation campaigns must have resulted in a more thorough and widespread 'seeding' of the infection than would have been achieved naturally.

We believe that the principal vector in the 1951–52 summer epizootic was *Anopheles annulipes*. Its presence, as revealed by the discovery of adults in the warrens or local breeding, has been the one vector factor common to all those parts of the affected area in which we have been able to make adequate and timely observations. The intensity of disease activity has, in general, been correlated with the distribution of suitable *annulipes* breeding grounds—vegetated swamps, the weedy margins of slow-moving creeks, and waterholes formed by the drying up of hill streams. *A. annulipes* breeds with *Culex annulirostris* in the lagoons of the Murray flats, but it is a much more adaptable and far-ranging species than the latter. *C. annulirostris* probably played a vector part during the summer just passed, in the zone where it occurred; but the indications are that it was forestalled in time and outstripped in range by the Anopheline. Along the Murray, in 1951–52, where conditions made the comparison possible, a useful rabbit kill extended for almost as many miles back from the breeding waters as it did hundreds of yards during the previous summer's epizootic.

During this last phase of myxomatosis activity, high local mortalities were sometimes attained with the rapidity that characterized the 1950–51 summer epizootic; but in several areas the disease worked unobtrusively for two or three months to effect a comparable reduction in the rabbit population density.

In this perforce somewhat oversimplified account of the course of the myxomatosis epizootic from December 1950 to April 1952, it has been impossible to mention many interesting and often puzzling local outbreaks in which vectors other than mosquitoes seem to have been involved. (Discussion of these must await the full report of our field studies.) Our observations have admittedly been deficient in the outlying parts of the epizootic area, and on the eastern seaboard and highlands; and the picture we have presented above reflects this fact. Our main and most intensive investigations have been carried out in northern Victoria and southern New South Wales, where mosquitoes are undoubtedly the most important myxomatosis vectors. In this region our observations now cover the full cycle of the seasons, and the broad pattern of the ecology of the mosquito fauna is now becoming clear, with its succession of species attaining dominance as larval and adult habitats change in nature and extent. The important point is that the course of the epizootic in the Murray Valley can be very satisfactorily explained by the entomological picture that has been disclosed; and we feel that the information gained in this region will be broadly applicable to other areas in which the same species of mosquito occur.

It is clearly necessary to try to answer two questions that are inevitably being asked: What has been the overall effect of the epizootic to date on the rabbit population, and what long-term contribution to a solution of Australia's rabbit problem can we now expect from myxomatosis? Unfortunately, it is not possible to answer either of these questions confidently and satisfactorily.

We have considered most carefully ways and means of giving quantitative expression to our estimate of the efficacy of the epizootic, but have reluctantly abandoned it as impracticable. While we might hazard the guess—which would not be a 'blind' one—that an average overall reduction in the rabbit population of the order of 50 per cent had been achieved in those districts where the disease had been active, such a statement would be of little value without a quantitative definition and estimate of the areas in question, and this cannot be given. (Appreciation of the vastness of the region involved, and the impossibility of acquiring detailed knowledge of more than an insignificant fraction of it, should make this point self-evident.) A tentative estimate that myxomatosis had been active, that is, had caused an appreciable mortality, in one-fifth of the rabbit-infested country of Victoria, and one-tenth to one-eighth in New South Wales, might be very wide of the mark.

The epizootic, especially during the recent summer, was observed to work more effectively in heavily infested spots, thus "levelling out the peaks" of the variable regional population. One survey, of a sample area of a hundred square miles (64,000 acres) between the Murray and Murrumbidgee Rivers near Albury, revealed that while 20,000 acres were classed as heavily rabbit infested before the epizootic, only 640 acres remained so immediately after it. There are substantial tracts of land in south-eastern South Australia, Victoria, and New South Wales over which rabbit density has been reduced to a very low level, as little as, or even less than, one-tenth of the 1950 figure. Many landholders (perhaps to be numbered in thousands rather than hundreds) have had their personal rabbit problems virtually solved for the time being by myxomatosis; and immediate obvious benefit in the form of increased pasture growth and stock-carrying capacity has been reported from a number of districts.

Our observations indicate that there has been no substantial recovery of the hardest-hit rabbit populations as a result of breeding; but this may be explicable to some extent by the seasonal conditions. In parts of the epizootic area, for example, in Queensland, rabbits reappeared 4–8 weeks after disease activity had ceased, necessitating a reduction in the original, very high, estimate of regional mortality. We can offer no explanation of this temporary disappearance of most of the surviving population.

The epizootic took place at a time when rabbit numbers were generally high; and the area affected included much of Australia's most heavily infested country. With this in mind, and a knowledge of the statistics of the skin and carcase trade, we would say that the rabbits killed by myxomatosis in the period under review could be numbered in tens of millions (rather than in millions—certainly not in hundreds of millions). This estimate is given merely as a matter of general interest. It provides no indication of the 'control value' of the epizootic: no figure for a short-term mortality could do this.

One thing that makes it difficult to assess, on the basis of our analysis of the current epizootic, the importance of the part that myxomatosis will play in the control of the rabbit in Australia is the fact that the 1950–51 and 1951–52 seasons have both been somewhat abnormal. The former provided exceptionally favourable conditions for transmission in northern New South Wales and Queensland; and while the following summer was definitely unfavourable in the north, we are inclined to believe—though this conclusion needs to be checked by future observations—that dry, but not too dry, conditions in the south may have resulted in an unusually widespread prevalence of *Anopheles annulipes*. (For this vector to breed prolifically in the belt of undulating country that benefited most in the 1951–52 epizootic, the spring-fed creeks must be maintained in the right condition for a reasonable period of time, free from flushing on one hand and too great a degree of drying-out on the other.) Another fact that has to be taken into account is that the virus of myxomatosis is still in what might be termed the colonizing stage, and that the future should see it more widely—and at the same time more uniformly—distributed through the rabbit population, and hence better able to take advantage of local conditions favouring rapid transmission.

It is now reasonably certain that myxomatosis will be permanently established as an enzootic infection in the wild rabbit population of Australia. Its long-term overall effects will depend on something more than the summation in space and time of local mortalities. For example, the extent to which rabbits tend to concentrate in, and repopulate by immigration, well-watered country, and the effect of the disease on the development of normal breeding behaviour—two things about which we know next to nothing—may be of critical importance.

Apart from those just given, there is one very cogent reason for hesitating to estimate the future potentialities of myxomatosis. The possible effect of the natural process of mutual adjustment between parasite and host—the myxoma virus and the rabbit—cannot be ignored. The questions involved in this aspect of the myxomatosis problem lie in the specialized fields of the virologist and the geneticist; and they are receiving attention at the present time from Prof. Frank Fenner, of the Australian National University, and others. A close watch is being kept for evidence of changes in the virulence of the virus; and the likelihood of the susceptible rabbit population being replaced, within a period of years rather than decades or centuries, by one possessing a significant degree of resistance to the infection is being examined. Our observations suggest that recoveries in the field have been more frequent than the laboratory indication of virtually 100 per cent lethality would lead one to expect. If recovery is shown to have a genetic basis, the acquisition of some degree of resistance by the Australian wild rabbit population must be regarded as inevitable.

Too many people for individual mention—colleagues in the Organization, officers of State Departments, and landholders in the epizootic area—have helped us in our work. A detailed account of our investigations is being prepared for publication, in due course, as a C.S.I.R.O. Bulletin or in one of the Australian scientific journals. It remains only to record that the enthusiastic and persistent advocacy by a Melbourne specialist in virus diseases, Dame Jean Macnamara, was a material factor in the decision to initiate experiments with myxomatosis in 1933, and to resume field studies in 1950.

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ALCHEMICAL ILLUSTRATIONS*

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THE ideas and practice of alchemy are to-day so foreign to the mind of the age that, contrary to our custom, we have felt the need to preface the exhibition of "A Hundred Alchemical Books" by some thoughts about the nature of the art and the character of the illustrations that purport to explain it.

How, then, does alchemy differ from chemistry? On what grounds do we call this book alchemical and that book chemical? As in all distinctions of real things, the line of demarcation is not quite sharp; but the principal difference of alchemy and chemistry is to be found in their purpose. Alchemy was a practical art purporting to make gold from base metals or to perform some other master-work of perfecting some created thing in its own nature: chemistry is a science directed to the investigation of the nature and properties of all kinds of matter. One is a work to be done: the other understanding to be gained.

There are other, though less-essential, differences. Alchemy looked backward. There were great men in the past who had done the work, known the secret and concealed it in their books: the task of the alchemist was to penetrate these cryptic repositories of knowledge, a task of reflexion rather than experiment. Chemistry looks forward, honouring the men of the past, but seeking knowledge never yet in the mind of man, through the process of reasoning and experiment.

Alchemy was a lonely work, to be done and completed by a single worker for his own ends. Were the work once done, the laboratory and its manual tasks would be abandoned and the alchemist would lead a new enlightened life, of which we are told but little.

Chemistry is cumulative, the work of hundreds of thousands, sharing and transmitting the knowledge they gain: it is never-ending, for every research opens the way to more. In all this may be seen the resemblance of alchemy to an art, rather than a science.

Yet alchemy was one of the contributors to chemistry. The very idea of chemistry was unknown until the early sixteenth century. There was a theory of matter, there was alchemy, there was a diversity of practical arts which we should to-day regard as within the field of the chemist, but that all these should be treated as kindred subjects concerned with the transformation of matter was the idea of Paracelsus, who sought to group them together under the name of 'alchemy'. For him alchemy was the way the stomach concocted the food and the doctor prepared the medicine; the smelting of iron was alchemy, as was also what was done by the baker, the cook and even the stoker. In all this we see the ideas of separating the pure from the impure, and the transforming of matter. Nearly a century later Andreas Libavius took the name Alchemia for what we would call the first general text-book of chemistry. Thus in the seventeenth century alchemy had at first the double meaning of the gold-maker's art and the science of chemistry: only gradually was 'Alchemia' reserved to the first and 'Chemia' to the second. Gradually through this century the subjects became separated. Alchemy became ever less chemical and more symbolic, while chemistry relinquished, first its interest, then its belief in the alchemical process.

Alchemy gave more to chemistry than a name. The first chemical laboratory, perhaps the first laboratory, was an alchemical laboratory, and practically all the apparatus used before the period of the study of gases was invented by alchemists, and can be seen illustrated in the books on alchemy.

The ideas of alchemy as expressed in the alchemical works are a tangled web of notions drawn from science, philosophy and religion, but in them it is possible to see a certain broad pattern. That metals were to be transmuted into gold was an idea made acceptable by its promise of release from poverty: that metals could be so transmuted was made credible by the Aristotelian theory of matter, which allowed the possibility of every element being changed to every other. The works of Aristotle also put forward the theory that all metals were compounded in the earth of two exhalations, a moist and a smoky. What Nature could do in the rocks, the alchemist might hope to bring about in his vessels. The idea of these exhalations was akin to that of the all-pervading *pneuma*, spirit or world-soul, which in the Hermetic and Stoic philosophies was at once the material of all things and agent of all changes, operated by the ever-changing influence of the heavenly bodies.

This was the fundamental idea of alchemy: to gather the active spirit (the philosopher's mercury) and make it operate the change of one metal into another. But how to gather it? Somewhere, before about A.D. 100, the process of distillation was invented and provided the means of apparently drawing the volatile active part of bodies—the spirit—out of a great many natural bodies, and in the liquors so obtained were the hopes of the alchemists. From the first century to the eighteenth century they distilled and worked with every volatile body that they knew. Mercury and sulphur were favourites, and known before the accepted date of the beginning of Western alchemy: arsenic trioxide, ammonia, alcohol, the mineral acids were probably alchemical discoveries. Dew was a magical material for them, the direct product of the heavens, and they also distilled every conceivable plant and animal material in search of their 'philosophers' mercury'.

At some time, perhaps during the period of study of alchemy by the Arabs, there arose the idea of a 'medicine' or 'powder', a small dose of which, added to a molten base metal, would transform it into gold. This idea rapidly gained strength in medieval Europe, and a standard process for transmutation was gradually evolved. The philosopher's mercury was to be gathered in some fashion—and this was the secret most sedulously guarded. It was to be set in a sealed vessel with a little gold and silver, often made more mysterious and unattainable by being described as 'our' gold and 'our' silver, and subjected to gentle heat. The gold and silver were depicted as dissolving and 'marrying', forming a double being that died and was corrupted to a black mass, then was revivified, passing through glorious colours to the white stone that transmuted to silver, and by a repetition of the process to the red stone that transmuted to gold, and indeed would perfect every creature in its own kind. It is of little use to try to find a modern chemical equivalent of these supposed changes, for no chemicals to which the alchemists had access could have produced any of these effects. We may be sure that they did seal up various things and subject them to heat, causing changes which they observed. The more fruitful way of looking at the problem is to ask why they *expected* such changes and why they symbolized them as they did.

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* Substance of an address given at the opening of an Exhibition of Alchemical Books at the Science Museum, London (*Nature*, 169, 1041, June 21, 1952).

What did a chemical change mean to the men of the Middle Ages ? It was essentially a generation of a new body and was thought of in terms appropriate to generation. There must be a marriage : gold must generate the seed of gold ; so gold, symbolized by the sun, must marry silver, symbolized by the moon. The character of the body produced in any generation was determined by the heavenly influences : the mercury of the philosophers was the physical condensation of those influences. The product was a seed · the seed must die in the ground, as the scripture tells, and from its black and putrefied remains springs the new being, the glorious body of the stone. The myth, if we may so call it, combines the two most potent ideas of man—the idea of marriage and the idea of resurrection and renewal. Is it surprising that the process fired the imagination of the artists ?

But why understand a physical process in such terms ? Man always desires to understand what he sees or conceives under some visual analogy. We have the atomic theory and conceive our chemical changes as the rebuilding of a structure. With a continuous theory of matter no such picture could be formed, and the human and spiritually oriented philosophers of the Middle Ages saw the chemical change under the analogy of the life of man. Man is generated and born, he dies to sin and is born again, he dies physically and is resurrected ; these transformations were what the medieval alchemist expected to see and supposed that he saw in chemical change.

Moreover, by a very characteristic reversal, the alchemists first constructed their view of chemical change on the analogy of man, and in later ages viewed man under the analogy of chemical change. Thus in the later years of alchemy, certain writers, notably Jacob Boehme, symbolized the mystical progress of man by the process of alchemy. The result is a fascinating equilibrium of chemical and mystical ideas, displaying a thousand shifting aspects to be exploited by the writer and his artists. Thus we expect and find in alchemical illustration not only figures of laboratory apparatus, but also every symbol that has a bearing on the ideas of transformation, marriage, generation, death, growth and renewal.

Both representational and symbolic illustrations are found in the alchemical manuscripts written in Greek, the texts in which were mostly written between A.D. 100 and 700. The Arabic manuscripts are, to my somewhat slender knowledge, but scantily illustrated, but certainly contain both elements. The elaborate series of symbolic pictures occurred in medieval manuscripts before they found their way into printed books, and it would seem that the more elaborate did not appear before the fifteenth century.

Printed alchemical books appear from the beginning of the sixteenth century. The first are distillation books, chiefly pharmaceutical, with alchemy taking a minor part. Some of these, such as the magnificent works of Brunschwyg, are illustrated by very fine woodcuts of a representational character. Symbolic alchemical works illustrated by woodcuts appeared at intervals throughout the sixteenth century ; but it is in the early seventeenth century that these attain their zenith. About the year 1625 there issued from the presses of De Bry and of Lucas Jennis a stream of finely printed alchemical books, adorned with finely conceived and beautifully executed engravings. As the seventeenth century proceeded, alchemy and chemistry achieved their separation. Chemical works with good plain pictures of apparatus abounded, though these commonly retained some alchemical matter and often a symbolic frontispiece. By the close of the seventeenth century, alchemical illustrations had disappeared from chemical textbooks, while the alchemical works, still produced in great numbers, displayed more of the influence of Rosicrucianism, the Cabala and Free-masonry.

We learn a not insignificant part of the history of chemistry by studying alchemy and its pictures ; also our eyes are opened to a view of the world other than the modern scientific—a view which we may regard as a horrifying example of unscientific thinking or as the addition of a poetic and human quality to our outlook on material things. Moreover, we learn something about man, his eternal problems and aspirations, and the manner in which desires and ideology affect his very observations, let alone the interpretation he gives them. We cannot view the scientific way of thinking truly except by a contrast with non-scientific thinking about the same subjects, a contrast for which the Exhibition now at the Science Museum provides material.

OBITUARIES

Sir James Irvine, K.B.E., F.R.S.

With the death, on June 12, of Sir James Irvine, principal and vice-chancellor of the University of St. Andrews, this ancient seat of learning mourns the loss of an illustrious son whose career at St. Andrews extended over a period of fifty-seven years in the successive capacities of student, lecturer, professor and principal. His services to the University, particularly during his tenure of the highest office for more than thirty years, can truthfully be described as inestimable. In that period he changed the face of the University and brought prosperity and high prestige to a time-honoured academic foundation which in his early days was marked by poverty, a paucity of students, and a lack of proper buildings and equipment for the teaching of science.

James Colquhoun Irvine was born at Glasgow on May 9, 1877. After his early education at Allan Glen's School and the Royal Technical College, Glasgow, he entered the University of St. Andrews in 1895 and graduated B.Sc. in 1898. Here he became a brilliant disciple of Thomas Purdie, professor of chemistry, who always remained in his memory. It was during an ensuing period of study under Wislicenus at Leipzig that he conceived the novel idea of applying Purdie's method of methylation to the investigation of the molecular structure of carbohydrates. From this idea sprang the famous carbohydrate research school at St. Andrews, which he developed with so much energy and success during his tenure of the chair of chemistry from Purdie's retirement in 1909 until his own appointment, in 1921, as principal of the University. These pioneer researches led to later work of the first importance in carbohydrate chemistry, much of which was carried out at Birmingham under the direction of Sir Norman

Haworth, who had formerly held an appointment in Irvine's department at St. Andrews.

Irvine's researches were interrupted by the First World War; at the same time, however, the experience of the St. Andrews school was brought into full play in meeting the demands of the British, French and Russians for such indispensable carbohydrates as dulcitol, inulin, fructose, maltose and mannitol. There followed the complete preparation, in quantity, of novocain. These tasks, together with difficult and dangerous work on mustard gas, hindered the expansion of the fundamental researches on carbohydrates. This work was once more getting into stride when Irvine became principal in 1921.

Soon afterwards, the scientific contributions that the new principal had made to the national war effort were recognized by the bestowal upon him of a knighthood; he had been elected a Fellow of the Royal Society in 1918. A portrait of this fourth professor of chemistry in the United College of St. Salvator and St. Leonard, painted some years later (1933) by Oswald Birley, hangs in the Senatus Room of the University of St. Andrews beside that of his teacher, predecessor and friend, Thomas Purdie. A distinguished pupil of Irvine has said that "he was an inspiring teacher, and his lectures were models of clearness. More than that, they inspired in the students a love of chemistry and gave them a desire to take part in the discoveries that Irvine himself was initiating".

Irvine had shown his administrative ability as professor and also as dean of the faculty of science; but few suspected his latent powers until the broad opportunities of the principalship unfolded themselves before him. A profound love for his University and an unfailing faith in its high destiny enabled him to combine the vision of the seer with the drive of the man of action, and to use tradition as the handmaid of progress and development. He cherished the picturesque attributes of his ancient University, and drew into practical service the pageantry and colour of the 'College of the Scarlet Gown'.

During his long term of office, the development of the residential system with its attached Harkness entrance scholarships, together with the institution of regents, played a leading part in widening the field of recruitment of students and in raising their number to an economic level. New chairs were founded judiciously in every faculty of the University. Among many notable advances in the part of the University situated in Dundee were the growth of the schools of medicine and engineering, and the expansion of the chemistry department of University College. These rapid developments, combined with the geographical handicaps imposed upon a University with centres situated upon both sides of the Tay, have inevitably given rise to growing pains. Such difficulties, however great, must be overcome in the interests of the University as a whole. In Irvine's own words (1950): "Let it be an encouragement and an inspiration to each one of us to reflect that, within the history of our own times, obstacles so formidable have been met and surmounted. . . . I have faith, unconquered and unconquerable, in the beloved University of St. Andrews".

Irvine's interests and activities, although concentrated upon the University of St. Andrews, spread outwards in ever-widening circles as the years went by. He took a great and practical interest in preserving the historical character of the city of St. Andrews. In the outside world he rendered invaluable services to the Scottish Universities Entrance Board, the Scottish Education Department, the Forest Products Research Board, the Carnegie Trust, the Pilgrim Trust, the Commonwealth Fund, and many other organizations. He was a member of the Prime Minister's Committee on the Training of Biologists (1931), chairman of the Viceroy's Committee on the Indian Institute of Science (1936), of the Committee on Higher Education in the West Indies (1944), and of the Inter-University Committee on Higher Education in the Colonies (1946–51). He was a prime mover in founding the University College of the West Indies, where the scarlet student-gown of St. Andrews may be seen in a new environment. He was also an ever-welcome visitor to the United States; on various occasions he delivered special lectures and addresses in that country, as at Williamstown (1926), Princeton (1929), and Yale (1931).

He was awarded many honours: in 1948 he became K.B.E.; in chemistry he was Longstaff medallist of the Chemical Society, Davy medallist of the Royal Society, Willard Gibbs medallist of the American Chemical Society, and Elliott Cresson medallist of the Franklin Institute of Pennsylvania. He received numerous honorary degrees from the universities of the homeland, the British Commonwealth and the United States.

He married in 1905 Mabel Violet, younger daughter of Mr. John Williams, of Dunmurry, Co. Antrim. Throughout his subsequent career he owed much to his wife's unfailing devotion and counsel, and to the background of a happy home-life. He had three children, including one son, Nigel, who died on active service during the Second World War.

It is difficult to do justice in words to Irvine's many-sided character and personality. A richly stored mind found expression in speech that could attain a rare eloquence and charm, whether at great moments or upon more intimate occasions. He was an admirable chairman, ever ready to lighten the routine of business with an apt anecdote or reminiscence. He had a remarkable power of reducing a complicated problem to its essentials; at the same time, he had an equally remarkable memory for detail of all kinds. Persuasive in argument, tenacious of opinions carefully formed, he showed the greatest determination and forcefulness in carrying through a cherished project passionately held. He was a stern disciplinarian when occasion demanded; yet his students knew instinctively that in him they had a firm friend. He had, indeed, a discerning sympathy with youth; he would sometimes pause at his desk in the midst of the weightiest matters in order to write a charming letter of encouragement or of congratulation to a youthful acquaintance: from him came many kindnesses of which the world knew nothing. In himself he preserved throughout his life a certain element of spiritual boyishness, allied closely with his eager zest for new knowledge and fresh experiences.

Two years ago Irvine wrote: "I find myself—a twentieth-century scientist—gazing across the chasm of five hundred years to a strange remote world and am conscious afresh of a feeling which never entirely escapes me that, as the thirty-fourth Principal of St. Salvator's College, I am privileged to share in the inheritance of a solemn trust; at once I am brought face to face with the question if the duty committed to that long succession of Masters has been faithfully discharged". The answer is clear to us and will be even clearer to posterity.

JOHN READ

Dr. F. W. Carter, F.R.S.

FREDERICK WILLIAM CARTER, who was until his retirement in 1946 consulting engineer with the British Thomson-Houston Co., died on May 29 at the age of eighty-one.

A man of impressive appearance and of great mathematical ability, he was nevertheless very modest, gentle and reserved. He was almost the first mathematician of high order to apply his abilities exclusively to the practical problems arising during the development of a great engineering industry, and in so doing he built up a world-wide reputation. Behind the mathematics which he used so successfully, he had a clear physical conception of the problems with which he dealt, and in many cases saw the form of the answer before the problem had been worked out in detail. So his analyses included those factors which would give a satisfactory engineering answer, and ignored factors not significant. All his writings are models of lucidity and of the economical use of words, and are a pleasure to read in spite of the difficulty of the subject-matter.

Dr. Carter's choice of subjects was very wide; the first paper published in 1898 dealt with "The Smashing Point of a Glow Lamp"; the last, published in 1944, with "Anti-aircraft Gunnery". Between these two extremes he ranged over many problems both electrical and mechanical. His papers were published in the *Proceedings* of the Royal Society, of the Cambridge Philosophical Society, of the Institution of Civil Engineers, of the Institution of Electrical Engineers, and in many of the important technical journals.

By electrical engineers Dr. Carter will always be remembered for his investigations on magnetic fields in electrical machines. In this work he used the Schwarz–Christoffel transformation, described by J. J. Thomson in "Recent Researches in Electricity and Magnetism". He was the first to apply it to a practical engineering problem, and after a lapse of time, while engineers acquired an understanding of this weapon of attack, others followed his lead. Three papers on this subject were published: one in 1900, another in 1901, and the third, where he collected the results of his researches, in 1926. 'Carter's coefficients', quoted in text-books on electrical design, and used by electrical machine designers, were derived from this work and perpetuate his name.

In mechanical engineering Dr. Carter completed one investigation of outstanding originality. It relates to the running characteristics of locomotives with special reference to their stability of operation. He began, in a paper on "The Electric Locomotive" in 1916, by propounding a theory to explain unstable running of locomotives, introduced and defined a new quantity which he called 'creepage', and made a qualitative analysis for conditions of stability. The subject was developed in two further papers in 1926 and 1928, based on Love's work on elasticity and Routh's work on criteria of stability. A final paper, in 1930, applied these earlier results to analyse the characteristics of certain locomotives involved in derailment accidents. Using models, he gave a practical demonstration of the correctness of his theory at a conversazione of the Institution of Civil Engineers in 1929.

One further sample of his work is worthy of special mention. In 1922 he published a book on "Railway Electric Traction". Thirty years later it is still accepted as the standard book dealing with the fundamentals of the subject.

In addition to his published works, comprising thirty-four papers and one book, he carried out many investigations for the British Thomson-Houston Co., which he served during almost the whole of his professional career. One of these, in 1939, was the determination of stresses in a large forging during heating and cooling and in the transition from the plastic to the elastic state.

He entered St. John's College, Cambridge, in 1892, taking his degree in 1895, when he was placed eighth wrangler. In 1926 he was awarded the Sc.D. degree at Cambridge, the first in the Faculty of Engineering for more than fifteen years, so far as can be traced in the records. He was elected a Fellow of the Royal Society in 1932. He became a full member of the Institution of Civil Engineers in 1919, and was awarded the George Stephenson Medal and the Telford Premium by the Institution. He became a full member of the Institution of Electrical Engineers in 1912, and was awarded a premium for his work on magnetic fields.

He married in 1908 Edith, youngest daughter of James Cramp, of Coventry, and sister of Prof. William Cramp. He is survived by his widow and three sons, the eldest of whom is Prof. G. W. Carter, professor of electrical engineering in the University of Leeds. K. R. HOPKIRK

NEWS and VIEWS

Meteorology in the University of London: Sir David Brunt, F.R.S.

SIR DAVID BRUNT is retiring in September from the chair of meteorology in the University of London and the post of head of the Department of Meteorology in the Imperial College of Science and Technology, London, to which he was appointed in 1934. The Department, the only one devoted to the subject in a British university, has greatly flourished under Sir David's direction and has attracted students from all parts of the world. The research work carried out there has much increased, and the teaching staff, apart from Sir David, has grown to five and includes two University readers. After a brilliant career in mathematics at the Universities of Wales and Cambridge, Sir David became a meteorologist in 1916 as an officer of the Meteorological Section, Royal Engineers. On demobilization in 1919 he was appointed Superintendent of Army Services in the Meteorological Office. This post involved control of meteorological work in chemical warfare and ballistics; thus the study of turbulence and diffusion in the lowest layers of the atmosphere, to which he has since contributed so much, became a major official responsibility. During his service in the Meteorological Office he also made important contributions to the study of periodicity in European weather, to radiation, and to the dynamics of depressions and anticyclones. Shortly after his appointment in 1934 to the Imperial College, he produced his monumental book "Physical and Dynamical Meteorology", in which was given the first full, connected and critical account of those aspects of meteorology. Since then, while not neglecting radiation and turbulence, Sir David has worked mainly on cloud formation by eddy motion, on the effect of atmospheric conditions on human comfort and capacity for work, on the meteorology of soaring flight, and on the application of meteorology to agriculture and industry.

Sir David was elected to the Royal Society in 1939, received a Royal Medal in 1944 for his contributions to meteorology, and became a secretary in 1948 and a vice-president in 1949. He was knighted in 1949. He has also been president of the Royal Meteorological Society, from which he received the Buchan Prize in 1933 and Symons Medal in 1947, and of the Physical Society. He has been a member of the Meteorological Research Committee of the Air Ministry from its formation in 1942. Sir David's work has covered a very wide range and has been characterized by strict adherence to physical reality leading to results of immediate practical value. He has had great influence in stimulating among meteorologists the application of exact physical reasoning to meteorological problems, and among Service officers and engineers in revealing to them the help which meteorology can give in the solution of their problems.

Mr. P. A. Sheppard

MR. P. A. SHEPPARD, University reader in meteorology in the Imperial College, is to succeed Sir David Brunt. He was born in 1907, graduated in 1927 at the University of Bristol with first-class honours in physics and joined the staff of the Meteorological Office in 1929 as resident observer at Kew Observatory. His early work lay largely in the field of atmospheric electricity, and he took part in the British Polar Year expedition of 1932–33 to Fort Rae in Arctic Canada as the specialist in that subject. Shortly after returning from Canada he joined the Meteorological Section of the Chemical Defence Establishment, Porton, and there investigated problems of wind structure in the layers of atmosphere just above the ground. To aid in this work he designed a sensitive cup anemometer of very low inertia and with a linear calibration curve which would record in a wind as light as 40 ft./min. His paper on the aerodynamic drag of the earth's surface published in the *Proceedings of the Royal Society* in 1947 describes a study of the wind drag on a torsionally mounted plate, and establishes the validity of von Kármán's constant in the terrestrial boundary layer. Mr. Sheppard left the Meteorological Office in 1939 to go to the Imperial College; but the outbreak of war brought him back to the Office in the autumn of the same year. His major work during the War was the technical direction of the work of the British *radiosonde* observing stations and of the meteorological reconnaissance aircraft. He also collaborated with Dr. Sverre Petterssen and others at the Central Forecast Office in devising techniques for the use of upper air information in forecasting and in work on the determination of the large-scale vertical currents from the structure of horizontal wind flow. He returned to the Imperial College in 1945 and since then has been actively interested in atmospheric turbulence and cloud structure. He has served the Royal Meteorological Society as a secretary and as editor of its *Quarterly Journal*. Another valuable service to his fellow meteorologists has been the writing of the surveys of progress in meteorology published in *Science Progress*. He is a member of the Air Ministry Meteorological Research Committee, chairman of its Instruments Sub-Committee, and an original member of the Civil Aviation Research Committee.

Zoology at Reading: Prof. C. H. O'Donoghue

PROF. CHARLES H. O'DONOGHUE will retire from the chair of zoology in the University of Reading in September. Prof. O'Donoghue graduated with first-class honours in zoology and physiology in the University of London (King's College) in 1908, and was appointed assistant to the professor of zoology at University College, London. In 1912 he was awarded the degree of D.Sc. and a Beit Memorial Fellowship for Medical Research. He spent six months in Freiburg in 1913 under Prof. Doflein, the protozoologist, and in the following year was elected a Fellow of University College, London. In 1918 he went to Canada as professor of zoology in the University of Manitoba, and was elected a Fellow of the Royal Society of Canada in 1922. He was a member of the Biological Board of Canada. He spent five summers at the Pacific Coast Biological Station at Nanaimo, Vancouver Island, and acted as director during 1923. In 1926 he was visiting professor for two terms at Stanford University, California. He also took part in two biological expeditions to Jasper Park in the Rocky Mountains.

Returning to Great Britain in 1927, Dr. O'Donoghue served under the late Prof. J. H. Ashworth as senior lecturer, later reader, in zoology, in the University of Edinburgh. He was elected a Fellow of the Royal Society of Edinburgh and served on the Council of the Royal Physical Society, becoming its president in 1933. In 1932 he was awarded the Neill Prize and Gold Medal of the Royal Society of Edinburgh for his published researches in the *Transactions* of that Society, and in 1937 was made biological secretary. He became professor of zoology in the University of Reading in September 1939, on the retirement of Prof. F. J. Cole. A new department was being built, and though the outbreak of war caused a cessation of work, building was later resumed and the Department was opened in December 1942. Prof. O'Donoghue was dean of the Faculty of Science during 1944–48, and deputy vice-chancellor of the University during 1950–52. His researches have covered a wide field in zoology. Under Prof. J. P. Hill at University College, he worked on the mammary gland and corpus luteum of marsupials. He has published numerous papers on the vascular system of fishes, amphibians and reptiles; his study of the blood-vascular system of the tuatara, *Sphenodon punctatus*, has become a classic. His later work is taxonomic, and he is an authority on the Nudibranchiate Mollusca and the Bryozoa, having described collections from many parts of the world. Prof. O'Donoghue is a member of the Council of the Zoological Society of London.

Prof. A. Graham

PROF. ALASTAIR GRAHAM has been elected to succeed Prof. O'Donoghue. He graduated with first-class honours in zoology in the University of Edinburgh in 1929, and then took up an appointment as lecturer in zoology in the University of Sheffield, leaving in 1933 to become reader in zoology at Birkbeck College, University of London, under the late Prof. H. G. Jackson. In 1943 he was made head of the Department and professor of zoology in 1947. Prof. Graham is a governor of Birkbeck College. As chairman of the Board of Studies in Zoology, and of the Board of Examiners in Zoology, he has given valuable services to the University of London. Prof. Graham can look back with pride on his achievement in keeping the Department at Birkbeck College going during the War. In 1940 the Zoology Department was destroyed by bombing, though most of the teaching specimens were salvaged. The Department was set up in the condemned building of Graystoke, and when further bombing restricted its activities, classes were carried on in a cellar, and on several occasions in the open air. He preserved the continuity of the Department through every calamity and raised it to its present high status—a department consisting almost exclusively of part-time students, of whom one-fifth are engaged in research for higher degrees. Prof. Graham's research work has been on the functional anatomy of molluscs, with special reference to feeding habits, and the structure and function of the alimentary canal. He has recently been awarded the Keith Prize of the Royal Society of Edinburgh for the period 1949–51.

Sir George Thomson, F.R.S.

A FAREWELL dinner was held on June 24 at the Imperial College in honour of Sir George Thomson, who after twenty-two years as head of the physics department is leaving on August 1 to become Master of Corpus Christi College, Cambridge. The Rector of the Imperial College, Sir Roderic Hill, presided at the dinner, and the Governing Body was represented by its chairman, Viscount Falmouth. Nearly one hundred people attended, representative of present and past members of the staff and the research students; and on their behalf a presentation was made to Sir George of a watchmaker's lathe, this being suitable for the miniature model-making which is Prof. Thomson's favourite hobby. Prof. W. D. Wright, speaking on behalf of the departmental staff, recalled that it was twenty-five years ago, almost to the day, that a letter had appeared in *Nature* entitled "Diffraction of Cathode Rays by a Thin Film"; that letter marked the beginning of Sir George's well-known researches in electron diffraction. Since 1930, at Imperial College, Sir George had directed notable researches in electron diffraction, nuclear physics and cosmic rays, and he had also given valuable service to the Government as a scientific adviser, both during and after the War. Many personal tributes were paid to Sir George by subsequent speakers, who included the Rector, Viscount Falmouth, Prof. H. Dingle and Prof. H. Levy. They emphasized in particular Sir George's penetrating scientific insight, and the deep respect which he had won from all associated with him. Just as his distinguished father, Sir Joseph Thomson, had been affectionately known in his laboratory as "J.J.", so Sir George was always referred to as "G.P.". He takes with him to Cambridge the good wishes of all at the Imperial College of Science and Technology.

Peter Artedi: A Contemporary of Linnæus

THE yearbook for 1950–51 of the Swedish Linné-Sällskapets (Årg. 33–34, 1950–51; pp. iii+188; Uppsala: Almquist and Wiksell, 1951) includes two contributions by Dr. O. Walde and Prof. H. Engel dealing with the biography of Peter Artedi, the friend and fellow student of Linnæus. Artedi was accidentally drowned in 1735 before completing his important work on ichthyology on which his reputation rests. His manuscripts were saved by Linnæus, who edited and published the "Ichthyologia" in 1738, adding a brief biography of the author. Very little is known of Artedi personally, and only one of his letters has survived. Dr. Walde has discovered, in the Royal Library at Stockholm, a small volume dealing with alchemy, botany and agriculture, which was recognized as the work of Artedi. Prof. Engel relates that Artedi lived a lonely life, going to the tavern from 3 to 9 p.m., working from 9 p.m. to 3 a.m., and sleeping from 3 a.m. to noon. This article comments on some of the legal documents connected with Artedi's death and on the personal effects left by him.

A New Anti-malarial Drug: 'Daraprim'

'DARAPRIM', a new anti-malarial drug, has recently been put on the market by Messrs. Burroughs Wellcome and Co. It is 2 : 4-diamino-5-*p*-chlorophenyl-6-ethylpyrimidine, and is the most active of a large series of substituted 2 : 4-diamino-pyrimidines which have been synthesized and tested against laboratory infections of *Plasmodium gallinaceum* in chicks and *P. berghei* in mice (Falco *et al.*, *Brit. J. Pharmacol.*, 6, 185; 1951). Trials in quiescent cases of human malaria have been reported by Archibald (*Brit. Med. J.*, ii, 821; 1951), and in overt infections of *P. falciparum* and *P. malariæ* in man by McGregor and Smith (*Brit. Med. J.*, i, 730; 1952). They concluded that it has a powerful action on schizonts and a lesser and inconstant action on trophozoites. It acted as swiftly in non-immunes as in others possessing partial immunity; it is tasteless and no toxic reactions of any kind were observed. The drug is an effective suppressant of *P. falciparum* infections, even in doses as small as 5 mgm. daily. Goodwin (*Brit. Med. J.*, i, 732; 1952) took this amount daily for one year. During this time he deliberately exposed himself to the bites of four mosquitoes later shown to be infected with *P. falciparum*. He also slept without a mosquito net for six months while in West Africa. Throughout this period there were no toxic manifestations, and no abnormalities were produced in the blood, bone marrow, or urine. To each of a group of volunteers in England, 50 mgm. of the drug was given twice weekly for three months. Again there were no demonstrable effects on the urine, blood, or erythrocyte sedimentation-rate. Although it is too early to assess the value of this drug, and there are as yet no reports on its action in *P. vivax* infections, its schizonticidal efficiency in *P. falciparum* and *P. malariæ* infections appears to lie between that of paludrine and chloroquine, and it may prove to be a highly efficient malarial suppressant.

Geophysical Research Aboard the R.R.S. *Discovery II*

THE R.R.S. *Discovery II* has recently set sail on the second of its current series of research cruises (see *Nature*, May 24, p. 866), and is expected to be at sea for five to six weeks, going about six hundred miles seaward. The main purpose of the cruise is to elucidate the structure of the sea-bed by taking samples of the top strata and by seismic refraction 'shooting' at short and long ranges. The geological sampling will be carried out both in shallow and deep water by means of specially designed coring-tubes, capable of taking cores of the bottom sediment up to 30 ft. in depth. The seismic work will consist of refraction 'shooting' at short range (that is, up to a distance of twenty miles) in shallow water, and at long range (up to a hundred miles) on the edge of the continental slope, on the slope itself, and in oceanic depths; for the short-range work only one ship, equipped with sono-radio buoys, is required, but two ships are necessary for the long-range observations, and H.M.S. *Scott* will assist in this. Other work to be attempted during the cruise will include heat-flow measurements through the bed of the ocean, at a depth of about 2,000 fathoms (12,000 ft.), these observations being made with a specially devised probe which is driven 10 ft. into the bottom sediment and allowed to remain there for a specified time. The purpose of these measurements is to determine whether the heat-flow through a continent originates from radioactivity of the continental-type rocks which are, to a large extent, absent under the oceans. Wave recordings, with the special ship-borne wave recorder fitted for the previous cruise, will be continued as a normal routine, and special attention will be given to echo-sounding, more particularly on the continental slope and in deep water. The ship is operated by the National Institute of Oceanography; during this voyage it will work in co-operation with the Department of Geodesy and Geophysics, University of Cambridge, and the following men of science, among others, will be on board during parts of the cruise: Dr. E. C. Bullard, director of the National Physical Laboratory, Teddington; Prof. W. B. R. King, Department of Geology, and Dr. M. N. Hill and Mr. B. C. Browne, of the Department of Geodesy and Geophysics, Cambridge; and Dr. H. F. P. Herdman, of the National Institute of Oceanography.

Indian Jute Mills Association Research Institute

The formal opening by the Prime Minister of India, Mr. Nehru, on January 2, of the new buildings of the Indian Jute Mills Association Research Institute in Calcutta completes the second part of the Association's post-war scheme of co-operative development, which had already been partly realized by the inauguration of a training college for apprentices (*Nature*, 167, 1058; 1951). The Research Institute, founded in 1936 to provide the type of service usually given by research associations in Britain, was originally housed in central Calcutta, under conditions which left a good deal to be desired by the scientific workers on the staff, and in 1945 it was decided to provide more adequate accommodation in the suburbs. The new premises provide modern amenities for a staff of 85, including 45 qualified scientific men or technologists. Laboratories for physics (4), chemistry (4), biological sciences (3), X-ray crystallography, optics, testing, dyeing, finishing, and chemical technology; administrative offices, a lecture room, library, canteen, stores and workshop occupy most of the 50,000 sq. ft. of floor space in the two-storied air-conditioned building. Among the laboratory services are included laid-on compressed air and vacuum. In order to prepare the staff for making the best use of the new laboratories, senior members of the various sections (physics, chemistry, testing, etc.) have been sent to Great Britain during the past five or six years for training in research; the majority of these went to the University of Leeds and qualified for higher degrees in textile science or technology. The director of research of the Institute is Dr. W. G. Macmillan.

Safety of Domestic Electrical Installations

A paper entitled "Domestic Electrical Installations—Some Safety Aspects" was presented on January 24 to the Utilization Section of the Institution of Electrical Engineers by Mr. H. W. Swann, who is senior electrical inspector of the Factory Department of the Ministry of Labour and National Service. The paper gives a comprehensive review of the hazards commonly arising from electrical faults in domestic consumers' installations, and of the methods of protection employed and their limitations. Statistics relating to fires attributed to electrical causes are quoted for the period 1946–50, and attention is directed to the question of the effect of the age of electrical installations on fire risk. Detailed consideration is given to the effect of leakage current on fire and shock risks. It is emphasized that with the increased load now taken by many domestic consumers, normal fuse-settings are often sufficiently high to prevent operation with the maximum fault current that can flow in the 'earth loop', and in this connexion the advantages and limitations of earth-leakage protection devices are discussed. It is suggested that changes in method may become necessary and that the inspection and test of protective devices may prove to be more practicable than large-scale inspection and test of installations and appliances already in use. The paper constitutes a much-needed reminder that means of protection of consumers' installations which were satisfactory at an earlier stage, when electrical energy was utilized on a much smaller scale than to-day, are being rendered ineffective by the sheer growth of the consumption of electricity.

Training of Designers for the Printing Industry

A report on the training of designers for the printing industry prepared by a subcommittee of the London and Home Counties Regional Advisory Council, Higher Technological Education (Report No. 11; obtainable from the Council, Tavistock House South, London, W.C.1; pp. 20; 1952; 1*s*.), recommends that training courses for this purpose should be held in, or in association with, colleges containing reasonably comprehensive departments of printing. In allocating practical accommodation to classes in colleges, it is recommended that priority should be given to classes for apprentices under the indenture approved by the Joint Industrial Council. Local education authorities are recommended to ensure that their scholarship arrangements permit financial assistance for specially selected apprentices attending part-time classes to transfer to full-time attendance for a course in design, and trade associations should consider offering a limited number of scholarships to enable gifted apprentices to take full-time courses in design. Practical instruction in trade processes—to the limited extent recommended—should, for students in a four-year full-time design course, be confined to the last two years. The report is manifestly concerned solely with technical education—the basic principles by which the training of designers for the printing industry should be guided in the future. Nowhere in the report is there any concern with higher technological education, and on the evidence of this report the title itself of this Regional Advisory Council is one more illustration of the sad confusion between technical and higher technological education which appears to be impeding the formulation of an adequate and effective policy for either.

Society of Cosmetic Chemists of Great Britain: Officers for 1952–53

THE fourth annual general meeting of the Society of Cosmetic Chemists of Great Britain, which is an associate of the Society of Cosmetic Chemists (U.S.A.), was held at the St. Bride Foundation Institute, London, on June 13. Mr. W. A. Poucher was elected as the Society's first honorary member. The following officers and members of council were elected for the year 1952–53: *Chairman*, Dr. R. H. Marriott; *Vice-Chairman*, F. V. Wells; *Honorary Secretary*, F. Hulley (24 Bride Lane, Fleet Street, London, E.C.4); *Honorary Treasurer*, E. Polan; *Members of Council*, A. B. Bell, Dr. H. W. Hibbott, H. Holmes, Dr. A. W. Middleton and J. Pickthall.

University of Glasgow: Appointments

THE following appointments have been made in the University of Glasgow: G. Hoyle (zoology) and R. B. Morrison (bacteriology) to lectureships; F. C. Flack (physics) and M. F. Grundon and H. J. E. Lowenthal (organic chemistry) to Imperial Chemical Industries, Ltd., research fellowships. P. A. Sweet, lecturer in astronomy, has resigned from the University on his appointment as assistant director of the London University Observatory and lecturer in astronomy at University College, London. The following promotions have been made in the University: Dr. G. Pontecorvo (genetics) and Dr. H. S. D. Garven (histology) to readerships; J. R. Atkinson (natural philosophy), J. A. Downes and Dr. J. D. Robertson (zoology), and Dr. J. D. Loudon and Dr. J. C. Speakman (chemistry) to senior lectureships; B. W. Ribbons (botany) and I. C. Smith (zoology) to lectureships.

National Research Council of Canada Scholarships for 1952–53

THE National Research Council of Canada has recently announced the award of its scholarships for the academic year 1952–53. The details are as follows, with the corresponding figures for last year in brackets. Altogether 241 (215) awards have been made, totalling 227,900 (192,100) dollars in value, of which 65 (72) are bursaries, worth 600 dollars each, 114 (92) are studentships worth 900 dollars, and 39 (30) are fellowships at 1,200 dollars each. Eighteen special scholarships at 1,500 dollars have been awarded for study in universities or institutions abroad, to be held as follows: four at Cambridge, three at Oxford, two each at Cornell, London and North Carolina, and one each at Chicago, California, Edinburgh, Illinois and at the John Innes Horticultural Institution, Hertford. Five overseas post-doctorate fellowships at 2,500 dollars have been granted for work at universities, two being at Oxford, and one each at Cambridge, Dublin and London.

Institution of Electrical Engineers: Premium Awards

THE Institution of Electrical Engineers has made the following award of premiums for papers read or accepted for publication during the session 1951–52. *Institution Premium:* D. P. Sayers, Dr. J. S. Forrest and F. J. Lane. *Kelvin Premium:* Dr. A. L. Cullen. *John Hopkinson Premium:* T. H. Flowers. *Non-Section Premiums:* Dr. H. L. Haslegrave (Llewellyn B. Atkinson Premium); J. E. Flood and Dr. J. R. Tillman; and P. R. Howard. *Measurements Section Premiums:* Prof. F. C. Williams, Dr. T. Kilburn, G. E. Thomas and Dr. A. A. Robinson (Silvanus Thompson Premium); D. F. Lawden (Mather Premium); and J. V. L. Parry. *Radio Section Premiums:* Dr. R. N. Bracewell, Dr. K. G. Budden, J. A. Ratcliffe, Dr. T. W. Straker and Dr. K. Weekes (Duddell Premium); T. Kilvington, F. J. M. Laver and H. Stanesby (Ambrose Fleming Premium); Dr. A. T. Starr, T. H. Walker, H. Grayson, T. S. McLeod, R. A. G. Dunkley, G. Dawson, G. King, L. Lewin, J. Lipinski and J. B. Setchfield; D. J. Harris and R. J. Ryan; J. T. Machowicz; N. G. Meadows; P. N. Prior and A. J. Walsh.

Announcements

THE Albert Medal of the Royal Society of Arts has been awarded to Sir Frank Whittle for the development of the continuous-combustion gas turbine and jet propulsion.

SIR ALAN DRURY is to retire on September 30 from the post of director of the Lister Institute of Preventive Medicine. He will be succeeded by Dr. A. A. Miles, deputy director of the National Institute for Medical Research and director of its Department of Biological Standards.

THE following announcements have been made by the University of London: Mr. J. R. Napier, lecturer in anatomy at St. Thomas's Hospital Medical School, has been appointed to the University readership in anatomy tenable at the Royal Free Hospital School of Medicine from October 1. E. C. Cherry, an appointed teacher at the Imperial College of Science and Technology, has been awarded the degree of D.Sc.(Eng.).

THE title and status of reader in zoology in the University of Leeds has been conferred upon Dr. T. Kerr, senior lecturer in the Department of Zoology. Dr. R. Brown, reader in plant physiology in the Department of Botany, has been granted leave of absence by the University for the period October 1, 1952–September 30, 1953, to enable him to accept an invitation to an appointment as visiting professor at Cornell University.

AN 'open-day' will take place at the National Fruit and Cider Institute, Research Station, Long Ashton, Bristol, on July 15, when the annual meeting of members will be held and the laboratories, cider house, etc., inspected.

A SYMPOSIUM on New Research Techniques in Physics will be held at Rio de Janeiro, São José dos Campos and São Paulo, Brazil, during July 15–29, under the joint sponsorship of the Brazilian Academy of Sciences, the National Research Council of Brazil and the Centre of Scientific Cooperation for Latin America (Unesco). Further information can be obtained from Prof. J. Leite Lopes, Centro Brasileiro de Pesquisas Fisicas, Avenida Pasteur 250, Rio de Janeiro.

PROF. J. Z. YOUNG asks that attention be directed to a mistake in the description of the support provided for research on the flying spot microscope described in *Nature* of June 7, p. 963. This work has been made possible by grants from the Nuffield Foundation and from the Research and Development Division of the British Steel Founders' Association which, in connexion with its industrial health research, is particularly concerned with the high-speed counting of dust particles.

IDENTIFICATION OF ORGANIC COMPOUNDS FROM INFRA-RED SPECTRA

By Dr. A. E. MARTIN

Sir Howard Grubb, Parsons and Co., Newcastle upon Tyne

MOST organic chemists are well aware of the assistance to be gained from a study of the infra-red spectra of their compounds; but probably many do not realize just how valuable infra-red data could be if a complete catalogue of spectra were available. At the present time several organizations, mainly in the United States, are collecting spectra from many laboratories; but the total number has scarcely reached 3,000 and is only increasing at the rate of about 1,000 per annum, so that clearly progress will have to be greatly accelerated if anything like a complete catalogue is to become available in an acceptable period of time.

It is the purpose of this article to point out that with a little concerted effort fairly complete data of the spectra of organic compounds could be recorded in a reasonable period, notwithstanding that a recent estimate[1] puts the total number at about 500,000, of which some 70,000 can be regarded as the more common; this is approximately the number listed in the "Dictionary of Organic Compounds" by Heilbron and Bunbury. A simple method of recording and filing spectral data is also described.

Experimental Procedure

A modern double-beam spectrometer with rock-salt prism is capable of recording a spectrum from 2 μ to 15 μ with sufficient resolution for our needs in twenty minutes or less, so that allowing for repeat runs and the fact that for the present purpose it is only proposed to use the spectral region 7–15 μ, it should be possible to record the spectrum of a given substance in one hour, say eight compounds per day, 40 per week and 2,000 per annum. With ten instruments fully occupied in this way, 20,000 spectra could be recorded in a year, 100,000 in five years and 500,000 in twenty-five years.

It is desirable that the work should be carried out with a comparatively small number of instruments, since then greater control could be exercised over the accuracy and uniformity of the results. It would be a simple matter to arrange for each instrument to record the spectrum of a given test substance once a week, so that a high standard of accuracy could be maintained.

The question of how a spectrum shall be obtained from a given substance is one of considerable difficulty, and careful consideration is desirable before deciding on a rigid procedure. Comparatively few compounds exist as liquids or solids of low melting point; these can be examined in the liquid state. Many substances can be examined in solution at low concentration (about 1 per cent) in carbon disulphide or carbon tetrachloride, while intractable materials of high melting point and low solubility can be examined as a suspension in 'Nujol' (medicinal paraffin). The 'Nujol' technique is extremely useful, as practically any organic substance, liquid or solid, can be examined in this way. Inevitably a fair proportion of the incident radiation is scattered and lost, but in general this need not exceed 30 per cent. 'Nujol' has strong absorption at 1,450 and 1,375 cm.$^{-1}$, but this latter band causes little interference below 1,350 cm.$^{-1}$ and no other important absorption is encountered in the region used. In the case of rare substances or very small samples, an adequate spectrum can be obtained with as little as 30 μgm. by using a simple reflecting microscope in conjunction with the spectrometer.

The supply of pure substances from laboratories all over the world would be necessary for the successful operation of the scheme; but this should present no great difficulty since the quantity required is very small.

For the purpose of recording the salient features of a spectrum, the positions of the six most intense bands will in general be sufficient. The concentration of the substance under investigation and the length of cell would be chosen so that the strongest band reaches about 80 per cent absorption. Bands will then be quite sharp and the relative intensity of the stronger ones readily determined. If the weaker of the six bands correspond to less than about 20 per cent absorption, it will be desirable to record further spectra at a higher concentration or with a longer length of cell.

The region of the spectrum to be utilized is limited to 650 to 1,350 cm.$^{-1}$ (the so-called fingerprint region), since the frequency-range 1,350–5,000 cm.$^{-1}$ is unsuitable for our present purpose. The 3-μ region is valuable in elucidating details of structure, particularly with regard to OH, NH, NH$_2$, CH, CH$_2$ and CH$_3$ groups, but to make full use of this region greater resolution is required than is normally obtainable with a rocksalt prism. Between 2,800 and 1,800 cm.$^{-1}$ few important frequencies occur, so that this interval is not of great interest. At about 1,750 cm.$^{-1}$ the important carbonyl frequency occurs; but this is easily recognized and need not be included in the present scheme. Similarly, the CH$_2$ and CH$_3$ deformation frequencies at about 1,450 cm.$^{-1}$ are quite easily picked out, together with the CH$_3$ deformation frequency (symmetrical) at 1,375 cm.$^{-1}$; they can also be excluded.

Filing System

In order to classify bands between 650 and 1,350 cm.$^{-1}$, this region is conveniently divided into seventy 10 cm.$^{-1}$ intervals. In most cases sharp bands are available which can be measured to $\pm$ 2 cm.$^{-1}$. Band positions can be entered on punched cards, and machines are available for sorting the cards in various ways, to find a match for the spectrum of the unknown. However, even with only 100,000 cards, the sorting process would be lengthy and the necessary machines are quite costly, so that it would scarcely be possible for many laboratories to install such equipment. Fortunately, a much simpler and cheaper alternative is available. By dividing the spectra into 70 × 70 groups, each spectrum can be classified according to the positions of the strongest two bands. If the interval 650–659 cm.$^{-1}$ is called number 1, 660–669 cm.$^{-1}$ number 2, and so on to 1,340–1,350 cm.$^{-1}$, which would be designated number 70, a spectrum with its most intense band at 1,071 and its next strongest at 796 cm.$^{-1}$, for example, would be classified as 43/15.

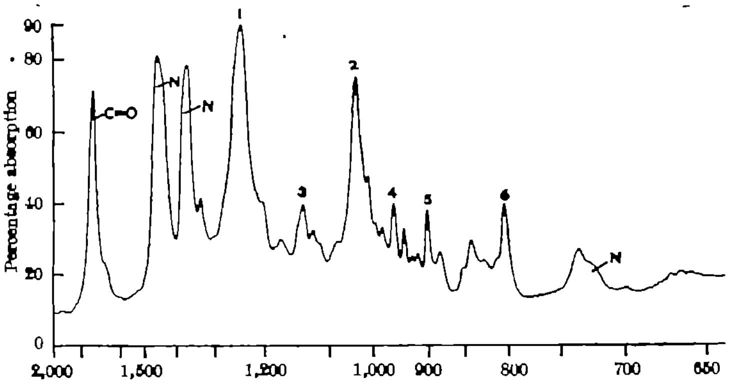

Fig. 1

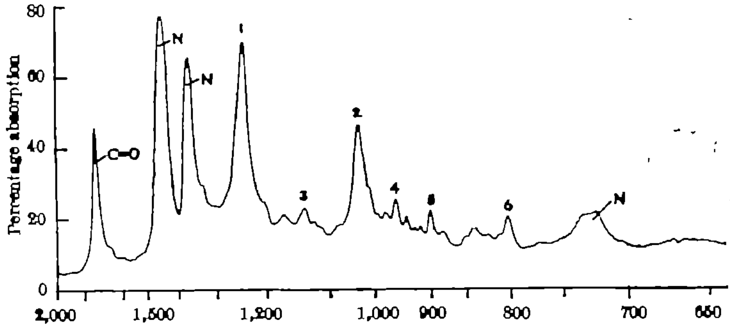

Fig. 2

Absorption spectra of cholesteryl acetate at two different 'concentrations' in 'Nujol'; length of cell, 0 01 mm.; recording time from 1,350 to 650 cm.$^{-1}$ 7 min. *N* denotes absorption due to 'Nujol'

Cards would be filed in order from 1/1, 1/2, etc., to 70/1, 70/2 . . . 70/70, and since there would be 4,900 classification numbers there would be, for a total of 500,000 compounds, something of the order of a hundred substances for each classification number.

With the details of thirty or forty compounds printed on a single card, three cards would, on an average, suffice for each classification number, and some 15,000 cards would be required for 500,000 substances. Quite a modest set of filing cabinets would house this number of cards. Once the strongest two bands have been measured in the spectrum of an unknown, it is the work of seconds to pick out the cards containing details of all compounds with their strongest two bands in the same 10 cm.$^{-1}$ intervals as in the unknown. At the worst, it is then only necessary to look through the spectral details of some hundred compounds to find one which matches the unknown.

It might be thought that the scheme as outlined so far, while possible for relatively simple substances, would fail with larger and more complicated molecules, on account of the large number of conflicting absorption bands. That this difficulty is not so serious in practice is shown by the spectrum of cholesteryl acetate, a fairly large and complex molecule (see Figs. 1 and 2). The two key bands in order of intensity are 1 and 2, while the others in order of diminishing frequency are numbered 3, 4, 5 and 6. The classification number is therefore 60/40 and the entry on the card would read:

No of spectrum	Molecular formula	Absorption frequencies
——	$C_{29}H_{48}O_2$	1,244, 1,040, 1,138, 960, 902, 804

It is not necessary to classify the four weaker bands in order of intensity, except that when the absorption is less than 20 per cent (the strongest band corresponding to 80 per cent absorption) the frequency can conveniently be underlined to direct attention to the fact. By placing the four weaker bands in order of frequency, it becomes a simple matter, when identifying an unknown substance, to select the most distinctive band of the four and to look rapidly through all the compounds with the proper classification number to pick out any with a band in the same position. A detailed check with the remaining bands would, of course, be made to establish the identity of the two substances. If an impurity frequency happened to be chosen as the most distinctive of the four weaker bands, probably only one or two spectra at the most would have a band in the same position, and a check with the remaining bands would cause these compounds to be rejected. It would then be wise to repeat the search using another of the four bands.

In some cases it may even be possible to identify major impurities. After the bands of the main constituent have been eliminated by reference to the spectrum of the pure material, the remaining bands can be dealt with in the usual way, the strongest two being used to obtain the classification number.

Each spectrum of a known substance is given a number for the purpose of identification, and a separate index will, of course, be necessary, so that the full chemical description of the compound and classification number corresponding to a given spectrum number can be found. Conversely, if the spectral details corresponding to a known chemical compound are required, it is only necessary to look up the substance by name, obtain the classification number and then look through the cards with this number to find the desired spectral data. If more detailed information is required, recourse must be had to the original spectrum, which can easily be located once its number is known.

Some Difficulties

R298

Of course, various difficulties could arise in putting the project into operation. For example, the spectrum of an unknown might have among its strongest bands several of similar intensity, so that the selection of the most intense and next strongest for determining the classification number is not straightforward. As an illustration, if a substance has nearly equally intense bands at frequencies denoted by *X*, *Y* and *Z*, it will be necessary to use the combinations *XY*, *YX*, *XZ*, *ZX*, *YZ* and *ZY* to exhaust all possibilities.

Yet another difficulty might be caused by one or both of the key bands of a pure substance being broad or of complex structure, so that the frequencies could not be measured with the usual accuracy. In this case the unsatisfactory bands would be discarded for the purpose of obtaining the classification number.

This should not cause much difficulty in practice, since a similar situation would arise when the same substance occurred in an unknown, and as soon as the unsatisfactory nature of one or more of the stronger bands was realized, less intense but better defined bands would be employed. Unsatisfactory bands not used for obtaining the classification number could be bracketed to distinguish them. As already mentioned, when the intensity of bands is less than 20 per cent, the frequencies would be underlined. If a band is superimposed on a continuous background of absorption, allowance should be made for this when assessing the band intensity. The simplest procedure is to take the height of a peak above any part of the immediate background free from distinct bands. Both the above-mentioned points are illustrated by the following imaginary entry:

No. of spectrum	Molecular formula	Absorption frequencies
—	—	(930), (1,387), 803, 997, 1,284, 705

The classification number would now be 16/35.

If the spectrum of the unknown has its strongest bands at, say, 801 cm.$^{-1}$ and 1,239 cm.$^{-1}$, besides looking up the cards corresponding to 800–809 and 1,230–1,239, that is, 16/59, it would be wise to look up also the classifications 15/60, 16/60 and 15/59, in case small errors have occurred in the measurement of these key frequencies.

Costs

The cost of the project as outlined, apart from the initial cost of equipment and cost of the organic substances themselves, might be expected to amount to possibly £20,000 per annum to keep ten spectrometers working continuously and to cover the cost of printing data cards. This works out at about £1 per spectrum produced for an annual output of 20,000 spectra. The cards of data could be brought up to date and redistributed as necessary each year. Each laboratory possessing an infra-red spectrometer and wishing to make use of the service would take the complete set of data cards issued each year. It is reasonable to suppose that in time at least a hundred laboratories in Great Britain alone would require the cards of data, so that an annual charge of £200 would make the project self-supporting. After only one or two years, the value of the service should be well worth this sum.

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[1] Lord McGowan, "One Hundred Years of Chemistry" (Royal Institute of Chemistry: Lectures, Monographs and Reports 1951, No. 3). 1s. net.

COSMETICS AND DERMATITIS

At a recent meeting of the Society of Cosmetic Chemists of Great Britain, held at the St. Bride's Institute, London, a lecture on "Cosmetics and Dermatitis" was given by Dr. E. J. Moynahan, consulting dermatologist to Guy's Hospital.

Referring briefly to the history of cosmetics, Dr. Moynahan mentioned the fact that several different types of cosmetic are described in the Ebers Papyrus, and that many references to such preparations are to be found in the works of the alchemists and early herbalists. The empirical approach has continued to dominate cosmetic art and practice, however, until comparatively recent times. A noteworthy contribution to scientific study has been made by Sulzberger and others, who have begun to segregate and classify the various causes of dermatitis.

Very few primary irritants are used in modern cosmetics. Those that are found include permanent-waving reagents, which attack the keratin chemically and break down disulphide linkages; depilatories of closely related type; high concentrations of alkali; and oxidation hair-dyes such as *para*-phenylenediamine. Most of the relatively few cases of dermatitis provoked by cosmetic materials are due to sensitization.

Dr. Moynahan referred to the considerable protection provided by the skin's horny layer (if intact) and its supernatant layer of sebum against the majority of external agents, with the exception of such keratolytics as strong alkalis and acids. Dermatitis, which occurs in the lower rather than keratinous layers—that is, in the living cells—varies from redness and itching to swelling, vesicle formation and finally to necrosis. Oils and predominantly oily emulsions, owing to their ability to penetrate through the lipoids of the skin, are more likely to favour the onset of dermatitis than are aqueous solutions and mainly aqueous emulsions, although factors other than the constitution of the vehicle have also to be considered. High proportions of wetting agents may lead, for example, to an undesirable concentration of active agents below the prickle cell level.

In discussing typical cases of sensitization, Dr. Moynahan pointed out that primary irritants may in turn become sensitizers. With a few notable exceptions, such as the azo dyes and amine intermediate dyes, sensitizers are unfortunately difficult to classify in chemical groups, owing to the lack of exact knowledge of the response mechanisms of the skin. It is not always easy, therefore, to predict from chemical data the tendency to irritate the skin of newly introduced chemicals. Skilfully conducted patch tests are valuable; but, however carefully chosen be the concentration of product, size of patch and site of application, such tests have their limitations.

In a general review of cosmetics as causes of dermatitis, Dr. Moynahan said that occupational dermatitis, due to the handling of cosmetics, is comparatively rare. This may be partly attributable to the employment of automatic methods for mixing, filling and so forth. Face creams rarely give trouble except when irritant perfume materials have been incorporated in them. The same observations apply to face powders. Permanent-waving reagents give the most trouble, followed by hair dyes. Allergic dermatitis provoked by hair dyes is dramatic in character but in most cases easy to treat. In cases of lipstick dermatitis there is usually a history of exposure to ultra-violet light; indelible dyes such as eosin are photosensitizers (as is also bergamot oil, used in eau-de-Cologne, etc.). All brands of lipstick tend to give the same reaction in such cases of idiosyncrasy. Nail-lacquer dermatitis occurs mostly on the thinly keratinized skin around the eyes and on the chin or cheek; not on the fingers themselves. Several of the constituents of plastics have been known to act as sensitizers. A cause of nail brittleness which is more common than nail varnish solvents is the injudicious use of some of the newer detergents. Most of the anionic detergents used in cosmetics are satisfactory in the proportions normally employed: more trouble has been caused by other detergents and wetting agents used in the washing and treatment of fabrics. Rouge is virtually innocuous in character. As the keratin of hair is tougher than that of the skin, it would appear that depilatories are bound to affect the skin keratin. For the purpose of depilation, Dr. Moynahan said that he prefers the method of electrolysis, although this method is impracticable for axillary hair removal in women. After briefly referring to cases of oil dermatitis caused by the use of 'brilliantines', he interpolated some comments on keratoplastics and then referred to the merits and defects of barrier (protective) creams. His concluding remarks dealt with the indiscriminate use of disinfectants, which can easily intensify skin irritation, and with the potential dermatitis-provoking action of highly rosined soaps.

COPENHAGEN BIOLOGICAL CONFERENCE

RECENT developments and present trends in cellular biology, physiology and chemistry formed the subject of a joint Danish–British conference held during April 30–May 2 at the Danmarks Farmaceutiske Hojskole in Copenhagen. At the invitation of Danish biologists and the University of Copenhagen, a group of research workers from Great Britain as well as several Danish scientific workers reported on the progress of their own researches, dealing with a variety of topics, which were chiefly, though not exclusively, concerned with the correlation of cell composition with specific cell functions such as growth, division and survival.

The opening session, at which the chair was taken by Dr. A. F. Hughes, began with Prof. H. G. Callan's account of his studies on the amphibian oocyte nuclei; he was followed by Dr. W. S. Bullough, who spoke on the effect of œstrogenic hormones on carbohydrate metabolism and mitosis in mouse ear epidermis; and Dr. M. Webb on the influence of certain extraneous agents, chiefly magnesium, on cell division in bacterial cultures. Dr. F. Buchthal presided at the next session, which was devoted to papers by Dr. J. M. Mitchison, on the mechanical properties of the cell surface, particularly in relation to cleavage; Dr. E. Zeuthen on nuclear growth and respiration in dividing marine eggs, in the light of his recent experiments with the refined Cartesian diver technique; and Dr. C. Waymouth on the problems of maintenance and growth of tissues *in vitro*, in a variety of media of chemically defined composition.

The chair at the next day's meeting was taken by Dr. G. H. Bourne and Prof. P. Brandt Rehberg. The proceedings were opened by Drs. E. C. Slater and K. W. Cleland, who discussed the respiratory and phosphorylative ability of heart muscle sarcosomes. Dr. S. R. Pelc and Dr. A. Howard followed with a communication on the effects of X-rays and neutrons on the synthesis of deoxyribonucleic acid in plant roots; Dr. H. Holter surveyed critically the existing methods by means of which different parts of the cell can be separated mechanically and used for studies on the localization of enzymes in the cytoplasm; Dr. R. Brown described the enzymatic changes which occur in the plant cell during growth. A much appreciated contribution was made by Prof. K. Linderstrøm-Lang, who analysed in a detailed manner the phenomena of diffusion and precipitation in Gomori's histochemical test for phosphatase. Dr. E. Hoff-Jørgensen spoke on the deoxyribonucleic acid content of some bacteria in relation to requirements for vitamin B_{12}.

Prof. J. N. Davidson took the chair on the last day of the meeting. Dr. H. Kalckar described recent experiments in which he used radioactive phosphorus for the demonstration of a pyrophosphorolysis of uridinediphosphoglucose to uridinetriphosphate and glucose-1-phosphate; Dr. R. Markham reported on some new structural characteristics of nucleic acids as revealed by the combined application of enzymic and chromatographic methods; Dr. J. A. V. Butler then spoke on the action of radiomimetic substances on nucleic acid; and Dr. C. Lutwak-Mann on the behaviour of nucleic acid in blood-forming tissues with special reference to X-ray injury.

The contributions were followed by stimulating comments and discussion, notably by Prof. C. H. Waddington, Drs. J. Ebling, J. A. Kitching, R. K. Morton and others. In conjunction with the conference three evening lectures were given. Dr. D. J. Bell reviewed the subject of "Transglycosidation: a Natural Method of Stored-energy Transfer" before the Danish Chemical Society; Dr. T. Mann spoke on "Sperm Survival and its Dependence on Metabolic Processes" to the Danish Biological Society; and Prof. J. Z. Young on "Experiments on Learning in the Octopus" to the Natural History Society.

The British party, who enjoyed initially the support of Dr. M. Swann and later of their efficient secretary, Dr. W. S. Bullough, were most cordially received and entertained by their Danish colleagues. Prof. H. V. Brønsted, Dr. H. Holter, Dr. H. Kalckar, Prof. K. Linderstrøm-Lang and Dr. E. Zeuthen spared no effort to assure for the conference the maximum of scientific and social success. A banquet at the ancient Munkekaelderen was honoured by the presence of the rector of the University of Copenhagen, Prof. H. M. Hansen.

INTERNATIONAL UNION OF BIOLOGICAL SCIENCES

MEETING OF THE EXECUTIVE COMMITTEE

THE executive committee of the International Union of Biological Sciences met in London in the rooms of the Royal Society during March 4–5. This meeting was midway between the last General Assembly of the Union at Stockholm in 1950 and the next one to be held in the summer of 1953. Thirty members of the executive committee, from eight countries, were present, representing the nine Sections of the Union, namely, those of Biometry, Botany, Experimental Cytology, Embryology, Entomology, Genetics, Limnology, Microbiology and Zoology. Some of these Sections are identified with international bodies; thus the Section of Biometry is constituted by the Biometrical Society, the Section of Experimental Cytology by the Society of Cell Biology, the Section of Microbiology by the International Association of Microbiologists, and the Sub-Section of Zoological Nomenclature by the International Commission on Zoological Nomenclature. The executive committee expressed the desire that all Sections of the Union, some of which are already affiliated to the permanent committees of International Congresses, should as far as possible be identified with international organizations having similar activities and aims. Another wish was formally expressed that substantial financial aid be sought from international foundations for scientific establishments of the Union, in particular for the two centres of systematics and of experimentation which have been created by the Commission of the Union for Research on the Biological Control of the Pests of Plants.

The Union organizes annually a limited number of discussion symposia. In 1951 three were held on, respectively, cytochemistry, symbiosis in insects, and biometry in relation to plant growth. This year four are to be held: on the bacteriophage, at Royaumont near Paris; on cytodifferentiation and histodifferentiation, in Stockholm; on the scientific organization of botanic gardens, in London; and on the biochemical and structural bases of morphology, in Utrecht.

The International Union of Biological Sciences, which has been in existence since 1919, is a member Union of the International Council of Scientific Unions, and from time to time, as the need for them arises, joint commissions which last a few years are established between it and other Unions of the Council; for example, a new Joint Commission on Electron Microscopy with the International Union of Pure and Applied Physics has just been set up. The International Union of Biological Sciences possesses limited funds furnished by the subscriptions of its thirty-one member countries, and it acts in an advisory capacity to Unesco for expenditure by that body on biological sciences. Further information can be obtained from the general secretary of the Union, Prof. P. Vayssière, 57 Rue Cuvier, Paris.

BRITISH GELATINE AND GLUE RESEARCH ASSOCIATION

FIFTH RESEARCH PANEL MEETING

THE fifth research panel meeting of the British Gelatine and Glue Research Association was held at Beale's Restaurant, Holloway Road, London, N.7, on Tuesday, April 29, at which the total attendance of about seventy included staff of member firms, and of other research associations and government departments. The chair was taken by Mr. S. G. Hudson, chairman of the Association.

The first paper was given by Dr. J. T. Edsall, professor of biological chemistry in Harvard University and Fulbright visiting lecturer in the University of Cambridge. In his paper, entitled "The Conversion of Fibrinogen to Fibrin", Prof. Edsall commenced by underlining the striking character of the gel-forming process in blood clotting, shown all the more clearly when the purified protein constituents, thrombin and fibrinogen, are mixed in solution and a firm rigid gel is formed in a short period of time. The gel-forming ability is so great that Dr. J. D. Ferry has obtained fibrin gels at a concentration of 0·004 per cent. The two main stages in blood clotting are the formation of thrombin from prothrombin and, secondly, the thrombin–fibrinogen interaction which leads to clotting. It has proved possible to obtain purified prothrombin from which thrombin can be prepared for studies of its action on fibrinogen. Thrombin clearly acts catalytically, since the amount required to convert a substantial quantity of fibrinogen into fibrin is very small (1 part per million of fibrin). Quantitative studies of its enzyme action are, however, difficult to perform owing to adsorption of thrombin on the fibrin formed. Fibrinogen represents some 4 per cent of human plasma proteins and up to 10 per cent in beef plasma and the plasma of other animals. It has been separated by salting out or by low-temperature alcohol precipitation.

Flow birefringence, ultracentrifuge studies, diffusion and light-scattering give evidence of a molecular weight for fibrinogen of 400,000–500,000, the molecule being markedly elongated. Approximate dimensions are, for a rod-like shape, length 700 A. and diameter 38 A. Electron microscope studies by C. Hall, while confirming these figures in the main, show a considerable variation in length from molecule to molecule, and the structure appears bead-like along the length of the molecule. The sub-units may be related to observations of the action of urea in breaking down the molecule to give units of molecular weight in the region of 100,000. The molecular weight of thrombin is not known definitely, but is probably less than 100,000.

The early stages of the action of thrombin on fibrinogen have been shown by Lorand, Bailey and co-workers to involve the release of end-groups which can be estimated by Sanger's fluoro dinitrobenzene technique, giving a frequency of roughly one group per 100,000 molecular weight. In addition, 3–4 per cent of the protein weight is split off as a peptide, the composition of which is being studied. At *p*H 5 there is no evidence of clot formation when fibrinogen and thrombin are mixed. It is clear that some action occurs even in these conditions, since on raising the *p*H instantaneous clotting occurs, whereas in a mixture freshly made at the higher *p*H there is a time delay before clotting. Light-scattering indicates the formation of intermediate aggregates 2500–4000 A. long prior to setting. These aggregates are formed by the modified fibrinogen after loss of the peptide.

By appropriate choice of conditions (*p*H, salt content) the type of clot obtained can vary from a clear transparent stable gel to a doughy opaque mass easily giving rise to syneresis. The difference depends on the size of the fibrillar units, as has been confirmed by electron microscopy. The coarse clots are the basis of the fibrin films developed by J. D. Ferry and P. R. Morrison for use in neuro-surgery. The effects of *p*H, salt concentration, urea, guanidine hydrochloride, etc., on rate of clot formation have all been studied.

Electron microscope studies of the fibrils in the coarse type of clot show a periodic structure with a spacing of 230 A. reminiscent of the collagen structure. There is no ready explanation of this periodicity. The type of bonding appears to vary according to whether calcium, and a plasma component, are present or not. In the absence of these two, urea suffices to cause dispersal of the clot, but with both present it appears likely that more permanent links involving —SH groups are formed.

The second paper was given by Mr. E. Bradbury, of the British Cotton Industry Research Association, Shirley Institute, Manchester, and bore the title "The Effect of the Temperature of Preparation on the Mechanical Properties and Structure of Gelatine Films". Mr. Bradbury explained the significance of this work as fundamental to the study of the use of gelatine for rayon sizing. Gelatine films prepared by drying at 20° C., 70 per cent relative humidity, and at 60° C., 70 per cent relative humidity, differ appreciably in their properties. Tensile tests on the films after subsequent conditioning at different relative humidities showed that those prepared at 20° C. were stronger than those prepared at 60° C. At low humidities they were also rather more extensible before rupture occurred, but at high relative humidities the 60° C. films became very extensible. At 85 per cent relative humidity their extension at rupture was 129 per cent compared with 23·8 per cent for the 20° C. films. Further experiments showed rate of drying, and the moisture content left in the film at the conclusion of drying, to be of minor importance compared with the temperature of drying. With the guidance of X-ray diffraction results, a theory has been put forward attributing the differences to differing degrees of crystallinity in the films.

The discussion on Mr. Bradbury's paper was opened by Dr. Conmar Robinson, who made use of results on optical rotation and diffusion to put forward an alternative explanation based on two configurations of the gelatin chain. The high-temperature form is presumed folded, with internal hydrogen bonding, whereas in the low-temperature form intermolecular hydrogen bonds occur. Mr. A. G. Ward described results of dilute-solution viscosity measurements on gelatin solutions at 25° C. and 10° C. There appears to be no change in shape in the isolated molecules with temperature, although a slow aggregation occurs.

The final paper was given by Mr. R. A. G. Knight, of the Forest Products Research Laboratory, Princes Risborough, with the subject "Glue Testing at Risborough". Mr. Knight outlined the development of testing procedure and made clear the basic principle of choosing test conditions related to those which the glued joints or plywood are required to withstand in practice. The importance of both plywood and glued joints for the aircraft industry during the Second World War placed great emphasis on behaviour under full exposure to the weather, since aircraft were often parked for months on end in the open. The way in which the Forest Products Research Laboratory drew on the experience of the glue-manufacturing and wood-working and -using industries was described.

MAKERERE COLLEGE: THE UNIVERSITY COLLEGE OF EAST AFRICA

IN 1922, the Uganda Government opened a technical college at Makerere, one of the royal hills of the Kabakas of Buganda just outside Kampala. In 1924 a Government medical school and teachers' training course were also started at Makerere. Gradually all trades courses at the technical college were passed over to a neighbouring institution, and agricultural and veterinary courses took their place; a school certificate course was also developed. By 1937 the College had developed a corporate life of its own and, in that year, the De la Warr Commission recommended that Makerere should develop into a centre of higher education for East Africa; this had long been the wish of the founders of Makerere. From this time the College was to cease to be a Government institution and was to possess an independent Council composed of representatives from all the East African Territories whose Governments jointly made themselves responsible for its finances*.

As secondary schools developed in other parts of East Africa, the academic standards at Makerere quickly rose and, in 1945, the Asquith Commission on Higher Education in the Colonies confirmed that the College should press forward towards university college status. In 1949 it was announced that the College had entered into special relationship with the University of London, and the way was therefore opened for degree courses at Makerere.

The path was now clear for a programme of rapid expansion. On the recommendation of the Inter-University Council for Higher Education in the Colonies, early in 1950 the British Government promised the College £1,100,000 from the Colonial Development and Welfare Fund towards a programme of building development, and the East African Governments quickly responded by guaranteeing annual grants for a five-years development scheme totalling annually approximately four times their previous contributions. The programme already embarked on aims at raising numbers in steps from the present 240 students to 630 students and some 85 members of staff by 1955. The new medical school buildings, opened by the Secretary of State for the Colonies in May 1951, are already in use. The first of the new men's halls of residence, providing accommodation for 180 students, is now complete and was occupied at the opening of the new session in March 1952. An arts faculty building and a new physics laboratory building is also about to be brought into use. A start has been made on the first new women's hall of residence, further staff houses and a science workshop. Other buildings now at the drawing or planning stage include a new chemistry laboratory building, an agriculture block, a second men's hall of residence, a library which it is hoped will provide for the eventual needs of a university of some 2,000 students, and the adaptation of a number of existing buildings to provide further accommodation for biology and satisfactory premises for an enlarged school of art.

Makerere was started for Africans, and by force of numbers it will inevitably and rightly always remain predominantly an African college. The College's Charter, however, laid it down that it was to be open to all the peoples of East Africa. In 1951 the College Council determined that with the opening of new accommodation a start should be made in this direction. It was decided that, for the coming year's entry, six places should be reserved for qualified non-Africans; in fact, an English candidate has already been offered a place for the coming year, and there are a number of Indian candidates. The one stipulation made in admitting members of all races as well as of all religious persuasions is that all should share the common residential life.

The qualification demanded for consideration for admission is the possession of the Cambridge School Certificate (Overseas) with three credits. In practice there are already many more qualified candidates for admission than can be taken. As schools develop in number and quality the matriculation standard will be raised.

The admission problem for girls is far harder than that for boys. Though Uganda and Zanzibar have full girls' secondary schools, neither the first girls' school in Kenya nor the first in Tanganyika has yet reached a School-Certificate form, though both are due to do so within the next two years. Meanwhile, only a few girls have qualified for matriculation through predominantly boys' schools. Most of the women accepted for Makerere under "Special Entry" conditions have had some years teaching experience in primary schools, and, though they often find it a hard struggle to survive academically, some of them develop during their life at the College a hitherto hidden maturity. The whole question of the College's contribution to women's education is at present being studied with the help of an advisory committee of persons engaged in this sphere in the territories.

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* *Universities Review*, **24**, No. 2.

Like the sister Colonial university colleges, Makerere is in special relationship with the University of London so far as its courses for the B.A. and B.Sc. degrees are concerned. The College takes the initiative in putting forward its own proposals for syllabuses which it submits to the relevant Boards of Study of the University. The process of negotiation up to the final stages is carried through informally between opposite numbers. Similarly, the College examiners submit the first drafts of the Intermediate and Final degree papers and do the first marking of the scripts, which are then sent by air mail to the University of London examiners for the final determination of results. It is too soon to assess the full potentialities of the scheme.

If Makerere is to serve East Africa's needs as a university it will also have to become a centre of research. A start has been made. There are two research schemes for which the College has taken responsibility but which are separately financed from Colonial Development funds—the East African Institute of Social Research under the directorship of Dr. Audrey Richards, and a scheme to investigate malnutrition and anæmia under Prof. Eric Holmes, the head of the College's physiology department.

The most critical problem at Makerere is the recruitment of staff. Not only will Makerere have to find men and women with the necessary specialized qualifications to teach at university-level, but among them those who are willing to offer their experience and skill and adapt them to the teaching problems and the opportunities of an African university college.

STATISTICS FOR COLONIAL AGRICULTURE

IN January 1947 the Agricultural Economics Research Institute of the University of Oxford was asked to undertake a review of the organization and methodology of agricultural statistics in Colonial territories, in the light of reports received from the various Colonial Administrations.

The report, prepared by Mr. K. E. Hunt of the Institute*, opens with a useful selection of statistical series for first study, followed by a programme, in broad outline, for obtaining such data, first of all on a small (village) scale, with later developments either more intensive or more extensive. The first section concludes with a suggested set of definitions of terms used in agricultural statistics. Succeeding sections deal in more detail with techniques appropriate to the various kinds of information sought. A glance at the 'contents' gives some idea of the comprehensive nature of the review. There are sections on village studies (3), extensive surveys (4), crop yield and production estimation (7), crop production forecasting (8), mixed crops (9), tree crops (10), land utilization (11), livestock populations and output (12), and two sections on marketing and distribution. With the more intractable problems of the later sections, the detail is naturally less. Under these headings many other important practical topics, such as recording technique, approach to selected communities, sample selection, correction of bias in eye estimation, crop cutting techniques, etc., are discussed.

Various methods and the results of much valuable experience both in office and field—in preparation, planning, inauguration, execution, analysis and reporting—are thus brought together. By clearly defining the main features in each of these situations, whether difficulties, possible approaches or points to consider, and including actual examples, the report makes most informative and stimulating reading. Many suggestions will need but slight modification to suit the locality. Matters, more of experience than principle, such as preparation of schedules and questionnaires, measuring areas, tabulation, analysis and records are dealt with in the appendixes.

The extremes of excessive detail but limited application and of discussions in abstract general terms are alike avoided; instead, principles are described in homely terms, statistical refinements not being considered necessary at the present. This publication will surely do much to satisfy a long-felt need.

G. E. HODNETT

ABORIGINAL RAIN-MAKERS

IN many parts of Australia droughts have an appalling effect upon the sources of food of an aboriginal tribe, and it is not surprising to know that both the black and the white man have sought to stimulate Nature to greater generosity with her life-giving rains. The ways in which they seek to induce rain are described by Frederick D. McCarthy in the *Australian Museum Magazine* (10, No. 8).

The aborigines desire rain at specific times both for individual and for group or collective purposes. A man attempts to create a storm or shower to obliterate footsteps when eloping with a woman, or, if he is a criminal, escaping the vengeance of his victim's friends. The making of rain, however, becomes a serious matter when it is organized by a local group whose reason may be the overwhelming one of survival in a drought-stricken land, or the desire to carry out important seasonal ceremonies upon which the life-giving power of the community depends; a local group may wish to punish another one by sending storms to spoil their hunting and fishing.

The rites are usually performed during the day; but the Yaroinga of Queensland have one method in which special songs are sung during the night. The rain-maker uses his deep knowledge of local weather conditions as a guide and performs his rites in seasons and at times when rain can reasonably be expected; as a result his efforts are often rewarded with success. In many tribes the rites may be performed by any individual; but as a rule there are one or more rain-makers in a local group who either confine their magical activities to this sphere or are fully initiated medicine-men. In most tribes women cannot witness the rites; in others they participate in some methods or perform a simple type of magical act themselves.

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* Statistics for Colonial Agriculture—Report on the Organization of Recording and Estimating. Colonial Research Publications No. 11. H.M.S.O.) 7s. 6d. net.

The methods employed by the rain-makers are surprisingly varied, originating as they do in a dream, as a traditional rite performed by the dream-people, or from an incident in daily life which has been followed by rain. Many of the methods are imitative of clouds and falling rain, and of aquatic animals; others seek to persuade the ancestral beings to release the rain, and some medicine-men believe they can go up to the sky to open the clouds.

The Dieri and other tribes of the Lake Eyre district believe that the mura-mura, their spiritual ancestors who made and inhabited the earth in the dream-time prior to man's occupation, now live in the sky, and some of them have to be influenced by ceremonies to release the rain from the clouds.

In south-east Australia storms of wind and rain, and also floods, were believed to be sent by enemies to disturb hunting and fishing activities. The Kurnai of Gippsland squirted water from the mouth in the direction from which rain usually came, and sang magical rain chants acquired in dreams by both men and women.

In Arnhem Land pounded bark (used for poisoning fish) is wrapped in grass, weighted in stones, and taken out into either salt or fresh water by a man until his shoulders are covered; here he drops the bundle, sings a song about falling rain, and pushes the water with his hands to represent the rain splashing on its surface. He expects the clouds to form in about three days and the rain to come on the fourth day after this rite. Here, too, a large bundle of green grass fashioned into a human image is buried and when it swells up rain is expected to fall. The rain is stopped by taking the grass out of the water or ground and spreading it out to dry.

AIR MASS CLIMATOLOGY OF THE BRITISH ISLES

SOME simple facts about the air mass climatology of the British Isles, such as the difference between the relative coldness of east and the relative warmth of south-west winds in winter, have been common knowledge for ages. In the second and third decades of this century the Norwegian school of meteorologists, led by V. and J. Bjerknes, elaborated the ideas of Shaw, Lempfert and others to depict the atmosphere as 'organized' not only into cyclonic and anticyclonic systems but also into warm and cold air masses (often referred to respectively as tropical and polar air) with different life-histories. The interplay of different air masses was shown to produce the day-to-day weather changes of the temperate and polar regions.

In a recent Air Ministry/Meteorological Office* memoir, which is a contribution to synoptic climatology, Dr. J. E. Belasco has investigated the more important physical properties of the atmosphere over the British Isles in twenty-one subdivisions of tropical and polar air, using surface and upper-air data for the period 1931–45. The generalized tracks over which the air masses reach the British Isles are shown by maps, and the frequency of occurrence of the air masses and the average temperature and humidity of the atmosphere in them at the surface at Kew Observatory and in the upper air up to 450 mb. (about 6 km.) over the British Isles are set out in tables and thermodynamic diagrams. There is also a discussion of the changes of temperature and humidity which maritime tropical and direct polar air masses undergo as, on their way to the British Isles, they pass over a surface respectively colder and warmer than their lowest layers. With the aid of this memoir, it has now become possible for the first time to explain some aspects of the climate of the British Isles in terms of the incidence and of the physical properties of different air masses instead of describing them statistically by the usual presentation of means and extremes.

The discussion shows that the correspondence between air mass and wind direction is quite rough and far from unique. Thus, north-west winds usually bring a cold air mass with a large fall of temperature with height and associated showery weather; but when an anticyclone remains stationary westward of Ireland, such winds can bring air originating over the sub-tropical Atlantic which has been cooled from below on its way. Again, polar air of a particularly unstable type can come with a south wind having travelled around a stationary depression centred south-west of Ireland. Quite the coldest air mass is, as is well known, the one which comes in winter from Russia and reaches the British Isles from the east or south-east. This air mass has in January a mean maximum temperature of 31° F. at Kew. The warmest air mass in January comes from the Madeira area and has a mean maximum of 53° F. at Kew. In July the temperature differences between the coldest and warmest air masses are nearly as great as in January. Air of west Mediterranean origin has at Kew in July a mean maximum of 82° F. and air direct from the sea north of Norway a mean maximum of 64°. The differences of temperature between air masses in the upper air are larger than at the surface because the primary heating and cooling occur at the surface.

Dr. Belasco's memoir will be of value not only to those seeking a physical explanation of British climate, but also to the weather forecaster in stating the weather to be expected in an air mass the arrival of which he has foretold.

PAPER PULP RESEARCH AT THE DEHRA DUN RESEARCH INSTITUTE

INVESTIGATIONS on the pulping of *illuk* grass (*Imperata arundinacea*) by the soda and the mono-sulphite processes* have been undertaken at the Forest Research Institute, Dehra Dun, at the request of the Ceylon Government, which forwarded samples for the purpose, with the view of ascertaining the respective economics and suitability of the two processes to the species. Research has shown that the cost of chemicals required for pulping the grass by the mono-sulphite process is 38 per cent more than that required by the soda process. Of the two methods of digestion, namely, 'overhead' and 'fractional', as applicable to the soda process, the 'fractional' method of digestion appears to be more suitable, as well as more economical, for pulping of *illuk* grass.

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* Air Ministry: Meteorological Office Geophysical Memoir No. 87: Characteristics of Air Masses over the British Isles (M.O. 530b). By Dr. J. E. Belasco. Pp. 34. (London: H.M.S.O., 1952.) 2s. 6d. net.

* Indian Forest Bulletin No. 145: Pulping of Illuk Grass (*Imperata arundinacea*) by Soda and Mono-Sulphite Processes. By Chattar Singh and Dr. S. R. D. Guha. Pp. ii+10. (Delhi: Manager of Publications, 1951.) Annas 8; 9d.

In Indian Forest Leaflet No. 124 of the Research Institute*, R. V. Bhat and N. S. Jaspal discuss investigations on pulps for writing and printing papers from the castor oil plant (*Ricinus communis*). In India, so far, bamboo and *sabai* grass (*Eulaliopsis binata*) are the chief raw materials used in the paper industry. The local supplies of these materials are insufficient to meet the requirements of the existing mills. Bamboos are used in India for a large variety of other purposes, and the *sabai* grass only grows in particular areas. The production of paper in Indian mills in 1949 amounted to 170,000 tons. To meet domestic demands for paper, a large quantity is annually imported, and these demands are increasing. The instalment of further new pulp plants depends upon larger amounts of raw material being available.

Reimold had advocated the cultivation of the castor oil plant in America, as a high-grade cellulose could be produced at a low price owing to the cheapness of the raw material. The castor oil plant is commonly grown as an annual crop in several parts of India for its seeds, from which the oil is obtained, and it is upon the stalks, for the purpose of making pulp, that experiments were made at Dehra Dun. The plant is also grown as a perennial small tree, and this, too, was the subject of research work.

The conclusions arrived at are as follows. Easy-bleaching pulps with satisfactory strength properties can be prepared from stems of castor oil plants by the soda and the sulphite processes, the latter being the more suitable. The stems of the annual and the perennial varieties can be used for pulping without the removal of the bark. The pulps from the wood are short-fibred, whereas those from the bark are long-fibred. Owing to this, pilot-plant experiments will have to be carried out to determine whether these pulps can be used as such for the production of writing and printing papers or whether they must be mixed with long-fibred pulps such as those from bamboos and *sabai* grass. Since in India the castor oil plant is grown for its seeds and oil production, it is considered that the stalks should be available at a cheap rate.

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* Indian Forest Leaflet No. 124: Indigenous Cellulosic Raw Materials for the Production of Pulp, Paper and Board. Part 2: Pulps for Writing and Printing Papers from the Castor Oil Plant *Ricinus communis*. By Dr. R. V. Bhat and Narendra S. Jaspal. Pp ii+15. (Delhi: Manager of Publications, 1951.) Annas 8; 9d.

ORNITHOLOGY IN THE U.S.S.R.

THE ornithology of the U.S.S.R. has been somewhat imperfectly known in other countries, especially of recent years. On behalf of the British Ornithologists' Union, Dr. Hans Johansen, formerly professor in the University of Tomsk and now of the Zoological Museum, Copenhagen, has prepared a paper which attempts to review the place of ornithological studies in the U.S.S.R. to-day (*Ibis*, 94, No. 1). Johansen's task has not been easy because no journal devoted entirely to ornithology has been published in the U.S.S.R.; some of the publications containing ornithological articles are unobtainable. Information about articles on ornithology can frequently only be obtained through lists of Russian literature, so that the articles cannot be seen or judged on merit. Although Johansen's survey must, therefore, necessarily be regarded as incomplete, the author is to be commended for undertaking a task which has involved consideration of not less than five hundred publications.

A summary of Johansen's article indicates that the old traditions of Russian ornithology were best and most strongly represented by faunistic reviews which have almost completely surveyed the whole of the enormous country. Large amounts of material were collected in the form of bird-skins, which made possible the systematic revision of many groups of birds. This again made possible broad concepts of the avifauna of the U.S.S.R. as a whole and the numerous zoogeographical and historical faunistic descriptions.

In addition to these old branches of work, new problems have arisen in recent times, as in the rest of the world. Of these, biological and ecological subjects are prominent and, among other things, have led to the production of ecological–geographical monographs on the birds of Russia.

Many investigations have also been made into the problems of bird migration; in addition to ringing and field observations, laboratory experiments have been made, with good results.

Some work has been done on anatomy and physiology in which attempts were made to connect them with biology, ecology and systematics. Investigations on parasites as well as the disadvantages and benefits of birds to forestry and agriculture were specially supported by the authorities.

If the accomplishments of the Russian ornithologists are considered from a wider and more international point of view it can be said that, on the whole, development has proceeded on the same lines as in other countries, though studies naturally show the peculiar influence of the country.

Because of the great extent of the country, from the Baltic to the Pacific Ocean and from high polar latitude to the subtropical conditions in the Transcaucasus, Russian ornithologists have done little work outside their own country. There is, however, the work of Zarudny in Persia and the numerous Russian expeditions made long ago in Mongolia and central Asia. In recent times these works were continued by Sushkin, Tugarinov, Sudilovskaia (Kashgaria) and, more especially, by Madame Kozlova.

The extent and variation of the U.S.S.R. have also been the reason why the so-called line of faunistic research has received special attention. In recent times, according to Russian information, the emphasis has shifted to ecological–geographical characteristics of entire taxonomic groups of birds. This can be regarded as a new branch of Russian ornithology, though publications have not been received in other countries.

Another speciality of Russian ornithology, which was started by Nikolai Severtzov so long ago as 1877, is the profound zoogeographical analysis, which was chiefly combined with historical conclusions. Of the latest achievements, Stegmann's work on the ornithogeographical division of the Palæarctic Region can claim originality, since he provides new methods and techniques of zoogeographical description.

LETTERS TO THE EDITORS

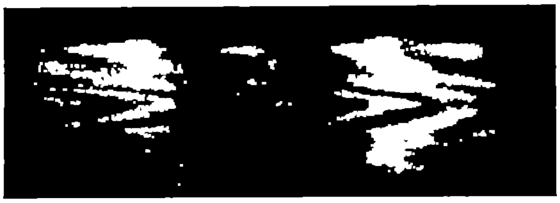
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Interference Microspectroscopy

ONE of the main advantages of interference microscopy over phase-contrast microscopy as normally practised is that certain forms can be used for the quantitative determination of the phase change or optical path difference introduced by the object[1]. Not all types of interference microscope, however, are equally suitable for quantitative work, as the phase difference between the interfering beams cannot always be varied continuously. It is therefore useful to have an alternative method of measuring the phase change.

It is well known that, if light from an interferometer system is viewed through a spectroscope, a series of dark bands can be seen crossing the spectrum when a source of continuous radiation is used. When the phase difference between the interfering beams is uniform throughout the field of view these dark bands are straight; but when additional path differences are introduced, as by a refractile object, the bands become displaced and distorted in a manner related to the phase change produced by the object. Thus, if the image of a transparent object such as a cell is projected through an interference microscope on to the entrance slit of a spectrograph, the displacement of the dark bands gives a convenient method of determining the phase change produced at each point of the object the image of which is formed along the slit.

The technique used is similar to that described elsewhere for ultra-violet absorption microspectroscopy[2]. The measurement of the phase change in the object can be applied to the determination of mass as recently described[3]. An unexpected advantage of the method is that the contrast of the bands seen in the spectrograph is much greater than that of the interference fringes in the field of view. Indeed, this type of method is often used for demonstrating the presence of interference effects which may be suspected but cannot be otherwise detected. This is particularly the case when white light is used and when the path difference between the interfering beams is great. The accompanying photograph illustrates this point. The object was an unstained human oral epithelial cell, mounted in water between a semi-rhodiumized slide and coverslip, as suggested by Merton[4]. A tungsten filament lamp was used as source and the separation between slide and coverslip was rather large. The full illuminating aperture of the condenser was used. In these circumstances, no interference fringes whatsoever could be seen in the field of view and the object, being transparent, was virtually invisible. Fringes were quite easily seen in the spectrograph, however, and their contrast could be enhanced photographically without loss of detail.



Interference microspectrograph of epithelial cell, in visible region, taken under conditions of zero contrast in field of view of microscope

We thus have the possibility of obtaining precise optical information concerning an object which cannot be seen under the microscope. Moreover, since the full illuminating aperture is used, the resolving power of the microscope itself is high. The contrast, which may be very low or even zero in the microscope, can be largely recovered in the spectrograph. If the apparatus is adjusted to give good fringes and high contrast in the microscope field of view, the contrast in the spectrograph is very much better than that shown. It is not essential to use a tungsten filament lamp, as most high-pressure mercury lamps emit sufficient continuous radiation between the spectral lines to enable the dark bands to be seen. Such lamps are generally preferable for visual work.

If the object contains absorbing material, anomalous dispersion may occur in the region of absorption bands, so that the refractile and absorbing properties may be simultaneously observed. Finally, at those points which introduce zero phase change, the refractive index will be equal to that of the mounting medium at the same wave-length.

I wish to acknowledge the help received as Johnston, Lawrence and Moseley Research Fellow of the Royal Society.

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Department of Human Anatomy,
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March 1.

[1] Dyson, J., *Proc. Roy. Soc.*, A, 204, 170 (1950).

[2] Barer, R., Holiday, E. R., and Jope, E. M., *Biochim. Biophys. Acta*, 6, 123 (1950). Barer, R., in 'Cytology and Cell Physiology'' (edit. G. H. Bourne, 2nd edit., Clarendon Press, Oxford, 1951).

[3] Barer, R., *Nature*, 169, 366 (1952).

[4] Merton, T., *Proc. Roy. Soc.*, A, 189, 309 (1947).

Thermal Measurements on Small Transient Systems

EXPERIMENTS recently carried out in this laboratory have shown that it is practicable to heat the wires of a thermocouple by the passage of an electric current and at the same time to record the temperature of the junction by means of the thermo-E.M.F. A high-frequency current is used in order that the concomitant voltage (order 10 volts) may be separated from the thermo-E.M.F. (order 0·001 volts) by means of inductance-capacitance filters. The apparatus can be used for measuring the thermal constants of poor conductors placed in contact with the couple wires.

It has been found convenient to pass a pulse of current (after which the system returns to its original state) and to make deductions from the E.M.F.-time record obtained during the heating period. If the pulse is long enough for a steady state to be achieved, the highest temperature is inversely proportional to the thermal conductivity; otherwise both conductivity and specific heat have to be considered. Calculations made by Dr. S. Paterson and Miss Jean

Substance with which wire was in contact	Proportion of energy retained by wire after 96 msec.	
	Observed	Calculated
Medicinal paraffin	0·57	0·52
Castor oil	0·48	0·48
Glycerol	0·33	0·38
Water	0·19	0·28

Davidson have shown that it is in principle possible to calculate absolute values of these quantities from a single record. In practice it has not been yet possible to do this, because available couples are not perfect cylinders; comparison with theory has shown that they behave in this work as though they are 50–100 per cent larger than the nominal diameter of the wire. Nevertheless, measurements made relatively either to the original state of a given system or to a system having well-established properties have been possible. The precision of these measurements is indicated by the accompanying table, in which calculated and observed values of the energy retained by the wire after being heated at a steady rate for a chosen time are compared. In obtaining these figures the values for castor oil have been made to agree by an arbitrary adjustment equivalent to the assumption that the wire is 1·64 times its nominal diameter. The time chosen is such that both thermal conductivity and specific heat play an important part in determining the results.

The method has advantages over conventional methods, notably in speed and in the minimum size of the system on which measurements are practicable: with, for example, 40 S.W.G. wires, which are not inconveniently fine, a measurement takes only 100 msec. and the system need be only 1·0 cm. long by 0·1 cm. in diameter. Moreover, because the average temperature need not be controlled for long periods, measurements at elevated temperatures offer no particular difficulties. The method is therefore very suitable for studying small transient systems such as exist in the reaction zones of thermal self-propagating reactions; it is at present being used for measuring how much the thermal conductivity changes when reaction is propagated in mixtures of iron and potassium permanganate[1].

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April 19.

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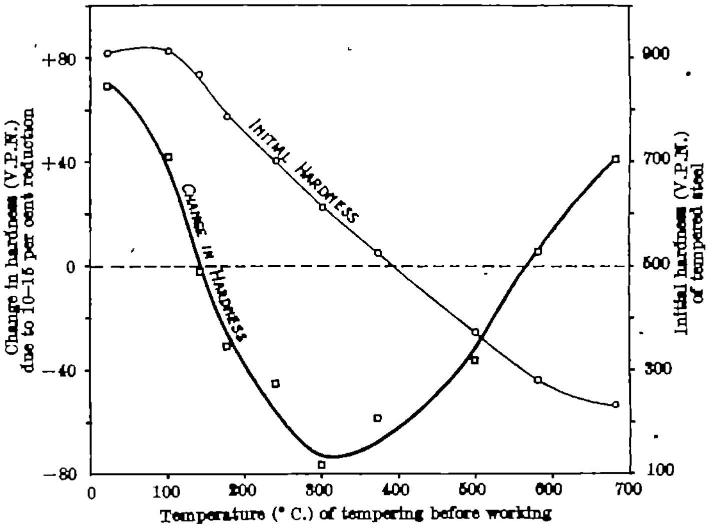
[1] Hill, R. A. W., Sutton, L. E., Temple, R. B., and White, A., *Research*, 3, 569 (1950).

Magnetic Properties, Internal Strains and the Bauschinger Effect in Metals

Polakowski[1] has recently drawn some general conclusions about the behaviour of metals during reversed deformation, and has suggested that the influence of reversed straining on certain properties, including intensity of magnetization, may be predicted on this basis. Since not all changes which may result from plastic deformation are associated with reversible internal strains, however, the behaviour of a change of unknown cause cannot be predicted. On the other hand, if it be concluded on the basis of experiment[2] that the change in the Curie temperature of cementite in cold-worked steels is directly related to the textural stresses set up between the cementite and ferrite, then it may be expected that this effect will give a more certain indication of magnitude of strain in the cementite particles of a steel than can be derived from hardness tests.



Influence of previous heat-treatment on the change in indentation hardness due to 10–15 per cent reduction in height by compression. 0·88 per cent carbon steel, water-quenched from 800° C., immediately cooled in liquid oxygen, and then tempered at the temperatures indicated for 2 hr., before deformation. Hardness values represent the mean of 12 readings taken within 2 hr. of straining. (Increase in hardness of specimens tempered below 140° C. may be under-estimated due to local cracking)

In this connexion I suggest that, in order to understand the mechanism of the work-softening effects discussed by Polakowski, it will be necessary to consider the nature of the textural stress systems present in the different materials. In the case of the softening observed in hardened and tempered steels after moderate degrees of cold-working, for example, a textural stress system which is effectively isotropic on a macroscopic scale is partially replaced by a directional system and, in general, the reduction in indentation hardness is not accompanied by any softening in the direction of working.

The extent of 'work-softening' effects may depend not only on the intensity and directional characteristics of the initial textural stress patterns but also on their scale.

The accompanying diagram summarizes results showing that, in the case of a heat-treated 0·88 per cent carbon steel, the change in indentation hardness which results from a moderate degree of deformation is dependent on the microstructure (approximately the reductions were those which cause the maximum degree of 'work-softening'). Up to a certain limit, about 600 Vickers Pyramid numeral in this case, with increasing initial hardness the magnitude of the softening effect increases progressively. At higher hardness values, however, the observed softening is less, although the initial internal strain energy will continue to increase with hardness. Martensite tempered below about 140° C. does not show the softening effect. Probably rather similar patterns of behaviour are shown by certain age-hardening alloys.

A possible explanation of these effects may be visualized in terms of the suggested influence of the scale of the internal stress pattern on the movement of dislocations in solid solutions and duplex alloys[3]. When the separation of particles of the precipitate is sufficient to allow the formation of dislocation loops around individual particles, then the initial internal stress pattern may be greatly modified as a result of plastic deformation, and indentation tests may indicate abnormally low rates of work-hardening during the early stages of deformation.

However, it is possible that the behaviour of steel, which shows marked strain age-hardening effects, may be complicated by the influence of carbon atoms associated with the ferrite.

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[1] Polakowski, N. H., *Nature*, 168, 888 (1951).

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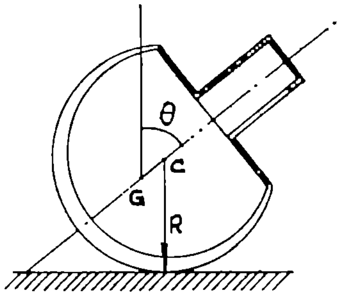
The Symmetrical Spherical Top

A TOP with a cross-section as shown in the accompanying diagram exhibits, when spinning on a horizontal plane, a surprising effect: the stem, which originally points upward, moves away from the vertical while continuing to rotate about this direction, until it touches the supporting plane; whereupon the top quickly rises on the stem and continues its rotation in this stable position. A similar behaviour is shown by a sphere consisting of two halves of different specific weight. If the initial angular velocity is large enough, the centre of gravity will rise until it reaches the highest position possible, the sphere then rotating about its axis of symmetry.



It is possible to show[1] that this effect is due to the friction arising when the point of contact slides over the supporting plane. The torque resulting from this force causes the angular momentum vector to move over the surface of a cone with vertical axis. Thus the angular momentum will have a component perpendicular to the plane through the vertical and the axis of symmetry, which effects a change of the angle θ between these two lines. In this way the following two effects can be described:

(1) If the centre of gravity, G, lies eccentrically in a sphere with axially symmetric distribution of mass, while the moments of inertia about the axis of symmetry and another axis through G perpendicular to the former are equal, the rotation will be stable if the position of G is as high as possible.

(2) If G coincides with the centre, C, of the sphere, while the moment of inertia, A, about the axis of symmetry differs from that, B, about an axis through G perpendicular to the former, stable rotation will be about the axis with the greatest moment of inertia.

The two effects can combine with different results, all of which are characterized by the vanishing of the sliding motion of the point of contact.

(3) If G is eccentric and $A \neq B$, the stable equilibrium value of θ is:

$$\theta = 0 \text{ or } \theta = \pi \qquad \text{if } \frac{A-B}{A} > \frac{GC}{R},$$

$$\theta = \pi \qquad \text{if } -\frac{GC}{R} < \frac{A-B}{A} < \frac{GC}{R},$$

$$\cos\theta = \frac{GC}{R} \cdot \frac{A}{B-A} \quad \text{if } \frac{A-B}{A} < -\frac{GC}{R}.$$

The value of θ given for the latter case is an approximation which is valid at high rotational energy.

A homogeneous sphere with a cavity near a point of the surface is an example of the first case of (3), the sphere with the two halves mentioned above of the second one. An example of the third case of (3) is a sphere, which except for a concentration of mass near a point of the surface, is of homogeneous density. The top shown in the diagram—commercially available in Holland under the names "tippetop" and "toupie magique"—is of the same type. However, before the equilibrium value of θ is reached the stem will touch the supporting plane. The effect due to the eccentricity of G is strengthened then and the top rises on the stem.

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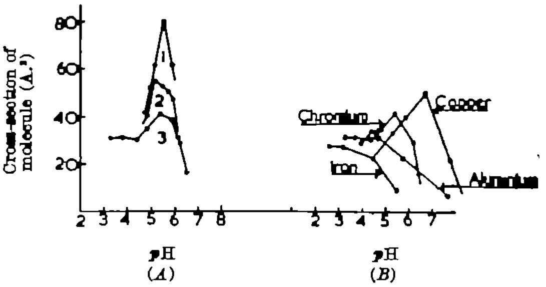
Tanning of Fatty Acid and Protein Monolayers by Metal Ions (Cr, Al, Fe and Cu)

IT has been shown by Wolstenholme and Schulman[1,2] that metal ions such as Fe, Al, Co, Cu interact with fatty acid monolayers over the pH stability range of the basic metal ions. There were indications that the association could be influenced also by the size and shape of both the fatty acid molecule and the basic metal ionic unit. The present communication shows how these ideas can be applied to the chromium ionic system, together with a direct analogy between the interaction of the basic chromium ion, with fatty acid monolayers, and the tanning of a protein monolayer. Here, the reactivity of the carboxyl group is important in both systems.

It can be readily shown that a chromic acetate solution does not react with long-chain amine monolayers, since there are no basic chromium ions avail-



(A) (B)

Fig 1. (A) Effect of M/2,000 chrome alum on fatty acids (1) 4:10 fatty acid $C_{10}H_{21}.\underset{C_4H_9}{\underset{|}{C}}HCOOH$ (cross-sectional area 46 A.²); (2) 1:12 fatty acid $C_{12}H_{25}\underset{CH_3}{\underset{|}{C}}HCOOH$ (cross-sectional area 30 A.²); (3) myristic acid $C_{12}H_{25}CH_2COOH$ (cross-sectional area 20 A.²).

(B) Effect of pH on area of solidification—myristic acid

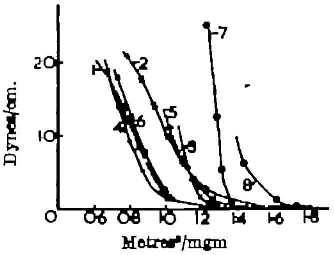


Fig. 2. Bovine albumin films (1) pH 3·8, M/100 sodium sulphate, 21° C.; (2) pH 2·88, M/100 ferric chloride, 21° C. (2 hr.); (3) pH 2·86, M/100 ferric chloride and M/110 sodium sulphate, 21° C. (1½ hr.); (4) pH 4·2, M/100 aluminium chloride, 21° C. (1 hr.); (5) pH 4·4, M/100 aluminium chloride and M/10 sodium sulphate, 20·5° C. (1 hr.); (6) pH 5·52, M/100 copper sulphate, 20° C.; (7) pH 5·26, M/2,000 chrome alum, 18·5° C. (1 hr.); (8) pH 7·15, phosphate buffer and tannic acid, 80 mgm./L., rigid unstable film after 1½ hr.

able over the pH range in which the amine is associated. Strong interaction takes place with the carboxyl group in fatty acids over the pH range in which the di-basic chromium ion exists. This reaction is shown by the change in the area of the solidification of the molecules and the mechanical properties of the fatty acid monolayers on the metal salt solution. These results are summarized in Fig. 1.

Fig. 1,*A* shows how the basic chromium ionic unit can expand to accommodate the increasing size of the fatty acid molecule (that is, from 40 A.^{2} to 80 A.^{2}). This property of the interlinking basic ionic aggregates appears to be greatest with copper, and decreases in the following order[2]:

$$Cu^{++} > Cr^{+++} > Al^{+++} > Fe^{+++} > Co^{++},$$

as shown in Fig. 1,*B* (for myristic acid monolayers).

These results on solidification of fatty acid monolayers by the basic metal ion can be applied to the tanning of protein monolayers. Fig. 2 shows how the rigidity and expansion of the protein monolayer is affected by the basic metal ions, over the same optimum pH range as in the tanning of the fatty acid monolayers. It appears that there is a potential barrier[3] to be overcome by the adsorbing basic metal ion aggregate, due to the positively charged amine group in the protein monolayer. This barrier can be readily overcome by the addition of sulphate ions. This tanning process works well with iron, aluminium and chromium salts, but curiously, not at all with copper. A tannic acid or vegetable tanning[4] of the protein monolayer is given as a comparison. In this case, the amine groups in the protein monolayer are interlinked by the phenolic groups on the tannic acid molecule.

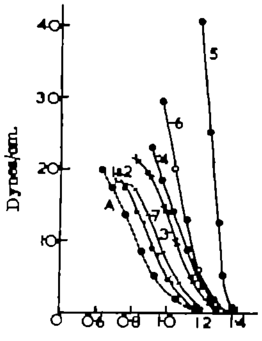


Fig. 3. Bovine albumin films: (*A*) pH 3·8, M/100 sodium sulphate, 18° C.; (1) pH 2·1, M/2,000 chrome alum, 18° C. (1 hr.); (2) pH 3·7, M/2,000 chrome alum, 20° C. (1 hr.), (3) pH 4·21, M/2,000 chrome alum, 17·5° C. (1 hr.); (4) pH 4·76, M/2,000 chrome alum, 18·5° C. (1 hr.); (5) pH 5·26, M/2,000 chrome alum, 18·5° C. (1 hr.); (6) pH 5·71, M/2,000 chrome alum, 18·5° C. (1 hr.); (7) pH 6·07, M/2,000 chrome alum, 18·5° C. (1 hr.)

Fig. 3 shows the complete tanning of bovine albumin monolayers with chrome alum solutions over a pH range which gives a direct analogy with the tanning of fatty acid monolayers.

As was found by Wolstenholme and Schulman[1], minerals containing chromium can be floated by soluble fatty acids over the pH range where the fatty acid monolayers are made insoluble by the basic chromium ions, giving an identical optimum pH range. This shows that chromium ions are available on the mineral surface and form a monolayer network of fatty acid – basic chromium ionic complex, which is hydrophobic.

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[2] Wolstenholme and Schulman, *Trans. Farad. Soc.*, **47**, 483 (1951).

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A Possible Source of Artefacts in the Chromatography of Tissue Extracts containing Inorganic Iodide

Unknown substances containing iodine, apparently associated with inorganic iodide, have been detected in the plasma of patients who had previously received therapeutic doses of radioiodide[1,2]. These substances were discovered by chromatographic separation of the radioactivity present in butanol extracts. The methods of preparation involved paper chromatography with acid solvents[1] and extraction of acidified plasma[2].

Acidification of solutions of inorganic iodide is known to cause the liberation of elementary iodine, and we decided to test the possibility that iodination of unsaturated compounds present in the starting material might take place during extraction and chromatography in acid solutions. Preliminary work on pure substances was clearly desirable; and this communication describes experiments with cholesterol, cholesteryl oleate and triolein, using the radioactive isotope, iodine-131.

0·5 c.c. of a solution of sodium iodide-131 containing 3·5 μC./c.c. was added to 2 c.c. of an acidified aqueous suspension of the lipoid. The suspensions were extracted three times with 5 c.c. of water-saturated *n*-butanol, the layers being separated by centrifugation, and the butanol extracts were evaporated to dryness under reduced pressure on a boiling water-bath. The residues were each taken up in 0·5 c.c. of *n*-butanol. 1-μl. aliquots of the resulting solutions were placed on filter paper strips 2 cm. wide (Whatman No. 1) and chromatographed by the descending method in *n*-butanol/dioxane/2N ammonia, prepared according to Gross *et al.*[3]. The butanol extract of an acidified solution of sodium iodide-131 alone was prepared and chromatographed directly with, and without, the addition of lipoid in ether solution to the spots. For these latter experiments *n*-butanol/dioxane/2N ammonia and *n*-butanol/

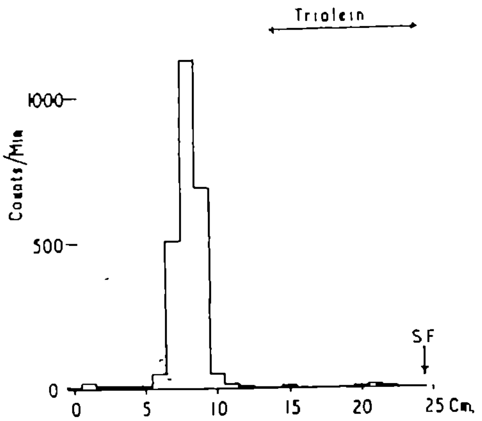

Fig. 1. Distribution of radioiodine on a filter paper strip after chromatography of sodium iodide-131 and added triolein in *n*-butanol/dioxane/2*N* ammonia (*S.F.*, solvent front)

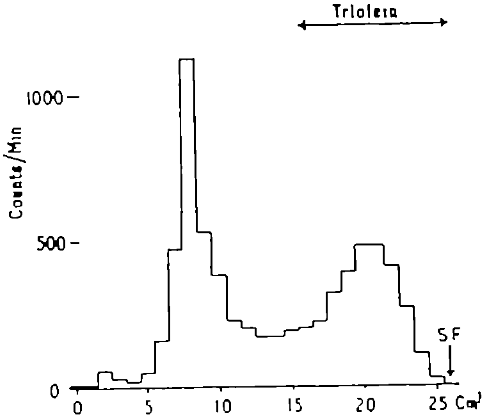

Fig. 2. Distribution of radioiodine on a filter paper strip after chromatography of the butanol extract prepared from an acidified aqueous suspension of triolein to which sodium iodide-131 had been added (*S.F.*, solvent front)

2*N* formic acid (Gross *et al.*[3]) were used as developing solvents in different runs. The lipoids were detected by their fluorescence in ultra-violet light. They formed bands or streaks extending behind the solvent front for distances depending on the amount added to the paper. The radioactivity of each 1-cm. length of the strips was measured separately by means of a Geiger counter fitted with a lead diaphragm. Five-minute counts were made in each position.

Solutions of radioiodide alone, with or without previous butanol extraction, showed one peak of radioactivity ($R_F = 0 \cdot 33$) after chromatography in butanol/dioxane/ammonia. In butanol/formic acid, the R_F of radioiodide was found to be 0·25, but there was some 'tailing' of the spot. In the latter solvent, there was also a small subsidiary peak, the R_F of which was 0·9, representing about 0·5 per cent of the total radioactivity on the paper.

In the case of solutions containing both lipoid and radioiodide, only one large peak of radioactivity was present if iodination did not occur (see Fig. 1). Iodination caused a second peak to appear in the same position on the paper as the fatty substance (see Fig. 2). Fig. 2 demonstrates iodination during extraction from an acidified suspension. Iodination during chromatography with butanol/formic acid gave rise to a similar picture.

No iodination of any of the three lipoids took place during chromatography in alkaline conditions. Cholesterol itself was not detectably iodinated during chromatography in acid conditions and was found to have taken up only 3 per cent of the added radioiodine in the course of extraction from an acidified suspension. Cholesteryl oleate showed significant iodination both during chromatography in the acidic solvent (63 per cent uptake) and during extraction from an acidified suspension (28 per cent uptake). The iodination of triolein resulting from butanol extraction in acid conditions is demonstrated in Fig. 2. During chromatography in butanol/formic acid, this compound took up 32 per cent of the radioiodine present.

It appears likely that artefacts could arise during the preparation and chromatography of tissue extracts containing inorganic radioiodide as a result of reactions similar to those described above. Lipoids may not be the only type of compound involved. Artefacts of this nature could probably be eliminated by avoiding extraction and chromatography in acid solution.

I wish to thank the Board of Governors of the United Sheffield Hospitals for financial assistance.

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May 12.

[1] Gross, J., and Pitt-Rivers, R., *Lancet*, ii, 766 (1951).
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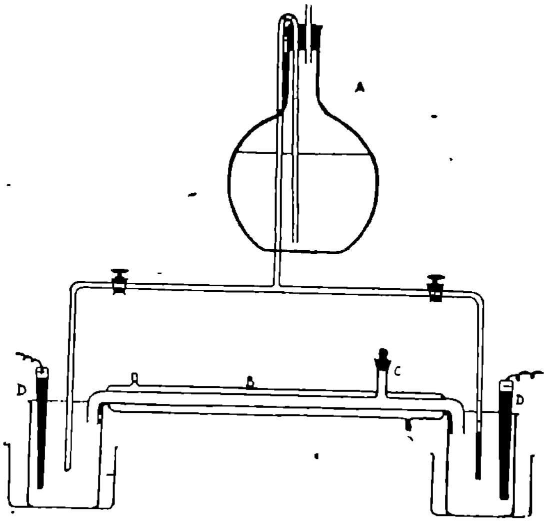
Ionophoretic Separation of Porphyrin Pigments

In the classical Tiselius procedure for electrophoresis of proteins, convection was prevented by the density gradient of the substances under investigation; but complete separation could not thereby be obtained, and the analysis was conducted by the observation of fronts. Later the medium was stabilized by silica or agar gel for the separation of amino-acids[1] and proteins[2]. Silica or agar gel will hold an excess of electrolyte and prevent convection currents; but it will allow substances to pass through independently and to separate into discrete bands. In addition, its use obviates contact of the moving substances with the electrodes.

Since porphyrin pigments are ampholytes, with differing numbers of carboxylic groups, it seemed likely that ionophoresis in a gel would provide a simple means of separation. Nicholas and Rimington[3] observed that the R_F values of porphyrins in paper partition chromatography were inversely proportional to the numbers of carboxylic groups in the molecule.

Agar gel was preferred to silica, since the former is easier to prepare, not so mechanically brittle, and gels in much higher dilution, thereby avoiding the introduction of large amounts of impurities. Nevertheless, stringent purification of the gel preparation was essential to avoid traces of metallic impurities, which would readily form complexes with porphyrins. Treatment with methanol[4] was found unsatisfactory as the product would not gel in the desired concentration. Satisfactory purification was achieved by washing powdered New Zealand agar (Davis) repeatedly with Sorensen *M*/15 phosphate



buffer pH 8·0 and then allowing it to stand over-night in the buffer. The volume was adjusted to give 0·5 or 1 per cent agar and the mixture warmed in the water-bath until solution was complete (half an hour), when it was transferred immediately to the bridge of the ionophoresis apparatus. The agar gelled on cooling, and the residual impurities were removed by ionophoresis for three hours. This treatment appears to replace calcium and magnesium ions of the gel by the innocuous sodium and potassium ions of the buffer[5].

In the subsequent analysis of porphyrin pigments, these were detected by their intense ultra-violet fluorescence. The apparatus could therefore be simplified (see diagram) as compared with that required for proteins.

The procedure was as follows. A small section of agar gel was removed from the bridge *B* via the side-arm *C*, using suction through a Pasteur pipette. The porphyrin solution in *M*/15 phosphate buffer pH 8·0 or in phosphate agar (0·5 ml.) was introduced through *C*, and a direct electric current then passed through the bridge, which was water-cooled as illustrated. With a bridge length of 50 cm., D.C. mains voltage of 200 V. across the carbon electrodes *D* (that is, 4 V./cm.), cooling was not obligatory, but voltages greater than 4 V./cm. caused the temperature to rise higher than 55°, with liquefaction of gel and losses of pigments. Adequate cooling was also advantageous in preserving a steady electric current through the gel. The buffer in the electrode compartments was replaced continuously from the reservoir *A* at the rate of one litre an hour.

After ionophoresis for a period dependent on the voltage applied, the agar was withdrawn by gentle suction into a long glass tube, and the fluorescent portions cut out using a glass microscope slide. Ether-soluble porphyrins were reclaimed by heating the gel with one volume of 20 per cent w/v acetic acid for 30 sec., cooling and extracting immediately into ether. Uroporphyrin was removed by similar hydrolysis of the gel with one volume 5 per cent w/v hydrochloric acid, with subsequent cooling and shaking with chloroform. Traces of unhydrolysed agar were thereby precipitated, and other interfering blue fluorescent material was extracted into chloroform, leaving the uroporphyrin in the aqueous phase.

Our findings were as follows: (1) The porphyrins in untreated urines of acute or congenital porphyria migrated as discrete bands, and the presence of individual pigments was readily apparent. (2) Protoporphyrin (2 COOH), coproporphyrin (4 COOH) and uroporphyrin (8 COOH) had mobilities which increased with higher number of carboxylic groups. (3) Coproporphyrin isomers I and III were not separable, even with a tube 80 cm. long and proportionally greater voltage. Similarly, uroporphyrin isomers could not be distinguished. (4) No separation was observed in a mixture of the dicarboxylic proto-, deutero- and meso-porphyrins. (5) Sensitivity and recoveries were good. 1 μgm. of each porphyrin could be measured, with yields of 60–80 per cent of that amount.

Ionophoresis of porphyrins in agar gel is thus a simple procedure for separation of porphyrin on the basis of constituent carboxylic groups[3]. The effect of other substituents on mobilities at pH 8·0 appeared to be minimal and isomers could not be separated, although separation of coproporphyrin methyl esters has recently been effected by paper partition chromatography[6].

We should like to thank Dr. J. F. Wilkinson, director of this Department, for his continued interest in this work.

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The Soret Effect

Although thermal diffusion in condensed systems has been used experimentally for bringing about difficult separations, for example, in the Clusius and Dickel apparatus, and although considerable advances have been made recently in the descriptive treatment of the effect by Prof. S. R. de Groot[1] at Utrecht and Prof. Prigogine[2] at Brussels, experimental data by which theories of the Soret effect may be checked are still meagre.

According to de Groot, the shape of the thermal separation versus time curve is determined by the value of the diffusion constant at the mean temperature. The extent of thermal separation is not predictable, but the theory may be checked by evaluating the diffusion constant from time curves and making comparison with values found by conventional means for known systems.

Some measurements have been made in an apparatus similar to that used by me during 1924–27[3] in which the solution is confined in a shallow layer between horizontal metal surfaces at T and $T + \Delta T$ and optically analysed, without disturbance, by measuring the deviation produced in a horizontal beam of monochromatic light by the changing gradient of the refractive index. The method permits a nearly complete optical traverse to be taken between the top and bottom layers of the cell.

In orthogonally planned experiments with potassium chloride and barium chloride solutions in cells 0·695, 0·975 and 1·396 cm. high, with $T = 25°$ C. and $T + \Delta T = 35°$ C., diffusion constants required to satisfy the de Groot equations were substantially independent of cell height and concentration of solution, and in agreement with literature values for solutions ranging in mole fraction from 0·074 to 0·018 for potassium chloride, and from 0 019 to 0·002 for barium chloride.

The Soret coefficients for the above solutions are small, about 0·1–0·2 per cent per degree, and the measurements provided a test of the sensitivity of the experimental method.

It is hoped to publish the work in detail and to extend it to other systems.

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Cellular Permeability of Yeast to Metallic Ions

The apparatus devised by Dr. G. Protti for the kinetic study of cellular metabolism with radioactive isotopes[1] lends itself to permeability studies of yeast. We are using it to study their permeability to different metals.

The metal content of yeast is assumed constant, and the whole of the radioactive isotope is introduced at the beginning of the experiment. Then the rate of disappearance of radioactive metal ions is described by the differential equation:

$$\frac{V}{L}\frac{dx}{dt} = - v \frac{x}{Lb/V} v \frac{(x_0 - x)\, V/L}{a},$$

where a is gm. metal per gm. yeast; Lb/V is gm. metal ion per ml. solution; L is gm. yeast; V is ml. solution; x and x_0 are gm. radioactive metal ion per ml. solution at end and beginning of experiment respectively; t is time in hours; v is permeability measured in $\frac{\text{gm. metal}}{\text{gm. yeast hr.}}$.

Integrating this equation gives:

$$\frac{x}{x_0} = \frac{a.\exp\left(- v\frac{a+b}{ab}t\right)}{a+b} \, .\, b\,;$$

and then:

$$v = - \frac{1}{t}\frac{a.b}{a+b} \ln\left[\frac{x}{x_0} - \frac{b}{a}\left(1 - \frac{x}{x_0}\right)\right].$$

The validity of this equation has been confirmed by experiments using *Saccharomyces cerevisiae* and copper-64 obtained from the Atomic Energy Research Establishment, Harwell; in these experiments, $v = 7·2 \times 10^{-4}$.

Experiments with other metals are still in progress.

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A Novel Synthesis for Aroylacrylic Acids

This preliminary investigation was undertaken in an effort to apply the Doebner condensation to the synthesis of aroylacrylic acids according to the following equation:

$$\text{ArCOCHO} + \text{CH}_2(\text{COOH})_2 \xrightarrow{\text{pyridine}} \text{ArCOCH=CH—COOH} + \text{CO}_2 + \text{H}_2\text{O}.$$

The compound chosen for study was 2-naphthylglyoxal, because the properties of the resulting *beta*-2-naphthoylacrylic acid would help clear up certain doubts about its structure at the time this work was begun (however, see ref. 1).

2-Naphthylglyoxal was obtained easily in 75 per cent yield by oxidation with selenium dioxide of methyl 2-naphthyl ketone[2,3]. 2-Naphthylglyoxal monohydrate (15 gm.), malonic acid (7·5 gm.) and pyridine (15 ml.) were stirred for 22 hr. at room temperature. Carbon dioxide was evolved and a solid mass remained. The material was taken up in 5 per cent sodium carbonate solution and acidified to give a gummy semi-solid which hardened on standing several hours. Several recrystallizations from dilute alcohol (decolorizing carbon) gave a 12 per cent yield of bright yellow crystals of *beta*-(2-naphthoyl)-acrylic acid, melting point 164–166° [1] (calc. for $C_{14}H_{10}O_3$: C, 74·32; H. 4·46; neut. equiv., 226·2; found: C, 74·42, H, 4·56; neut. equiv., 227·1). The compound gave a rapid Baeyer's test and positive tests with phenylhydrazine and 2,4-dinitrophenylhydrazine. Tollen's reagent and Schiff's reagents were negative. It was quantitatively hydrogenated at 3 atmospheres pressure over a palladium-on-carbon catalyst to the known *beta*-2-naphthoylpropionic acid, melting point 170–172°. The acid is probably *trans*, since refluxing it with a crystal of iodine in either benzene or chloroform effected no change in the melting point.

Work to be reported elsewhere will show that this novel condensation is adaptable to the synthesis of negatively substituted aroylacrylic acids, such as *beta*-(4-nitrobenzoyl)acrylic acid—which are not obtainable through the conventional Friedel and Crafts reaction—and with considerable increase in yield over that reported here.

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Action of Alkaline Hypochlorite on 3 : 5 : 6-Trimethyl-*d*-gluconamide

The action of alkaline hypochlorite upon fully methylated hexonic and pentonic acid amides, using the Weerman procedure[1], results in the formation of cyclic urethanes[2]. Haworth, Peat and Whetstone[3], using this reagent, claimed the direct conversion of 3 : 5 : 6-trimethyl-*d*-gluconamide (which possesses a free α-hydroxyl group) to a 2 : 4 : 5-trimethyl arabinose, isolated as a syrup, to which a straight-chain aldehydic structure was ascribed.

The problem has been re-examined in this laboratory. Purified 3 . 5 : 6-trimethyl-*d*-gluconamide (obtained *via* 1 : 2-mono-*iso*-propylidene-3 : 5 · 6-trimethyl glucofuranose) melted at 138 5° and had $[\alpha]_{D}$ + 38·65° (water). Treatment of this amide according to the Weerman procedure, followed by the method of purification outlined by Haworth *et al.*, gave a syrup with properties almost identical with those described by these workers. However, the application of paper partition chromatography, using as mobile phase one part petroleum ether (100°–120°) and nine parts butan-3-one saturated with water, revealed the presence of at least four components of carbohydrate nature. Methods involving partition chromatography on cellulose columns resulted in the separation of four fractions, three of which each contain a different methylated pentose derivative. The fourth fraction contains little pentose but large amounts of organically bound nitrogen; it has not been further investigated at present.

Fraction 1 was obtained as a mobile syrup having $[\alpha]_{D}$ – 4° (1 per cent in methanol), n_{D} 1·4702 and OMe 34·5 per cent (theoretical value for a dimethyl pentose 34·8 per cent; for a trimethyl pentose 48·0 per cent). An aqueous solution of the syrup strongly reduced Fehling's solution in the cold, decolorized permanganate solution and immediately restored the colour of Schiff's reagent. These properties suggest a straight-chain aldehydic methylated pentose, and we presume this material to be responsible for the similar properties exhibited by the final product of Haworth *et al.*, since no other fractions obtained in the present experiments were capable of producing similar aldehydic effects.

Fraction 2 was obtained in small yield as an immobile syrup having $[\alpha]_{D}$ – 23·7° (1 per cent in methanol) and n_{D} 1·4730. This fraction also apparently consisted mainly of a dimethyl pentose derivative, since its OMe content was 34·4 per cent; but it showed none of the aldehydic properties of fraction 1 and the two fractions behaved very differently when subjected to paper partition chromatography.

Fraction 3, the largest fraction, was an immobile syrup consisting mainly of a trimethyl pentose having $[\alpha]_{D}$ + 13·2° (1 per cent in methanol), n_{D} 1·4718, and OMe 47·9 per cent (theoretical value 48·0 per cent). An aqueous solution of the syrup did not restore the colour of Schiff's reagent immediately, nor did it reduce Fehling's solution in the cold. After treatment with methanolic hydrochloric acid in a sealed tube at 100°, the methoxyl content increased to 59·3 per cent (theoretical value for a pentose with four methoxyl groups, 60 1 per cent) and the optical rotation became lævo, $[\alpha]_{D}$ – 12·5° (1 per cent in methanol), while n_{D} fell to 1·4530. The increase in methoxyl content and the change in the direction of the optical rotation indicate the presence of a hydroxyl group at C 1, and hence some ring structure, most probably propylene-oxidic, for the molecule as a whole.

Progress in this investigation awaits the isolation of crystalline derivatives, since the absolute homogeneity of each fraction is not claimed; and indeed certain chromatographic evidence indicates that fraction 3 may contain more than one trimethyl pentose. It is obvious, however, that under the conditions normally employed in the Weerman degradation reaction, the changes which 3 : 5 : 6-trimethyl-*d*-gluconamide undergoes are considerable and complex and appear to involve loss of methoxyl.

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Vision with a Stabilized Retinal Image

The small movements of the eye which persist when a subject fixates (that is, tries to gaze steadily at a given target) have been studied by several workers[1]. We have endeavoured to deduce the movements of the image across the retina from a recent study of the rotations of the eyeball[2]. The movements of the retinal image have the effect of moving the boundary between two regions of differing brightness across the retinal pattern of receptors and may therefore play an important part in vision.

It should be possible, by the following method, to obtain an image which does not move across the retina. The subject wears a contact lens which is specially made to fit his eye tightly and on which a small optical flat has been worked. The flat is covered (by vacuum evaporation) with a highly reflecting opaque film of rhodium. An image I of the object O is focused on to the screen S by means of the optical system shown in Fig. 1. The mirror M is the flat on the lens which is attached to the subject's own eye. The observer views I by reflexion in M_1 and M_2. His visual axis is in the direction V (see Fig. 2). If the distances are suitably adjusted, a small rotation of the contact lens moves I in such a way that the image of I on the retina is stationary. With the simple optical system shown it is possible to obtain compensation for *either* horizontal *or* vertical movements. A more complicated system enables both movements to be compensated at the same time. The adjustment of the optical system may be checked if the eye is replaced by a telescope with a small plane mirror attached to its object glass. When the

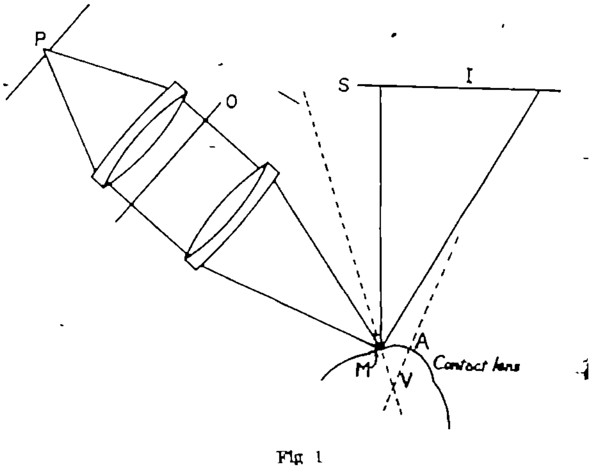

Fig 1

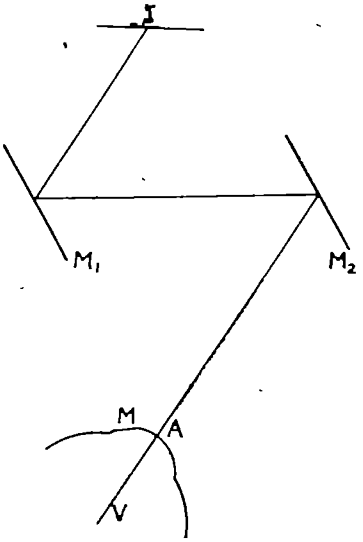

Fig. 2

adjustment is correct, the position of I with respect to the cross-wires is unaffected by a small rotation of the telescope.

Some preliminary experiments were made in 1945 by one of us (R. W. D.) in Dublin. It was found that the stabilized image disappeared at intervals. The results were not then published because they could not be repeated on every occasion, and because the necessary checks could not be made with the equipment then available. It was decided to use the contact lens method for studying the movements in detail before making another attempt to produce a stabilized image.

Recently, a fresh set of experiments has been carried out by the second author (B. L. G.). Only the horizontal components of the movements were stabilized. The object is shown in Fig. 3. The brightness of the right-hand area could be made 30, 40 or 60 per cent of that of the left-hand area. It was found that the line of demarcation disappeared and that A and B appeared to be of equal brightness for two or three seconds at intervals of about one minute. A second observer viewing I in the normal way did not observe any change. Similar effects were observed with other types of target. Although the effect is transitory, it is repeatable. The contrast threshold for the stabilized image is thus very much higher than the normal threshold for the same brightness. It seems that the eye recognizes that the situation is abnormal and makes some adjustment (possibly of accommodation) which temporarily defeats the stabilization causing the image to reappear.

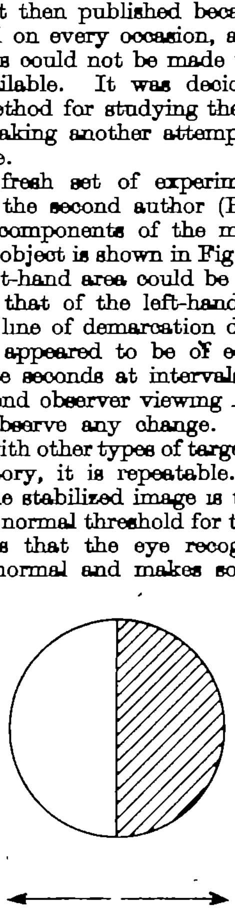

Fig. 3

The present experiments are regarded as showing, in a qualitative way, that the eye movements have a significant function. A further development of technique will be needed to obtain quantitative measurements.

One of us (B. L. G.) was in receipt of a maintenance grant from the Department of Scientific and Industrial Research during the period of this research.

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Some Speed, Error and Difficulty Relationships within a Problem-solving Situation

DURING the past three years, experiments have been conducted with subjects who have been given the task of solving mental-test items of a particular type[1] (Thurstone 'letter-series' items). Suppose P_C be the probability that a particular subject will continue to work at a particular problem for some time t before giving it up, and let P_E be the probability that if a solution is recorded within this time it will be the correct one. If the universe of discourse is now restricted to correctly solved items, the probability (P_S) that a particular correct solution will be returned within a period of t sec. after the moment the problem is presented will be a function both of the dynamics of the problem-solving process as such and also of P_C, for if $P_C \neq 1$ at time t then P_S must be modified, and if $P_C = 0$, P_S must be zero also. Let P_S be defined as the probability which would obtain if $P_C = 1$ for $t = \infty$. No comprehensive statement can be made about a person's ability to solve a problem which does not involve at least these three probabilities, that is, any attempt to measure 'intelligence' by mental-test methods should involve assessments of P_C, P_E and P_S.

No valid analysis of the experimental data can be made outside the range of difficulties defined by $D = 85$ and $D = 10$ (where D is as defined below) for reasons which will be discussed elsewhere. Within these limits, they strongly support the hypothesis that:

$$P_S = \int_0^t \frac{1}{\sigma_S\sqrt{2\pi}} \exp - (\log t - mD + S)^2/2\sigma_S^2 dt \quad (1)$$

$$P_C = 1 - \int_0^t \frac{1}{\sigma_C\sqrt{2\pi}} \exp (\log t - C)^2/2\sigma_C^2 dt \quad (2)$$

$$P_E = 1 - \int_0^D \frac{1}{\sigma_E\sqrt{2\pi}} \exp (D - E)^2/2\sigma_E^2 dD, \quad (3)$$

where σ_S, σ_C, σ_E all have the usual connotations for a normal distribution, D is the difficulty of the problem being considered, defined in the conventional but arbitrary fashion $D = [100 - R]$, and R is the percentage of an adult British population (unselected) who achieve success with the item; m is the slope

$d(\log t)/dD$, in the usual way. S, C and $\dot{E}$ are constants which define the subject's speed, continuance (a function of persistence) and solution–recognition–efficiency (see definition of P_E) within the test situation being studied.

If a problem is incorrectly solved, and if t_w is the time elapsing between the presentation of the problem and the recording of an incorrect solution, then:

$$P_w \text{ does not have the same form as } P_S, \qquad (4)$$

where P_w is the probability that the incorrect solution will be returned within a period t_w.

Equation (3) is of the same form as expressions suggested by Thorndike and Thurstone. So far as I know, (1) and (2) have not previously been advanced. The main interest of these results centres about (1), for there is very strong evidence that m and σ_S are identical for all the subjects who have so far been examined, not only within a particular test situation, but also between situations involving different degrees of motivation. $m = 0{\cdot}013$ (S.E.$_{\text{est.}} = 0{\cdot}0005$) and $\sigma_S = 0{\cdot}12$ (S.E.$_{\text{est.}} = 0{\cdot}005$), all values being in log-sec. units. The range of values of S encountered experimentally is such that as $D \rightarrow 0$ both m and σ_S must depart from these values. Such evidence as is available suggests that both parameters retain their values in the region $D > 85$. It seems probable that these two parameters can join Philpott's[2] fluctuation constants, p and T_0, bringing the number of true psychological constants up to four. There is presumptive, but not as yet conclusive, evidence that σ_C (1) is also a true constant.

It follows immediately from equations (1)–(4) that, when attempting to measure S, all the test items used should be easy and of identical difficulty, and that only items correctly solved can be used in calculating the score obtained. Existing methods of measuring mental speed ignore these requirements so completely that it seems justifiable to make this point even in a preliminary communication of this nature. Adherence to these principles has made possible the design of a speed-test which requires only some 15 min. to administer, and in connexion with which the concept of (statistical) 'reliability' can legitimately be used ($r_{11} \simeq 0{\cdot}9$). Equation (2) leads directly to a method of designing 'cognitive' tests in such a fashion that they can be scored for persistence as well as for the ability ostensibly under examination.

It is possible that σ_S results from the functioning of some kind of cerebral 'search' mechanism. For example, if the successful solution of a problem of difficulty D_b were to involve the bringing into relationship of b neural elements which had to be correctly selected in the right order from a pool of n elements, then we can postulate that for some time t_1 the search mechanism examines relationships involving less than b elements, so that no solution to a problem of difficulty D_b can ever occur during this time. At time $t_1 + \delta$ the first relationship involving b elements occurs, and relationships of this complexity continue to occur until all have been examined after time t_2. The suggestion is that σ_S is a function of the interval $(t_2 - t_1)$ and of the frequency with which correct solutions arise at different values of t within these limits, rather than of the error of determination of some value t_b which is the 'true' time for solution for all problems of difficulty D_b. The characteristics of a number of possible search mechanisms are now being examined in detail in the hope that the time-difficulty relationships of one of them will satisfy the requirements of equation (1), while at the same time being physiologically plausible. It is interesting to note that if the problem-solving process in any way resembles that suggested above, then item difficulty is a discontinuous variable, no values of D being possible between D_b and D_{b+1}.

This work has been carried out in the course of an investigation of methods of selecting students for universities which is sponsored by the Nuffield Foundation. Short papers presenting successive stages of the analysis were read before the Twelfth International Congress of Psychology[3] (Edinburgh 1948) and the British Psychological Society[4] (London 1950). A full report is being prepared for publication.

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Male Sterile Plants by Chemical Treatment

It is well known that treatment with 'growth hormones' reduces the fertility of plants. Not only do the 'auxins' seem to be antagonistic to the initiation of flowering, but also they reduce the number of seeds that develop from treated flowers, or they may cause total sterility. This effect is used in blossom-thinning sprays and in the production of parthenocarpic fruits.

The reasons for the sterility induced by chemical treatment have not yet been thoroughly investigated. Recently, Moore[1] and Naylor[2] reported that maleic hydrazide, a plant-growth inhibitor, produces only male sterility in maize, whereas the female flowers remain fertile and set seed after pollination with pollen from untreated plants. A method of inducing male sterility leaving the female organs fertile by a simple chemical treatment would be of great importance for the production of hybrid seed not only with maize but even more so with many other cultivated plants, where emasculation and pollination by hand are prohibitive to the production of hybrid seed on a large commercial scale, or where this method is impossible for technical reasons such as smallness of reproductive organs. Also with many breeding problems, for example, with beet, carrots, rye, such a method could be very helpful.

Plants of Hawksbury and Cape Mountain Sweet water-melons were treated with various concentrations of 2,4-dichlorophenoxyacetic acid, tri-iodobenzoic acid and maleic hydrazide. The chemicals were applied, about a week before the first flowers opened, to all parts of the plants in a hill as a spray in aqueous solution with a wetting agent. Degree and duration of male sterility were checked by pollinating protected female flowers from untreated plants with pollen from the treated plant. The female flowers of the treated plants were left open for pollination by insects.

The checking for male sterility was started one to three weeks after treatment. Full male sterility for more than one week was found with the following treatments: 10 p.p.m. tri-iodobenzoic acid, applied every week; 50 p.p.m. tri-iodobenzoic acid, application repeated once after four weeks; 250 p.p.m. tri-iodobenzoic acid, applied once; 5 p.p.m. 2,4-dichlorophenoxyacetic acid, applied every week. The pollen of the male sterile plants showed various abnormalities: grains with more or less vacuolated plasma, small, shrivelled, empty grains, and in the variety Cape Mountain Sweet, often a high percentage of giant, unreduced grains. In sterile pollen these visible abnormalities amounted always to 20 or more per cent.

The female flowers which opened in all these treatments during the period of male sterility were at least partly fertile. As with untreated plants, not all the female flowers set fruit, and some fruits grew only to a quarter or a half the size of normal fruits, but with fully developed seeds. The best fruit set was found with the plants treated with 250 p.p.m. tri-iodobenzoic acid, a very poor set with the plants treated weekly with 5 p.p.m. 2,4-dichlorophenoxyacetic acid, but this treatment had generally also a very detrimental effect on the growth of the plant.

Lower concentration of 2,4-dichlorophenoxyacetic acid and tri-iodobenzoic acid did not produce full male sterility. Maleic hydrazide was used only in the concentrations 250 and 500 p.p.m. These concentrations caused only a short inhibition of the vegetative growth, after which the plants were found fully fertile.

Laibach and Kribben[3] succeeded in increasing the proportion of female flowers in cucumbers by treatment with α-naphthalene acetic acid and β-indolyl acetic acid. The suppression of all male flowers would be another way of producing purely female plants. If applied to young water-melon plants, tri-iodobenzoic acid produces a higher proportion of female flowers (in two cases the first flowers which opened on a plant were female, whereas on untreated plants only male flowers open for some days before the first female flower appears), but never suppressed the formation of male flowers entirely. More successful was the treatment of a wild *Citrullus vulgaris* plant in full bloom which had only male and hermaphroditic flowers. Before treatment, this plant had a proportion of 10·1 male to 1 hermaphroditic flower. From the thirteenth to the twenty-second day after treatment with 50 p.p.m. tri-iodobenzoic acid, this changed to 0·8 male to 1 hermaphroditic, and for two days only hermaphroditic flowers opened. (During this period the bisexual flowers were self-sterile, the open-pollinated flowers set fruit.) A similar behaviour was shown by a cucumber plant in the greenhouse (variety Early Fortune), which after treatment with 25 p.p.m. tri-iodobenzoic acid produced five male and seven female flowers over a period of five days, and during two days only female flowers. (The male flowers were sterile; one of the female flowers developed seed after pollination with pollen from an untreated plant.)

As most of the work on parthenocarpy by chemical treatment has been done with tomatoes, some additional experiments were made with this plant. The plants were grown in pots in the greenhouse and treated about a week before the first flowers opened. Sterility for about eight weeks was obtained with 25, 50 and 100 p.p.m. tri-iodobenzoic acid and 10, 25 and 50 p.p.m. 2,4-dichlorophenoxyacetic acid, whereas 50 p.p.m. naphthalene acetic acid and 500 p.p.m. maleic hydrazide induced sterility for only 10–14 days. Crosses with pollen from untreated plants showed that the ovules of plants treated with 25 and 50 p.p.m. tri-iodobenzoic acid are able to produce seed during the period of sterility. 2,4-Dichlorophenoxyacetic acid in the concentrations used inhibits growth and flower formation for several weeks and seems to impair also the fertility of the female organs; no definite conclusions on the female fertility of the tomato plants treated with this substance can be made at this stage. The microscopic examination of the sterile tomato pollen showed visible abnormalities of the grains, various degrees of vacuolization, or coagulation of the plasma, or a certain percentage of small, empty grains.

It has been shown that treatment with certain growth-regulating substances produces male sterility in cucurbitaceous plants and in tomatoes for periods of one to several weeks.

These investigations are being continued. A full report will be published elsewhere.

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Detoxication of Hormone Herbicides by Soil Bacteria

The selective herbicides 2,4-dichlorophenoxyacetic acid (DCPA) and 2-methyl-4-chlorophenoxyacetic acid (MCPA) are known to undergo a gradual detoxication in soil due to biological agencies, and Audus[1,2] has recently reported the isolation of a bacterium capable of decomposing the former, which is apparently utilized as a source of carbon. In the course of work on herbicide detoxication in soil, we have succeeded in isolating two types of bacteria with similar properties from soil repeatedly treated with 2,4-dichlorophenoxyacetic acid. Pure cultures were readily obtained by plating from soil on an agar medium containing 0·10 per cent sodium salt of the acid as the sole source of carbon. The first organism (No. 1) grew abundantly in ordinary bacteriological media and was identified as *Flavobacterium aquatile* (Bergey[3]). The second (No. 2) bore some morphological resemblance to the organism studied by Audus —small, irregular, non-spore-forming, non-motile rods of a *Corynebacterium*-like appearance, but Gram-negative, sometimes with Gram-positive granules. It grew very feebly in ordinary media and showed no conspicuous biochemical activities; but on ammonium phosphate agar with 0·1–0·2 per cent sodium salt of 2,4-dichlorophenoxyacetic acid or 2-methyl-4-chlorophenoxyacetic acid it produced a slow but eventually quite vigorous, whitish and slimy growth. A mere trace of growth occurred on the basal medium without added organic matter. Glucose and glycerol were utilized very poorly; phenol, sodium benzoate and sodium salicylate not at all.

Measurements of the evolution of carbon dioxide from garden soil plus 0·01 per cent sodium salt of either acid, inoculated with cell suspensions of the two bacteria, showed that 50–100 per cent of the carbon added in the herbicides was liberated as carbon dioxide after two to three weeks at 25° C. After the experiment, tests with barley seedlings (percentage germination, and weight of sprouts) showed that the toxic effect of 2,4-dichlorophenoxyacetic acid had been completely abolished by both bacteria, and that of 2-methyl-4-chlorophenoxyacetic acid also by Bacterium No. 2. Cultures of both bacteria, when freshly isolated, also detoxified the former in solid (2 per cent) agar medium with ammonium phosphate as a source of nitrogen (see Table 1).

Table 1. INCUBATION 28 DAYS AT 25° C

Medium	Percentage germination of barley	Fresh weight per 100 sprouts of barley (gm.)
Agar + 0·005 *M* DCPA, sterile	9	0·22
„ inoculated with *F. aquatile*	98	6·28
„ inoculated with Bacterium No. 2	98	5·03
Sterile agar without DCPA.	99	6·63

Unlike Audus[1,2], we observed no significant detoxication by either organism in semi-solid (0·2 per cent) agar medium, or in soil extract.

After several transfers, *F. aquatile* grew very feebly on 2,4-dichlorophenoxyacetic acid but was still able to decompose this substance in sterile soil, like Bacterium No. 2, which also decomposed 2-methyl-4-chlorophenoxyacetic acid.

Table 2. GARDEN SOIL STERILIZED BY AUTOCLAVING AND INCUBATED AT 25° C. FOR FIFTEEN DAYS (WITH 2,4-DICHLOROPHENOXYACETIC ACID) OR FOR FOURTEEN DAYS (WITH 2-METHYL-4-CHLOROPHENOXYACETIC ACID)

Treatment	Percentage germination of barley	Fresh weight per 100 sprouts of barley (gm.)
Soil without addition, sterile	96	4·30
Soil + 0·01 per cent DCPA (sodium salt), sterile	47	0·79
„ inoculated with *F. aquatile*	98	4·31
„ inoculated with Bacterium No. 2	95	4·49
Soil without addition, sterile	96	4·86
Soil + 0·01 per cent MCPA, sterile	43	0·95
„ inoculated with Bacterium No. 2	95	4·64

In other experiments we obtained complete detoxication of 0·01 per cent 2,4-dichlorophenoxyacetic acid by *F. aquatile* in five days, but this organism was not active towards 2-methyl-4-chlorophenoxyacetic acid.

Two entirely different species of bacteria, one of which may be related to Audus's organism, are thus able to detoxify 2,4-dichlorophenoxyacetic acid, and one of them also 2-methyl-4-γ-chlorophenoxyacetic acid. The very feeble growth of the latter organism in all media except those containing the two herbicides suggests that it may be an induced mutant of some other soil bacterium which has become specialized in the utilization of a few cyclic compounds.

The results of our experiments will be published in detail elsewhere.

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Root Parasites in Loranthaceæ

THE plant family Loranthaceæ (mistletoes, etc.) contains several hundred species, almost all partial parasitic shrubs growing on the branches of trees. The following species are terrestrial shrubs or trees: *Nuytsia floribunda* R.Br., of Western Australia, several South American species of *Gaiadendron* G. Don, and *Atkinsonia ligustrina* (A. Cunn. ex F. Muell.) F. Muell., which is known only from the Blue Mountains of New South Wales, where it occurs sporadically on dry, rocky ridges. This small group of terrestrial species is stated by various authors (for example, Macgregor Skene[1]; Moore and Betche[2]) to be non-parasitic; but Herbert[3] has shown that *Nuytsia floribunda* is a root parasite, as was indeed conjectured by Harvey[4] in 1854. It attacks a wide range of hosts, including both native and introduced species. *Atkinsonia ligustrina* has now been investigated at Woodford, N.S.W., and shown to form haustoria attached to the roots of several host species, including *Acacia intertexta* Sieb., *Platysace linearifolia* (Cav.) Norman (syn. *Trachymene linearis* Spreng.) and the narrow-leaved form of *Leptospermum attenuatum* Sm. Thus, of the terrestrial Loranthaceæ, only the species of *Gaiadendron* (with which *Atkinsonia ligustrina* was associated systematically by Bentham and Hooker[5] and by Engler[6]) are not known to be parasitic. It would not be surprising if they too should prove to be root parasites.

It is hoped to publish elsewhere some details of the relations between *Atkinsonia* and its host plants.

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Observation of Egg-laying under Water of the Aerial Insect *Hydropsyche angustipennis* (Curtis) (Trichoptera)

DOUBT has existed about the mode of egg-laying in certain caddis flies, especially those the eggs of which are found under water in flat sheets cemented to the lower surface of stones. Accounts for most of these species are based on indirect evidence and incomplete observation. Consequently the following direct observation on the entry of *Hydropsyche angustipennis* into a watery medium may be of interest.

Unlike many Trichoptera, this caddis fly is not crepuscular, and on a sunny June afternoon an imago was observed alighting on a stone projecting above the water surface in an upland stream at Craigton, near Glasgow. She remained there for some moments with her antennæ bending over so that the tips were in the water, then suddenly flew up two or three feet, zig-zagged rapidly over the stream for a few yards and dived vertically down into the water. Air carried down on the hairy, folded wings gave her a silvery appearance as she swam rapidly straight to the lower surface of an inclined submerged stone. The stream here was about 9 cm. deep and the current velocity less than 15 cm. per second. These observations tend to confirm Wilson's remarks on *Stenopsyche* as recorded by McLachlan[1]. When, after a few seconds, the stone referred to above was raised and the female captured *in situ*, it was found that she had already deposited some eggs in a flat sheet with transparent, colourless cement between them. The captured female was kept in captivity, surviving for two days during which she again entered the water and laid some 460 eggs while continuously submerged for 37 min. Details of these observations will be given in a later paper.

The method of respiration enabling this aerial insect to remain under water for so long while performing strenuous activities requires further investigation. Possibly air carried down on the hairy body surface functions as a physical gill. It is doubtful whether a plastron is formed in caddis flies; it has only been demonstrated in certain aquatic beetles and in the bug *Aphelocheirus*[2].

In *H. angustipennis* there are no striking morphological adaptations for swimming such as have been described by McLachlan as indicative of possible swimming powers in *Amphipsyche*[3]. The female imago of *H. angustipennis* is bigger than the male; but relative to body-size there is little difference in the limbs of the two sexes. A fringe of hairs found only on the mesothoracic tarsi of the female might possibly aid in swimming.

The observations noted above may be significant in considering the ecological distribution and population density of this species; for example, the speed of the current may affect the ability of the female to reach suitable sites for oviposition and become a limiting factor in determining distribution.

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Jan. 25.

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[1] McLachlan, R., *Ent. Mon. Mag.*, 21, 234 (1885).

[2] Thorpe, W. H., and Crisp, D. J., *J. Exp. Biol.*, 24, 227 (1947).

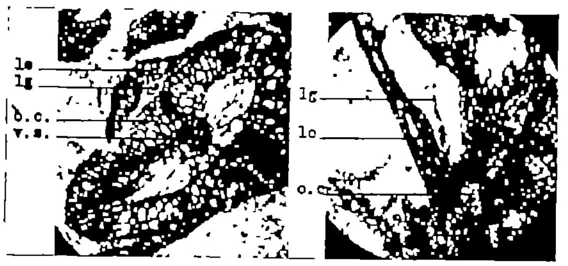
[3] McLachlan, R., "A Monographic Revision and Synopsis of the Trichoptera of the European Fauna", 7, 351 (London, 1878).

A Ligulate Pteridophyte from the Lower Coal Measures of Bacup, Lancashire

THE specimen to be described is a coal-ball petrifaction from the Old Meadows Pit, Bacup, Lancashire, and consists of a main axis, which followed a very sinuous course in the coal-ball. Of this axis the tissues of the outer cortex and the stelar xylem only are preserved, there being a wide space between the outer cortex and the central stele.

Interest in the specimen was stimulated by the observation that curious appendages were borne on the main axis, these appendages being very similar to Stigmarian rootlets but bearing ligulate leaves.

The vascular cylinder of the main axis, like the whole axis, followed a sinuous course in the coal-ball and only xylem tissue is preserved. The xylem consists of a solid core of primary xylem and some secondary xylem. The primary xylem is of scalariform tracheids only, with no recognizable protoxylem, although the central elements are smaller than the peripheral ones. In transverse section the secondary xylem appears as wedges of regularly arranged elements separated by wide primary medullary rays, the tissues of which are not preserved, but in each ray a xylem trace passes out from the primary xylem. These rays and xylem traces are clearly seen in longitudinal sections, and in longitudinal tangential sections the secondary xylem presents the appearance of an anastomosing network of elements with a xylem trace in the centre of each mesh. The secondary xylem elements are tracheidal in nature, show scalariform thickening, but are narrower and very much shorter than the primary xylem elements. Where preservation is sufficiently good, both primary and secondary xylem elements show the fine threads of thickening extending in a vertical direction between the transverse bars of thickening, a feature characteristic of the xylem of Lepidodendroid plants. The stelar xylem as a whole measures 2·5–3·0 mm. in diameter and the primary xylem 1·25–1·5 mm. in diameter.



(*A*) (*B*)

A, Transverse section leafy appendage. *B*, longitudinal section outer tissues of leafy appendage (× 25). *le*, leaf, *lg*, ligule, *o.c*, outer cortex, *v.s.*, vascular strand

The preserved remains of the cortex of the main axis, which is outer cortex, may be divided into two zones. The outer zone is part of the original outer cortex, while the inner zone, consisting of regular thin-walled cells, is phelloderm developed centripetally from a phellogen situated just inside the outer zone. No evidence can be found of leaves being borne on the main axis; but embedded in its outer cortex are the bases of the curious leafy appendages, which thus appear to arise endogenously.

The leafy appendages are bud-like structures, 1·5 mm. average diameter, with monarch xylem of rarely more than six tracheids. The tissue immediately outside the xylem is badly preserved and its nature is indeterminate (Fig. *A*). Between the monarch vascular strand and the outer cortex in the better preserved examples are strands of cells forming trabeculæ. Borne on these appendages are leaves, 3·3 mm. long, 0·6 mm. wide and 0·15 mm. thick at the base. These leaves possess neither vascular tissue nor stomata, and they are definitely ligulate (Figs. *A* and *B*). The ligule is 0·33 mm. long, four or five cells wide at the base and two cells thick, except at the tip.

Transverse and longitudinal sections of the cortex of the main axis show these appendage origins as cylindrical masses of parenchymatous tissue, in the centre of each of which is a very small vascular strand. Passing outwards through the cortex the vascular strand becomes better developed, but the parenchymatous cells around it become disorganized except for the trabeculæ. After careful searching it has been found impossible to show any connexion between the xylem of these appendages and the xylem of the traces which depart from the periphery of the primary xylem of the main axis.

The leafy appendages raise very interesting points. They may represent fully developed adult structure or they may be young stages of an arborescent type, or they may be organs of vegetative propagation.

In some respects the specimen is reminiscent of *Stigmaria bacupensis* Scott et Lang[1]; for example, in size. The diameter of the main axis, of the stele and of the appendages are all of the same order as in *S. bacupensis*; but this new specimen differs from *S. bacupensis* in the following features: (1) the protostele has no recognizable protoxylem; (2) the cortex of the main axis has quite a different structure; (3) the outer cortex of the appendages differs from the outer cortex structure of the rootlets of *S. bacupensis*; (4) the appendages bear leaves.

The structural features of this new specimen suggest a Stigmarian axis bearing appendages rather similar to Stigmarian rootlets; but the appendages of this new plant bear leaves and the leaves bear ligules. It may be that this new specimen indicates that the so-called rootlets of *Stigmaria* are really of stem nature. In this connexion it is interesting to note that in the same coal-ball and in close proximity to the specimen just described are remains of outer cortical tissues which are identical in structure with those of the new specimen, but this cortex bears ordinary Stigmarian rootlets and not leafy appendages.

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---

[1] Leclercq, S., *Ann. Bot.*, 44, 31 (1930).

Supra-vital Staining of Striated Muscle with Tetrazolium Compounds

The fact that a nearly colourless solution of 2 : 3 : 5 triphenyl tetrazolium chloride (tetrazolium salt) is reduced to a red formazan in contact with living tissue has been recognized for some time. This has been used in testing for viability and also for staining tissues; but detailed descriptions of the colour distribution within tissues are lacking. Since the red colour is due to reduction of the agent, the colour distribution should offer some evidence as to the intracellular distribution of reducing groups.

In the present work, small strips of striated muscle from freshly killed mice have been teased out in a 0·1 per cent solution of tetrazolium in normal saline or Ringer–Locke solution. The preparations were mounted under cover slips, ringed with a 'Vaseline'-wax mixture and examined immediately. The red colour appears within 3½ min. and continues to intensify until all the muscle fibres are deeply stained. Under the high-power microscope, the colour is seen to be concentrated in transverse bands in the muscle, while the intervening bands are but faintly stained; a narrow band of intermediate staining intensity traverses the centre of the faint band. This is illustrated in Fig. 1. Apart from the coloration, the appearance is very similar to that seen in a phase-contrast picture (cf. Fig. 2).

Experiments with the related compounds 2,2′-(*p*-diphenylene)-*bis*(3,5 diphenyl tetrazolium chloride) (neotetrazolium) and 2-(*p*-iodophenyl)-3-(*p*-nitrophenyl)-5-phenyl tetrazolium chloride (iodotetrazolium) have given similar results. In the case of neotetrazolium, the reduction colour is a deep purple-black, and in some preparations the longitudinal striæ of the muscle fibres have also appeared. The distinctive distribution of the colour is strongly suggestive of a similar distribution of reducing groups within the muscle fibre. Since the overall picture remains the same despite intensification of the colour, it appears unlikely that the result achieved is dependent upon differential rates of infiltration of the agent into the various portions of the muscle fibre.

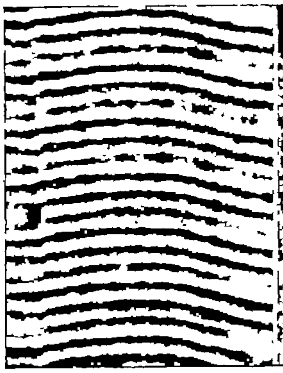
Fig. 1. Striated muscle stained with tetrazolium. (× 1,500)

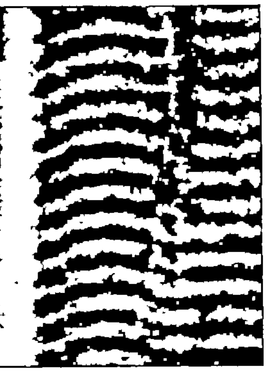
Fig. 2. Striated muscle, unstained (phase contrast. × 1,500)

It appears, then, that these salts not only provide a useful tool for histological demonstration, but may also offer evidence as to the distribution of cellular components.

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Noradrenaline and Accessory Chromaffin Tissue

Fulk and Macleod[1] showed that the retro-peritoneal tissue of many mammals contains a material which, like extracts of the suprarenal glands, produces inhibition of the isolated rabbit intestine and excitation of the isolated rabbit uterus. Using histological methods, Wislocki[2] confirmed that there is abdominal chromaffin tissue in these animals. Whereas Mulon[3] showed that the chromaffin tissue in the carotid bodies of horses contains a pressor substance, Fulk and Macleod[1] failed to obtain any sympathomimetic substance in extracts of the thoracic aorta (containing the chromaffin tissue of the cardioaortic bodies). Recently, West, Shepherd and Hunter[4] reported that the collection of chromaffin tissue known in babies as the organs of Zuckerkandl contains large amounts of noradrenaline. The paraganglia are situated along the aorta near the origin of the inferior mesenteric artery. We have therefore attempted (*a*) to confirm that a sympathomimetic substance is present in accessory chromaffin tissue of animals, and (*b*) to identify such a substance by biological and chromatographic methods[4].

The results shown in the accompanying table indicate that large amounts of noradrenaline may be found in the retro-peritoneal tissue of young dogs, rabbits, guinea pigs and cats, and in certain cases

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BROADCASTING AND TELEVISION IN GREAT BRITAIN

THE Government's Memorandum on the Report of the Broadcasting Committee*, which was published as a White Paper on May 15, dropped one of the proposals of its predecessors which had been much criticized as likely to endanger the independence of the British Broadcasting Corporation and expose it to pressure from local sectional if not party political interests. It included three new proposals, however, which have met with strong independent criticism cutting right across political party lines. Nevertheless, following debates in the House of Lords on May 21 and 26, the White Paper was approved in the House of Commons on June 11 after a debate which left considerable room for doubt whether that approval would, in fact, have been obtained on a free vote. Afterwards, on June 19, the Prime Minister announced that the proposal for a new method of electing the governors of the British Broadcasting Corporation would be abandoned, and hopes were raised that the Government would no longer insist on making the question of broadcasting policy a party issue. The new licence and agreement of the British Broadcasting Corporation with the Postmaster General, published on June 13, were, however, adopted on June 23 after a debate in which the House of Commons again divided on party lines, and a new Royal Charter for the British Broadcasting Corporation was promulgated by Order in Council on June 24.

No matter who was mainly responsible, making broadcasting policy a party issue will be generally regretted by that large volume of responsible opinion which has followed the discussion of the future of British broadcasting since the Beveridge Committee reported early last year. The recent debates in Parliament made it clear that on all the main issues the division of opinion does not lie on party lines. On balance, the general trend of opinion seems to be in favour of continuing the present arrangements broadly on the lines recommended by the Beveridge Committee, without prejudice to the issue of monopoly, or to the exact form which regionalism or decentralization might take owing to technical development in the next few years. Indeed, the discussions in Parliament were marked by the same open-mindedness on the question of monopoly as has characterized most public discussions on broadcasting policy during the past two years, even on the part of those who expressed the greatest admiration for the achievements and character of the British Broadcasting Corporation. There is a widespread distrust of the policy of continuing indefinitely to give to any one body the responsibility for an instrument which can influence so powerfully for good or evil the minds of men and women.

The debates scarcely did justice to the extent to which this sense of social responsibility marks discussion of this question outside the Houses of Parliament, particularly where television is concerned. It is this sense of social responsibility with regard to something the significance of which is at present only dimly appreciated that is behind the distrust with which anything like 'sponsored' or commercial broadcasting is widely regarded. It is considered unwise to place such powers anywhere but in the hands of a body with high standards of public service to maintain.

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* Broadcasting: Memorandum on the Report of the Broadcasting Committee, 1949. (Cmd. 8550.) Pp. 10. (London: H.M. Stationery Office, 1952.) 6d. net.

To this feeling the Government has done less than justice. Moreover, there is some room for doubt as to whether developments in television or in sound broadcasting, for example, in very-high-frequency broadcasting, need be quite so delayed by stringencies in capital resources, labour or materials as the White Paper suggests. The Government's inept handling of the whole matter has itself encouraged what are possibly quite unfounded doubts of its sincerity. By committing itself to a particular way of ending monopoly when there is a general readiness to consider impartially whether there are alternatives which can offer wider choice to the viewer or listener and at the same time maintain the present high standards of public service, it has exposed itself needlessly to the charges of yielding to sectional interests in matters which should be determined by technical inquiry and the public interest. It might be added that the Government's own proposals, so far as the British Broadcasting Corporation is concerned, may be expected, as indeed were those of Mr. Attlee's Government, to strengthen, through the inhibitions and restrictions they propose, the ossification which is almost inherent in any large organization with the passage of time.

Technical factors are a main reason for regretting the Government's determination to make broadcasting a party issue. The decision, moreover, does not assist a satisfactory solution of the other main problems—regionalism and the method of appointing governors. Here again an agreed and impartial solution demands more searching inquiry and constructive thought than was manifest in the Parliamentary debates. Disregarding speeches, such as those of the Lord Chancellor, which gave colour to the view that the White Paper represents a surrender to commercial interests or small pressure groups of extremists, even such reasonable and lucid speeches as those of Sir David Maxwell Fyfe in opening the debate on June 11 were sometimes a little naive. The Government cannot claim, without discrediting itself, that it has had only a few weeks to consider the future pattern of broadcasting before the Charter and licence of the B.B.C. expired. It has been obvious since the Broadcasting Committee issued its report in January 1951 that this was an issue on which any government in power would have to make up its mind before the end of the year.

The immediate need is for all who realize how large an influence both sound broadcasting and television have come to play in the lives and minds of the community to seek to prevent any further surrender to such political or commercial interests and to work out both the technical and the administrative measures essential to prevent either the lowering of standards or the abuse of power. The real questions are not brought out clearly in the Government's White Paper any more than in that of its predecessor last July. Even Sir David Maxwell Fyfe's careful summary of the arguments for and against monopoly in his speech on June 11 gave insufficient weight to the extent to which the question of 'sponsored' programmes has widened out to the complex question of whether monopoly is the best form of organization for broadcasting. It is assumed too readily that the only alternative to the sponsoring of programmes by advertisers is monopoly, and there have been few signs of any disposition to enter on the hard thought which must precede the evolution of any new system which could avoid the dangers and disadvantages of either the present monopoly or sponsoring by advertisers.

That, however, is the immediate task. The Government's proposal to permit some element of competition in the expanding field of television, when calls on capital resources make this feasible, and the promise that Parliament should in any event have an opportunity of considering, before the licensing of the first station, the terms and conditions under which competitive television would operate, will at least give further time for reflexion. The Government's own memorandum admits that it would be necessary to introduce safeguards against possible abuses and that a controlling body would be required for this purpose; indeed, the conditions proposed are, in fact, so onerous that it is difficult to imagine anyone risking capital on them, and that they have aroused such alarm is rather a measure of the extent to which the Government's good faith is distrusted.

On this point two further observations may here be made. First, that distrust might well have been less had the Government proposed to take the first step towards competition in broadcasting by letting broadcasters compete in public service. There would then have been no reason for the suspicion that business interests rather than the desire to afford the viewing public some choice of programmes has been the deciding factor. The second point is that some technical opinion is strongly opposed to any such distinction being made between television and sound broadcasting, holding that they should be encouraged to grow together, instead of being kept apart. This argument may well gain further support if sound broadcasting and television are considered as cultural factors and even as determinants in the social life and thought of the nation. That aspect, so powerfully emphasized in a recent report by Robert Silvey, head of B.B.C. Audience Research, published in the *B.B.C. Quarterly*, received less than its due notice in the debates, apart from incidental reference by Mr. Herbert Morrison. Mr. Silvey's picture of the way in which television is spreading rapidly among the lower-income groups of Britain, who now hold much the larger proportion of viewers, and its effect on family habits and leisure, emphasize what an important social factor television has already become and what grave dangers could attend its abuse by any sectional or commercial interest.

ABSOLUTE AMOUNTS (μGM.) OF ADRENALINE AND NORADRENALINE IN ANIMAL TISSUES

Species	Age	No. of expts.	Suprarenals		Retro-peritoneal tissue	
			Adrenaline	Noradrenaline	Adrenaline	Noradrenaline
Rabbit	*In utero*	6	0	4	0	4
	1 hr.	8	4	5	0	12
	1 day	4	0	7	0	5
	2 days	10	5	5	0	5
	4 days	6	10	2	0	2
	Adult	8	92	0	0	0
Dog	1 day	1	10	10	0	15
	6 days	1	45	20	0	12
	9 days	1	50	25	0	10
	Adult	1	500	200	0	0
Cat	*In utero*	4	3	10	0	3
	12 hr.	4	16	70	0	25
	1 day	2	20	70	0	10
	3 days	2	40	60	0	5
	Adult	10	120	80	0	0
Guinea pig	*In utero*	2	0	5	0	10
	1 hr.	2	5	5	0	10
	2 days	4	20	5	0	3
	Adult	8	71	0	0	0

this amount exceeds that found in the suprarenal glands. These additional chromaffin structures must therefore perform some autonomic function early in life—perhaps the maintenance of blood pressure. As the animal grows older and the suprarenal medulla matures, so the amine content of this accessory tissue declines. On the other hand, extracts of the carotid bodies and of the aortic bodies of rabbits, cats and guinea pigs did not yield any sympathomimetic material. This may not be so surprising, since chromaffin tissue is not necessary for the production of adrenaline and noradrenaline. Precursors of noradrenaline, such as hydroxytyramine and dihydroxyphenylalanine, were not detected in any of the above extracts.

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[1] Fulk, M. E., and Macleod, J. J. R., *Amer. J. Physiol.*, **40**, 21 (1916).

[2] Wislocki, G. B., *Bull. Johns Hopkins Hosp.*, **33**, 359 (1922).

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Effect of Cortisone on the Blood Pressure of Normal Rats

THE importance of the adrenal cortex in the regulation of the blood pressure has recently been emphasized by several authors. The effect of prolonged treatment with high doses of cortisone on the rat's blood pressure was therefore investigated.

Seventy-two male white rats weighing 144 ± 3 gm. were fed on a synthetic diet containing 30 per cent proteins, 56 per cent carbohydrates, 10 per cent lipids, 4 per cent McCollum salt mixture and supplements of vitamins and lipotropic factors; water was allowed *ad libitum*. Forty-six rats were injected subcutaneously with 5 mgm. of cortisone acetate ('Cortone', Merck) daily for twelve days; 26 controls received injections of 0·9 per cent sodium chloride solution. The blood pressure was measured by the method of Friedman and Freed[1]; in ten experimental animals and in ten controls the electroencephalogram was taken (lead 2) and their plasma and blood volumes were determined after a fast of 12 hr., using Evans blue according to the method of Wang and Hegsted[2].

The mean blood pressure of the controls was 119 ± 3·5 mm. mercury at the beginning of the experiment; after twelve days the value was practically unchanged (121 ± 4 mm. mercury). In the cortisone-treated rats the blood pressure increased from the initial value of 115 ± 3 mm. mercury to 140 ± 5 mm. after twelve days of treatment. The difference is statistically significant ($P < 0{\cdot}01$). No definite modification of the electroencephalogram was found, except a significant increase of the heart-rate in the cortisone group (440 ± 15 beats per min. against 340 ± 11 in the controls).

At the end of the experiment, plasma and blood volumes were respectively 3·6 ± 0·2 c.c. and 6·8 ± 0·3 c.c. in the controls and 3·5 ± 0·4 c.c. and 6·6 ± 0·8 c.c. in the cortisone-treated animals (values referred to 100 gm. final weight). The weight of the heart and of the kidney was increased in the cortisone group, when referred to 100 gm. final body-weight, but remained unchanged when referred to 100 gm. initial body-weight. Histological examinations failed to show arterial lesions in the kidneys and the heart in either of the two groups.

Our observations suggest that large doses of cortisone given to normal rats fed on a balanced diet and with a normal intake of sodium chloride have a hypertensive effect, which seems to be accompanied by an increase of the heart-rate. It is not associated with changes of the blood volumes or with vascular lesions in the kidney.

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[1] Friedman, M., and Freed, S. C., *Proc. Soc. Exp. Biol. and Med.*, **70**, 670 (1949).

[2] Wang, C. F., and Hegsted, D. M., *Amer. J. Physiol.*, **156**, 227 (1949).

A Unit of Wave-number

A YEAR ago[1], names suggested for the unit 'cm.$^{-1}$' were permicron, Rydberg and Balmer. In a recent review[2] of "Modern Interferometers", Prof. W. F. Meggers advocates 'Kayser'. Where early workers used the reciprocal of the wave-length in air, H. Kayser recognized that in complex spectra the wave-length in vacuum is essential, and so gave to 'cm.$^{-1}$' its proper definition. Moreover, he compiled the tables still used in the conversion. These arguments are convincing; the more so as Rydberg is commemorated by a constant and Balmer by a series, while K is here a more convenient symbol than R.

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[1] Bayliss, N. S., *Nature*, **167**, 367 (1951). Candler, C., *Nature*, **167**, 649 (1951). Bladergroen, W., *Nature*, **167**, 1075 (1951).

[2] Meggers, W. F., *J. Opt. Soc. Amer.*, **41**, 106 (1951)

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, July 7

ROYAL SOCIETY OF EDINBURGH (at 24 George Street, Edinburgh), at 4.30 p.m.—Prof. James Kendall, F.R.S.: "The First Chemical Society, the First Chemical Journal and the Chemical Revolution".

Monday, July 7—Saturday, July 12

INTERNATIONAL DIABETES FEDERATION (at Leyden, the Netherlands)—First International Congress.

MINISTRY OF FUEL AND POWER (at the Safety in Mines Research Establishment, Buxton).—Seventh International Conference of Directors of Safety in Mines Research.

Thursday, July 10—Friday, July 11

PHYSICAL SOCIETY (at Glasgow)—Summer Meeting.

Friday, July 11

UNIVERSITY OF LONDON (in the Clinical Theatre, Middlesex Hospital, Mortimer Street, London, W.1), at 5.30 p.m.—Prof. L. T. Samuels (Utah): "Enzymes Involved in the Synthesis of the Steroid Hormone".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT LECTURER IN THE DEPARTMENT OF PHARMACEUTICS—The Clerk to the Council, School of Pharmacy, 17 Bloomsbury Square, London, W.C.1 (July 10).

BERRIDGE STUDENTSHIP IN PHYSIOLOGY as applied to public health—The Registrar, King's College, Strand, London, W.C.2 (July 11).

ASSISTANT (Grade B) to teach PURE MATHEMATICS to Intermediate Degree and PRACTICAL MATHEMATICS to A1 level, at the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (July 12).

ASSISTANT LECTURER (temporary) IN BIOCHEMISTRY—The Registrar, The University, Sheffield (July 12).

PHYSICIST (with an honours degree in physics) to the Radiotherapeutic Department—The Group Secretary, Ipswich Group Hospital Management Committee, Anglesea Road, Ipswich (July 12).

SCIENTIFIC OFFICER (with a first-class or a good second-class honours degree in either physics or mechanical sciences) at the Agricultural Research Council's Unit of Soil Physics at Cambridge—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (July 12).

LECTURER IN CIVIL ENGINEERING at University College, Dundee—The Secretary, The University, St. Andrews (July 15).

GRADUATE ASSISTANT IN STATISTICS, for teaching, consultation and research in statistical science and biometry—The Lecturer in the Design and Analysis of Scientific Experiment, 6 Keble Road, Oxford (July 18).

READER IN EXPERIMENTAL FLUID MOTION AND DIRECTOR OF THE LABORATORY—The Registrar, The University, Manchester 13 (July 21).

CHAIR OF BACTERIOLOGY in the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (July 26).

DEMONSTRATORS (2, with qualifications in microbiology, biochemistry, or related subjects) IN THE DEPARTMENT OF MICROBIOLOGY—The Professor of Microbiology, The University, Reading (July 26).

HEAD OF THE CHEMISTRY LABORATORIES at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/490 (July 26).

LECTURER IN ELECTRICAL ENGINEERING (with special reference to electrical machines and heavy current engineering)—The Secretary, University College, Gower Street, London, W.C.1 (July 28).

LECTURER IN MECHANICAL ENGINEERING at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

PROFESSOR OF APPLIED MATHEMATICS in the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

VENTILATING ENGINEER in the Naval Construction Department of the Admiralty, Bath—The Ministry of Labour and National Service, Technical and Scientific Register, 26 King Street, London, S.W.1 (July 31).

TECHNICAL OFFICER (with a university degree in science with botany as major subject, or diploma of agricultural college, or equivalent qualifications; experience in cytological techniques essential) IN THE DIVISION OF PLANT INDUSTRY, Canberra, to assist the Chief of the Division and other officers engaged in cytological investigations—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3883 (August 9).

CHAIR OF ARCHITECTURAL SCIENCE in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 11).

DEPUTY PRINCIPAL INSPECTOR (in London) OF MECHANICAL ENGINEERING IN MINES AND QUARRIES, an INSPECTOR (in London) OF MECHANICAL ENGINEERING IN MINES AND QUARRIES, and INSPECTORS (5, in the Provinces) OF MINES AND QUARRIES—The Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting S.4153/52 (August 13).

CHAIR OF MATHEMATICS in University College, Dundee—The Secretary, The University, St. Andrews (August 15).

GEOPHYSICAL PROSPECTING OFFICER (with a degree in geology, and preferably with training or experience in geophysical prospecting methods) IN THE IRRIGATION DEPARTMENT, Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (August 15).

LECTURER IN PSYCHOLOGY at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

LECTURER IN ZOOLOGY at Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

SENIOR LECTURER IN PHILOSOPHY at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

LECTURER IN AGRICULTURAL ENGINEERING at Canterbury Agricultural College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 16).

CHAIR OF BOTANY in the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 30).

LECTURER (Chief Lecturer or Senior Lecturer grade) IN VETERINARY PATHOLOGY at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 31).

EDWARD A. DEEDS SENIOR FELLOWSHIP for research in physical science, viz., engineering, metallurgy, chemistry, physics, mathematical physics, or any cognate subject—The Secretary, University College, Dundee (September 1).

CHAIR OF APPLIED MATHEMATICS—The Registrar, University College, Exeter.

DEMONSTRATOR IN THE DEPARTMENT OF ENGINEERING—The Secretary and Registrar, The University, Southampton.

LECTURER and an ASSISTANT LECTURER IN CHEMISTRY—The Secretary, Royal Technical College, Glasgow.

MECHANICAL ENGINEER (Road Plant) IN THE PUBLIC WORKS DEPARTMENT, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'M/H Roads 1806'.

PHYSICIST (with a university degree in physics, or equivalent qualification, and an interest in experimental work on plant in actual operation) for research in Sheffield on methods of measurement and control of metallurgical furnaces—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

PRINCIPAL RESEARCH CHEMIST in the Division of Atomic Energy (Production), Windscale Works, Sellafield, to lead a section engaged on applied research work on a wide range of problems associated with the development of atomic energy (mainly in the field of inorganic and physical chemistry)—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 347.

RESEARCH FELLOWSHIP IN MECHANICAL ENGINEERING—The Registrar, The University, Nottingham.

TECHNICAL ASSISTANT IN THE FUEL SECTION of the Plant Engineering Division in London; the work initially will be largely in connexion with the utilization, instrumentation, and design of furnaces, and with operational studies involving the heating and cooling of steel ingots—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Fuel'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal Commission on University Education in Dundee, 1951–52: Report. (Cmd. 8514.) Pp. 75. (London: H.M. Stationery Office, 1952.) 2s. 6d. net. [55

British Electrical and Allied Manufacturers' Association. Forty-first Annual Report, 1951–52. Pp. ii+58. (London: British Electrical and Allied Manufacturers' Association, 1952.) [55

Peace and the United Nations. By Dr. Ralph J. Bunche. (Tenth Montague Burton Lecture on International Relations.) Pp. 14. (Leeds: The University, 1952.) 6d. [55

Lundy Field Society. Fifth Annual Report, 1951. Pp. 42+2 plates. (Exeter: L. A. Harvey, Secretary, University College, 1952.) 2s. 6d. [55

The Scientific Education of Physicists. Pp. 32. (London: Institute of Physics, 1952.) 2s. [65

Guide to the Use of Aluminium in Public Service Vehicles. (Publication AB.7.) Pp. 28. (London: Aluminium Development Association, 1952.) 2s. 6d. [65

Other Countries

Study on Assistance to Indigent Aliens. Pp. iv+81. (New York: United Nations; London: H.M. Stationery Office, 1951.) 50 cents; 3s. 9d. [65

Stanford Research Institute. Annual Report, 1951. Pp. 48. (Stanford, Calif.: Stanford Research Institute, 1952.) [65

Annual Departmental Report by the Director of Agriculture, Fisheries and Forestry for the Financial Year 1950–1. Pp. iv+72. (Hong Kong: Government Printer, 1952.) [65

Canada: Department of Resources and Development, National Parks Branch. National Museum of Canada, Bulletin No. 125 (Biological Series No. 43): Birds of the West James Bay and Southern Hudson Bay Coasts. By T. H. Manning. Pp. iii+114 (7 plates). (Ottawa: Queen's Printer, 1952.) 25 cents. [65

Stanford University Publications: University Series—Medical Sciences, Vol. 5, No. 1: Companionship of Water and Electrolytes in the Organization of Body Fluids. By James L. Gamble. (Lane Medical Lectures.) Pp. 90. (Stanford, Calif.: Stanford University Press; London: Oxford University Press, 1951.) 20s. net. [65

This impression is confirmed by the admirable account of British broadcasting and television contained in Mr. Gorham's recent book, "Broadcasting and Television since 1900"*. This book, which should be read by everyone who desires to follow the present discussion on the future of British broadcasting, should correct many current illusions about the aloofness of the British Broadcasting Corporation and its failure to respond to public opinion. Implicitly, rather than explicitly, Mr. Gorham, in an eminently fair and readable book, shows the dangers inherent in the continuance of the broadcasting monopoly; but his book disposes of some of the wilder charges that protagonists of sponsored broadcasting have levelled against the British Broadcasting Corporation in the recent debates.

The book is important for another reason. It does not merely emphasize the moral issue, which Lord Reith stressed in his impressive speech in opening the debate in the House of Lords, and show clearly why the whole question of broadcasting should be treated in the same way and on the same plane as questions of education and other matters which profoundly influence the life and thought of whole communities; it also indicates clearly the right questions to be asked before we can hope to arrive at a considered policy and give it expression in a carefully worked out scheme. Such a scheme and policy the Government cannot yet claim to have laid before Parliament. Of some of the issues it appears to be only half aware. It agrees with the views of its predecessor as to educational broadcasting, without apparently appreciating the implication of this for any proposal to introduce an element in which public service is not to be the first and dominant consideration. Nor does it see, like Lord Waverley, in television an instrument of immense power, the social and economic implications of which are as yet but dimly appreciated. Without such a scheme, it is proposed, instead of keeping television and broadcasting in the hands of people whose sole purpose is to serve the public interest, to disturb a system which has served, and is admitted still to be serving, the country well.

Some of the speakers in Parliament, it is true, showed awareness of these questions, which should be answered before we decide how or even whether we should introduce competition. Lord Waleran, for example, pointed out that Germany, Italy and other countries, with or without a State monopoly, have overcome the wave-length problem by installing scores of very-high-frequency stations, whereas in Britain this is still experimental. Several speakers in the debates seemed no less conscious than Mr. Gorham of the backwardness of the B.B.C. in some respects during the post-war years, while other countries had made swift advances in technique.

These technical problems, however, appeared to be overlaid by the political aspects in the debate in Parliament, although they should be the decisive factors in determining the lines of development in the future. Nor were even the economic factors fully examined. Although the case for sponsored television rests largely on the assumption that it will bring in a contribution to broadcasting revenue which would otherwise be unobtainable, no one appeared to point out that the consumer ultimately pays in the increased cost of the advertised goods he buys, or to suggest any attempt to ascertain the amount of revenue which might be obtained. It was emphasized in the Commons debate that sponsored broadcasting is in effect subsidized broadcasting. Few besides Lord Samuel, Lord Hailsham and Lord Listowel challenged the proposal in both the present and last year's White Paper to raid the B.B.C.'s licence revenue. Lord Hailsham, however, showed the muddle into which this proposal leads, and Lord Kenswood gave a broad hint that an attempt should be made to discover whether the licence-holder would be prepared to pay a higher licence fee either to permit capital development or for improved television programmes before holding up indefinitely capital developments in television.

These are only some of the questions suggested by Mr. Gorham's book which are ignored in the White Paper and only cursorily examined, if at all, in these debates. None the less, while a free vote in the House of Commons might have gone against the Government's proposals, there was a widespread readiness to consider the question of monopoly with open minds, and no disposition to copy slavishly either the American or any other competitive system with the B.B.C. There was a general confidence that we should be capable of devising a British system which, whether or not it includes sponsoring, would supply, by healthy emulation in public service, the alternative programmes that are rightly demanded, competitively stimulate technical advance, and provide the necessary funds and opportunity for expression of regional and minority aspirations without debasing the standards of broadcasting of which Great Britain is rightly proud.

The debates in Parliament centred largely around the monopoly issue and sponsored broadcasting; the latter in particular, coupled with the Government's insistence on a party vote, tended to divert attention from one of the fundamental objections to the existing monopoly—that of a single employer. That aspect was dismissed rather summarily, and the proposals of the White Paper, particularly in regard to the regional councils, are unlikely to help the staff appreciably. It was made clear in the debates that the proposal by which the broadcasting councils will be responsible for the appointment of staff wholly employed in connexion with the Home Service programmes for which they are responsible is disliked by the B.B.C. staff, and the proposal was also criticized as administratively untidy if not unworkable.

Apart from the objection to this particular proposal on the ground of administrative efficiency, it can be criticized as a surrender to self-conscious and extreme nationalism, which might give too much scope for enthusiastic minorities to impose their tastes on the majority of their countrymen. More important, it may block the way for much sounder federal developments of the type advocated by Prof.

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* Broadcasting and Television since 1900. By Maurice Gorham. Pp. 274. (London: Andrew Dakers, Ltd., 1952.) 18s. net.

Coatman. Decentralization such as he suggests, coupled with the possibilities which developments in very-high-frequency broadcasting have already put within our reach, should be able to satisfy all legitimate regional and cultural aspirations without detriment to the efficiency or the standards of the British Broadcasting Corporation.

For the rest, the new charter and licence provide for the B.B.C. to continue broadly on the existing basis. On the technical aspects of television, the Government will continue to seek advice from an advisory committee concerned with the development of television generally, and this advisory committee will also be asked to consider the best methods of introducing higher-frequency sound broadcasting, including the form of modulation to be adopted, on which consultation with the radio industry will be essential. The White Paper also points out that the establishment of new television services would require new stations and their ancillary services, such as studios, and that the radio industry must be advised as soon as possible in order to enable them to design and produce adaptors for existing television sets and new receivers capable of picking up either the B.B.C. programmes or those on other frequencies.

In this White Paper the Government accepts the view that, for many years, limitations on capital investment have prevented the B.B.C. from developing television in certain areas and from introducing very-high-frequency sound broadcasting. The latter view is not entirely accepted in the Beveridge Report, which included a memorandum on the subject by Mr. Geoffrey Crowther and Sir Robert Watson-Watt, and appears also to be disputed by Prof. Coatman when last year he pressed the Government to publish the report on very-high-frequency broadcasting submitted to the Postmaster General by the B.B.C. The Government considers that the B.B.C. has a continuing obligation to provide adequate national broadcasting services throughout the United Kingdom, and states that fulfilment of this policy must have first claim when labour and materials become available. Passages in the debate suggest that, where high-frequency broadcasting is concerned, neither finance nor materials need provide quite the obstacle to advance that is suggested, and Parliament seems to have missed in these debates an opportunity of insisting that the public should be given sufficient information for scientific men and technologists to form an independent opinion on this matter. As Prof. Coatman pointed out, it should not be left to confidential negotiation between the B.B.C. and the Postmaster General.

The most significant criticism of the proposals outlined in the Government's White Paper is that it shows insufficient imagination or sense of public responsibility for the immense power of sound broadcasting, and the possibly even greater power of television. That aspect was admirably stressed by Mr. Selwyn Lloyd in his minority report for the Beveridge Committee, and appeared to be the main reason for his disagreement with the majority report and urging the discontinuance of monopoly. Moreover, what was elsewhere urged in the majority report as to the tendency of sound broadcasting and still more of television to encourage passivity is substantiated by the findings of the report by Mr. Silvey already noted. Nor have the debates in Parliament removed this misapprehension, as was shown by the confused analogy with freedom of the press which the Lord Chancellor forced into his speech in concluding for the Government. That the Government has already reconsidered its proposals on the method of appointing governors may warrant the hope that it will think again on the major issues of the regional councils and the introduction of sponsoring. If in response to authoritative and impartial criticism the Government would take the whole question out of the whirlpool of party politics into which its own action has plunged it, a new charter and licence may still come into operation while the debate on monopoly and devolution proceeds. The scientific and technical factors in the development of both sound broadcasting and television should be urgently explored and publicly discussed in order to enable a decision to be taken on whether or not to abandon the existing system of monopoly. Moreover, if the decision were in favour of breaking the monopoly, it could then be done on the basis of a scheme embodying not merely safeguards which would ensure the dominance of the idea of public service and the prevention of the abuse of power, but would also ensure that the fullest possible use was made of the latest scientific and technical advances to give efficient administration and the maximum satisfaction to legitimate regional aspirations.

VAVILOV ON CULTIVATED PLANTS

The Origin, Variation, Immunity and Breeding of Cultivated Plants

Selected Writings of N. I. Vavilov. Translated from the Russian by Dr. K. Starr Chester. (Chronica Botanica, Vol. 13, No. 1–6.) Pp. xviii+364. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1951.) 7.50 dollars.

NIKOLAI IVANOVITCH VAVILOV was one of the outstanding contributors to the new science of plant breeding which developed during the first half of this century, following on the rediscovery in 1900 of the principles of Mendelian heredity. He was selected by Lenin to administer and direct agricultural research in the Soviet Union, and he became president of the Lenin Academy of Agricultural Sciences, which ultimately came to consist of a chain of four hundred experimental stations, scattered through the U.S.S.R. from Leningrad to Vladivostok.

Vavilov's most important contribution to science was on the genetical significance of the centres of origin of cultivated plants. The theory that cultivated plants can be assigned to known centres of origin was first put forward by de Candolle. Vavilov was able to co-ordinate the vast body of information which had become available since de Candolle, and he also developed the theory that genetical diversity is greatest in these centres of origin. The greatest concentration of dominant genes occurs at the centre of origin, and since many of these have been lost by the more sophisticated varieties of the cultivated regions, it was evident to him that material from these centres can be of the greatest possible use to the plant breeder. His early studies of immunity to disease in plants led him to believe that it is in the centres of origin that immune types are most likely to occur. This now is perhaps over-simplified, since cases are known of recessive immunity away from the centre of origin.

Accordingly, Vavilov organized expeditions to countries where the most important economic plants were thought to have originated. Even before the Russian Revolution, he had explored Persia, Turkmenia and Bokhara. Dobzhansky states that "in 1920–23 he visited various parts of Middle Asia, including Tadjikistan and Pamir. In 1924 he covered a long and arduous itinerary in Afghanistan. In 1925 he went to Khiva. In 1927 he studied the Mediterranean region from Portugal and Morocco to Syria and Trans-Jordan, and made an expedition to Ethiopia and Somaliland. In 1929 he visited Chinese Turkestan and Songaria. Finally, in 1930 and 1932–33 he travelled and collected extensively in Mexico and in central and south America". Altogether, he and his colleagues surveyed sixty different countries.

In this way he was enabled to make a beginning in the great and still unaccomplished task of a survey of world resources of economic plants, and of the formation of a series of living museums in which all the genetical variability of a plant could be made available to workers not only in the U.S.S.R. but also in other countries. His collection of wheat varieties, for example, numbered 26,000 types.

Vavilov was no narrow nationalist. He believed that our main task is to feed, clothe and house the millions of underprivileged human beings who still comprise the bulk of the world's population. For this work, the whole world must be called on to help and serve mankind.

The second important theory of Vavilov is that known as "The Law of Homologous Series in Variation". This puts forward the idea that related species, and even genera, tend to exhibit parallel hereditary variability. This concept has also been of value to the plant breeder, in that it has enabled the existence of useful but unknown variants to be predicted in a given crop.

Although Vavilov's work has long been known and appreciated by non-Russian workers, they have hitherto not been able to read it in complete form. But here in this well-produced and well-translated book are to be found Vavilov's most important writings.

There is an introductory essay on plant breeding as a science. All those that maintain that plant breeding is an art and not a science—an art for which there is a 'flair' possessed by a few—should read and profit by this chapter. Plant breeding is no longer merely an art; it is a branch of biological engineering.

The first section of the book proper covers the subject of the "Phytogeographic Basis of Plant Breeding". All the main centres of origin of cultivated plants, both primary and secondary, are here discussed in detail. Subsequent sections deal with "The Law of Homologous Series in the Inheritance of Variability", and the "Study of Immunity of Plants from Infectious Diseases". The third section is a complete and masterly survey of the "Scientific Bases of Wheat Breeding", and there is a concluding section containing a selected bibliography of the basic world literature on the breeding and genetics of wheat, up to 1935.

A perusal of this classical contribution to biological literature makes it more than ever mysterious why genetical science was destroyed in the Soviet Union at the very time when all the tools were ready to make an unprecedented advance in its practical application to agriculture. The book is a complete defence of plant-breeding technology as we are slowly coming to know it, against the pretensions of the Lysenko school who are now responsible for applied genetics in the Soviet Union. It will be read by all plant breeders; they can scarcely fail to be stimulated by the still novel points of view which abundantly occur. If its lessons are properly appreciated by those who guide our political and economic destinies, we may not attain for a long time to come the twenty thousand workers whom Vavilov had in his research institutes in 1934; but at least we shall hear less of the preposterous story of a possible surplus of biologists in Great Britain during the next five years.

The life and work of Vavilov must be viewed against the background of the political ideology of the Soviet Union, and this book should be read conjointly with the story as told by Huxley and Zirkel of how genetics was destroyed in that country after a long period of hostility. Vavilov died, defeated and disgraced, in Siberia in 1942. It is therefore altogether fitting that his best work should now be made available to the wide audience of the Western world.

S. C. Harland

THE LAW OF PATENTS

Terrell and Shelley on the Law of Patents
Ninth edition. By K. E. Shelley, Q.C. Pp. lxv + 680. (London: Sweet and Maxwell, Ltd., 1951.) 105*s*. net.

"TERRELL on Patents" has been for more than sixty years the standard text-book on the law of patents. This new edition, "Terrell and Shelley on Patents", rendered necessary particularly because of the passing of the recent Patents Act, has been prepared by Mr. K. E. Shelley, one of the most experienced of the small group of Her Majesty's Counsel practising at the Patent Bar. He is to be commended for producing so comprehensive and yet so succinct an account of the law of patents.

The British patent system was subjected to a detailed investigation by the Swan Committee set up in 1944 by the then president of the Board of Trade, under the chairmanship of Sir Kenneth Swan. Important and far-reaching innovations in patent law were recommended by this Committee, and the large majority were incorporated in the Patents Act, 1949.

As Mr. Shelley points out in his preface, patent law falls into two sharply distinguished categories: there is the purely administrative side, which is primarily concerned with the actual procedure of obtaining a patent; and there is the judicial aspect, which is concerned with the interpretation which the courts have placed on general concepts contained in the Patents Acts, such as 'manner of manufacture', 'new', 'useful', etc.

No attempt has been made in this edition to set out every detail of procedure of the administrative branch of the law, though the relevant sections of the Act and the Rules are printed in full in the appendix. The judicial aspect has, however, been very fully treated. Verbatim extracts of the leading judgments on each important topic have been quoted, and the author has not hesitated to criticize many of the decisions of the court. As he points out in his frankly written preface, "It is inevitable that in some cases a Court, approaching a problem of patent law for the first time, has come to a decision which seems erroneous to the specialist who has over a period of years reached a different conclusion, possibly through giving more weight to expediency in practice than to abstract rules of construction or the dictionary meaning of words. Such decisions have been frankly criticized in the following pages". It will be undoubtedly helpful to many a practitioner to have these critical and constructive comments.

In the contents are set out the principal changes enacted by the Patents Act 1949, many of which are likely to make the law more favourable to inventors who patent their inventions. New methods of processing or testing applicable to the improvement or control of manufacture are now patentable. New chemical substances may be patented *per se*, without reference to any particular method of manufacture, and this constitutes a substantial change in the law which is of importance in the chemical industry. Patents of addition are no longer to be invalidated by publication of the main patent or user of the invention which is described in it. Thus an opportunity is now afforded to a patentee to file a fresh application for letters patent covering details of his invention in the light of actual experience. This is likely to avoid the patentee being deprived in future of a chance of obtaining an effective monopoly for his invention.

The book commences with a brief history of the development of patents and the nature of patentable inventions. Next follows a chapter on the applicant and the application, including a valuable résumé of the difficult question which so frequently arises in practice—the extent of the ownership by an employee of an invention conceived while in the employment of a firm. The requirements laid down by the Act as to the contents of the specification and the grounds upon which the specification may be attacked before and after the grant of letters patent are set out in the succeeding chapters. The chapter on the action for infringement, the method by which a patentee in the last resort can enforce his patent privileges, contains an excellent summary of the principal matters to be considered and a review of the more important cases. The sections of the Act dealing with action which can be taken to deal with any abuse of the monopoly granted by way of patents are fully analysed. Now that government departments are so closely connected with industrial research, the sections of the Act dealing with questions of compensation payable by the Crown in respect of use of patented inventions are of considerable practical importance. These questions have been clarified by the new Act and are carefully summarized. No mention, however, is made of the facilities whereby a patentee may in certain circumstances have his claim dealt with by the Royal Commission on Awards to Inventors set up under the chairmanship of Lord Cohen.

While retaining the general layout of the former editions of this standard text-book, this new edition provides a more compact and logical approach to a difficult subject than did its predecessors. The book will be welcomed by all who are in any way concerned with inventions and patents. R. G. LLOYD

A HANDBOOK OF PAPER CHROMATOGRAPHY

Papierchromatographie

Von Dr. Friedrich Cramer. (Monographien zu *Angewandte Chemie* und *Chemie-Ingenieur-Technik*, Nr. 64.) Pp. 81+2 plates. (Weinheim-Bergstr.: Verlag Chemie, G.m.b.H., 1952.) 9.80 D. marks.

Of all forms of chromatography, the paper chromatogram has proved the most popular and is now universally established. Since its inception in 1944, many articles have appeared reviewing its applications; but while these have served a useful purpose, the time has come for something more permanent than a review, and which brings together all the important features and is designed to be a work of reference. This has been accomplished by Dr. F. Cramer in "Papierchromatographie".

The monograph is arranged in two parts, general and special. The first gives the principles underlying the different types of chromatogram. Counter-current distribution is discussed and linked up with partition chromatography. The paper chromatogram is discussed as a partition process, and the arguments against it are also presented. After the theoretical sections, there follows a full and detailed account of the practical aspects of paper chromatography. An outline of the various methods of quantitative analyses is next presented, and then the use of paper, either in sheet or powder form, for isolations. Though not strictly chromatography, paper electrophoresis is usefully included, and this completes the general part.

The special part of the book is concerned with applications to all the important classes—amino-acids, sugars, purines, and so on. The treatment is thorough; many tables of R_F values are given, and full details are provided of solvents, reagents, and some of the more important quantitative methods. Non-aqueous and reversed-phase chromatography and the use of radioactive tracers are not overlooked. The emphasis throughout is on sheet chromatograms; the use of paper and starch in columns is mentioned only briefly.

In a work of this kind, so packed with information, it is perhaps inevitable that errors and omissions occur, but these are remarkably few. The only serious criticism that one can offer is that there is no subject index, which is essential in such a work of reference. Of the few errors, there are one or two references which do not relate to the subject-matter in the text. Of the omissions, there is no reference to Durrum's important contributions on paper electrophoresis[1]. In the section on peptides, which is rather too brief, more could have been said about the techniques for determining the order of amino-acid residues in proteins and polypeptides, and a table of R_F values of peptides and derivatives might have been included. There is no mention of the theories relating R_F values of peptides with the thermodynamics of their structure[2]. A 'map' of the amino-acid spots of a two-dimensional chromatogram would have been useful. Though the illustrations are clear and the colour photographs are good, it is rather a pity that a better two-dimensional chromatogram was not chosen for reproduction.

However, these are small blemishes in a work which provides all the information that one expects from a good text-book. It is up to date, well arranged, generously illustrated and clearly printed on high-quality paper. The price, at present rates of exchange, is reasonable, and it is to be hoped that the book will be generally available outside Germany. Is it too much to ask for the monograph to be supplied in stiff covers? This would, of course, raise the price somewhat, but would be worth while as a protection against inevitable wear and tear. An English translation would undoubtedly widen its appeal. This book will be found invaluable by all, whether experienced or not in the subject, and Dr. Cramer and the publishers are to be congratulated on the production of an attractive text-book of outstanding importance.

R. CONSDEN

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[1] Durrum, E. L., *J. Amer. Chem. Soc.*, 72, 2943 (1950).

[2] Martin, A. J. P., Biochem. Soc. Symp., 3, 4 (1949).

ARCHÆOLOGY IN ECUADOR

The Archæology of the Santa Elena Peninsula in South-west Ecuador

By G. H. S. Bushnell. (Occasional Publications of the Cambridge University Museum of Archæology and Ethnology.) Pp. xv+155+5 plates. (Cambridge: At the University Press, 1951.) 42*s*. net.

THIS volume presents the results of Dr. G. H. S. Bushnell's field-work in an area until now practically unknown archæologically, together with a discussion of the small corpus of relevant comparative material, mainly the work of Spanish archæologists.

Dr. Bushnell's excavations indicate the presence on the Santa Elena Peninsula of three separate cultures: Guangala, Engoroy and Manteño. They were nowhere found in stratification, but there is some evidence indicating this sequence. Manteño, previously known from Manabí as probably the last period before the Spanish Conquest, the author considers to be intrusive in the Peninsula. He is rightly cautious about dating, but produces some comparative material suggesting that Guangala, the earliest found, is later than A.D. 900.

Detailed descriptions of these three cultures are given. There is also a brief chapter on a possible pre-Guangala culture (now being further investigated by E. N. Ferdon, jun.), and another on an early post-Conquest cemetery at La Libertad, partly excavated by the author.

Besides much characteristic pottery, sites belonging to all three cultures yielded tools of stone and shell. In Guangala and Manteño sites metal tools and ornaments were found, the single Engoroy site produced no metal. Among Manteño objects were two celts. That these at least were of local manufacture is indicated by the close correspondence of one of them to a clay mould excavated at La Libertad by Mr. A. J. R. Murray in 1923–24 (now in the Pitt Rivers Museum, Oxford). A metallurgical report by the British Non-ferrous Metals Research Association on some of the metal objects (Appendix *A*) shows them to be of copper and not of bronze.

Most of the human remains were either calcined or in very poor condition. In Appendix *B*, Dr. W. L. H. Duckworth reports on the seven skulls of the Guangala period which were capable of preservation. They show artificial deformation at the occiput such as is characteristic of Peruvian skulls, which they resemble in other details also.

In culture, however, Dr. Bushnell thinks that the Guangala period may prove to owe more to Central America than to Peru. For Engoroy he can suggest no outside relationship. He agrees with the view held by Saville from his work at Manabí that the Manteño culture shows "a considerable degree of independence of outside influence".

Although many problems remain unsolved, Dr. Bushnell's work has put into place a piece of the jig-saw puzzle which will eventually be completed to produce a picture of the archæology of coastal Ecuador. The book is well illustrated, with maps and plans, numerous line-drawings, photographs, and an excellent colour plate of Guangala pottery types. It should give a good start to the welcome new series which it inaugurates.

B. M. BLACKWOOD

PHYSIOLOGY OF MITOSIS

The Mitotic Cycle

The Cytoplasm and Nucleus during Interphase and Mitosis. By Dr. Arthur Hughes. Pp. viii+232+16 plates. (London: Butterworths Scientific Publications, Ltd., 1952.) 35*s*. net.

IT is rightly emphasized on the dust-cover of this valuable monograph that the process of cell division presents one of the most difficult problems the experimental biologist has yet attempted to solve, and, if this present account of the mitotic cycle is not an easily flowing and well-balanced narrative, the reflexion is not on the author but on the present state of our knowledge of the subject. There is a large and widely scattered literature of unequal relevance and of uneven quality. The lines of advance have been largely dictated by considerations of the materials and techniques available, and a strong medical bias is also evident. Thus we now have an extensive knowledge of the early cleavage of a certain few eggs, of the growth in culture media of a certain few tissues, of the methods of induction of cancerous growths, and of the methods of mitotic inhibition by a multitude of diverse substances. The obvious questions posed by the mitotic activity of normal animal and plant tissues have been almost entirely neglected, although very recently a start has been made towards their solution.

The book gives an extensive survey of this patchy subject, and it will for many years remain a valuable tool in the hands of those who are working in or around this field of research. Chapters are devoted in turn to the nucleic acids, to the cytoplasm and nucleus in interphase and in division, and to the experimental methods of analysis of the problems presented. Sections are contributed by Dr. M. M. Swann on the spindle, and by Dr. C. Waymouth on the nature of the stimulus to mitosis.

Because this is such an extensive review, the few gaps that are left unfilled appear all the more obvious. In particular, it has to be noted that the short section on hormones and mitosis gives a surprisingly inadequate account of our present fairly extensive knowledge. Another lesser criticism which may also be offered is that the long reference lists are arranged in order of mention and not, as is more customary in biological works, in alphabetical order. This is particularly regrettable, since these lists are one of the most valuable features of the book.

Such criticisms do not, however, invalidate the final judgment that this is certainly the best review of the difficult subject of cell division yet to be published, and its appearance will be warmly welcomed.

W. S. BULLOUGH

Elsevier's Encyclopædia of Organic Chemistry

Edited by F. Radt. Series 3: Carboisocyclic Condensed Compounds. Vol. 14: Supplement; Tetracyclic and Higher-Cyclic Compounds except Steroids and Triterpenes. Pp. xxxi+938S+Ind. 113. (Amsterdam and New York: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1951.) To subscribers, £23.

THIS is the first of the supplementary volumes of "Elsevier's Encyclopædia". It is mainly concerned with the polycyclic aromatic hydrocarbons and their derivatives, and summarizes the literature of the decade 1937–46. There are also references to some of the more important publications of later years, up to and including 1951. The size of this volume bears witness to the large amount of attention which has been devoted to polycyclic aromatic hydrocarbons in recent years; it is pointed out in the preface that the number of ring systems known has undergone a 60 per cent increase, having risen from 233 to 378. The original Vol. 14 consisted of 611 pages, excluding indexes, and included also the steroids and triterpenes which will form the subject of a second part of the supplementary volume.

In general, this supplement follows the pattern of earlier volumes, although a useful novel feature is the inclusion of references to the patent literature. The ring systems dealt with include those of the benzfluorenes and fluoranthene, 1 : 2-benzanthracene and naphthacene, chrysene, pyrene, cholanthrene, pentacene, dibenzanthracenes, picene, benzopyrenes, perylene, and coronene. Recent work on some of the vat dyes is also summarized; these include anthanthrone, pyranthrone, dibenzanthrone and *iso*-dibenzanthrone. There is also reference to some natural products, such as the diterpene phyllocladene and related compounds, and the photodynamic pigment hypericin.

The volume conforms to the customary standard of excellence in production, and will be of particular interest to those who have occasion to consult the literature of carcinogenic hydrocarbons and their derivatives. There are extensive references to their biological properties as well as to preparation and reactions. The volume will also be welcomed by the increasing body of chemists who make regular use of the "Encyclopædia". Unfortunately, only a relatively small area of the field of organic chemistry has been covered by the volumes which have been published so far.

Notions fondamentales sur les vernis et peintures

Par Louis Kientz. Deuxième édition revue et corrigée. Pp. xxi+234. (Paris: Libr. Gauthier-Villars, 1952.) 1300 francs.

M. LOUIS KIENTZ has written this work with the express purpose of providing a modern text-book to which all those who are connected with the different branches of the paint and varnish industry may refer if they wish to learn about recent scientific and technical developments in the industry. He therefore starts by outlining a few basic ideas of chemistry and physics appertaining to paints and varnishes, and discussing the chemistry of the raw materials used, namely, resins, oils, solvents and pigments. He then describes the processes involved in the different stages of the manufacture of various types of paints and varnishes, which are grouped into families under a system of classification introduced during the War by the Comité d'Organization des Peintures et Vernis (C.O.P.V.). There is a final chapter devoted to a survey of methods used for testing both raw materials and the finished paints and varnishes.

The subject-matter dealing with the actual manufacturing processes is clearly and logically presented, but the earlier chapters discussing the purely chemical aspects of the subject are open to a certain amount of criticism. Thus, the drying of oils is discussed without any reference to recent work on the hydroperoxide theory, and the polymerization reactions involved in the formation of stand oil are inadequately treated. It is also misleading, in a modern text-book, to give wood distillation as the only source of acetone. Furthermore, there are a large number of irritating misprints in simple chemical formulæ and equations, and the structural formulæ of compounds such as abietic acid, dipentene and pinene are quite unintelligible and show a complete disregard for the tetravalency of carbon. It is regrettable that these errors occur in what purports to be a revised and corrected edition; they reduce the value of this book, which in other respects may be regarded as a welcome addition to the technical bibliography of the paint and varnish industry.

A. E. A. Werner

A Guide to Bird Finding East of the Mississippi

By Olin Sewall Pettingill, Jr. Pp. xxi+659. (New York and London: Oxford University Press, 1951.) 30*s*. net.

THE title of this book is rather misleading, since it is really a guide-book to the best places to see birds in the twenty-six States east of the Mississippi. The volume is arranged under States, with each locality printed in capital letters, followed by the size in acres, or square miles, in brackets, and a statement whether it is a reserve or park under Federal or State management.

After a brief description of the type of country found in the reserve, some of the more interesting birds are mentioned and directions given how to get to the place. Visitors are warned always to call at the headquarters of a park or reserve before entering, and in the case of a private reserve to make sure of getting the owner's permission. Towns which have museums where there are collections of birds are referred to with a brief description of their contents.

As the author points out, this work was a co-operative undertaking, in the compiling of which three hundred people contributed information. It contains a great deal of interesting information regarding the reserves in the eastern United States, and might well be copied in a modified form in Great Britain.

Dyeing with Coal-Tar Dyestuffs

The Principles Involved and the Methods Employed. By Dr. C. M. Whittaker and C. C. Wilcock. Fifth edition. Pp. vii+375+17 plates. (London: Baillière, Tindall and Cox, 1949.) 21*s*. net.

THOUGH essentially technological, this book makes an approach to a synoptic view of the subject, and should be of value to students of textile chemistry. Theoretical treatment of the subject is notably lacking, however. Thus no adequate attempt is made to show how dyeing-rate depends upon a diffusion process, or how dyeing-rate and dyeing-equilibrium are affected by temperature and by salt addition. In view of the well-known pioneer work of the senior author, these omissions are surprising.

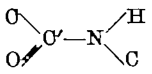
S. M. Neale

STRUCTURE OF PROTEINS

RECENT developments in the study of proteins and synthetic polypeptides have raised hope that some fundamental patterns of protein structure may be elucidated in the not very distant future. Progress in experiment and theory has been revealing to a degree that could scarcely have been anticipated even five years ago. The Royal Society discussion of May 1 on "The Structure of Proteins", organized by Prof. W. T. Astbury, served to focus the attention of many investigators on present achievements and on the deep and baffling problems that still remain to be solved.

The background of the discussion may be briefly sketched. Beginning about twenty years ago, Prof. Astbury and his associates studied the proteins of the keratin–myosin–epidermis–fibrinogen (k–m–e–f) group, all of which show a general similarity in the wide-angle X-ray diffraction pattern, and all of which are capable of existing with the polypeptide chains in a folded (α) or extended (β) configuration. The other great class of fibrous proteins, the collagens, show a fundamentally different type of pattern. The evidence is now overwhelming that protein molecules are composed of polypeptide chains; hence it was sought, by Astbury and others, to formulate configurations for such chains which might explain the observed facts. Thus in 1943 M. L. Huggins proposed a number of possible configurations, some of them helical. In 1950 Sir Lawrence Bragg, J. C. Kendrew and M. F. Perutz examined the problem in great detail, discussing numerous possible patterns of folding of the chains, and for the first time defining the proposed structures with considerable precision by giving the co-ordinates of the atoms to the nearest 0·1 A. However, the results which have aroused the strongest support, and the sharpest criticism, are those of Prof. L. Pauling and Dr. R. B. Corey, whose views were fully presented at the meeting. Fortunately, Dr. Corey was present in person to discuss the dimensions of the polypeptide chain; the involuntary absence of Prof. Pauling was keenly regretted by all at the meeting, and in his absence his paper was presented by Dr. E. W. Hughes.

Dr. Corey's contribution to the discussion rested upon precise studies of the crystal structures of amino-acids and peptides, which he and his associates have carried out over a period of many years. These led to a picture of the most probable dimensions of the amide group, the repeating unit of the polypeptide chain; the results are summarized in the following diagram and table.



Distances	
N—C	1·47 A.
N—C′	1·32 A
C′—O	1·24 A
C′—C	1·53 A.

Bond angles	
C—N—C′	123°
C—N—H	114°
H—N—C′	123°
N—C′—O	125°
N—C′—C	114°
O—C′—C	121°
C′—C—N	110°

Fundamental to all structural considerations is the large amount of double-bond character in the C′—N bond of the amide group, indicated by the short interatomic distance of 1·32 A., contrasted with the normal single-bond value for the C—N linkage, which is near 1·47 A. This implies that all the atoms in this group shown in the formula lie in the same plane, or very nearly so. A twisting of the atom pairs on either side of the C′—N linkage by 10° out of this plane should lead to a strain energy near 1 kcal. per amide group; a 20° twist should produce a strain energy nearly four times as great. Given this planar configuration, the arrangement of the outer carbon atoms may either be *trans*—as shown in the figure—or *cis*. The amide group in all peptides yet studied, and also in N-acetylglycine, has been found to be in the *trans* configuration, and the planarity of the group is maintained to a high degree of approximation.

The paper of Pauling and Corey considered the criteria for acceptable configurations of polypeptide chains in proteins, and laid down certain postulates concerning them. First, interatomic distances and bond angles must be the same, or nearly the same, as those found already in amino-acids and peptides. Secondly, the NH and CO groups must be linked by hydrogen bonds, with reasonable values for the N—H . . . O distance, and with a close approach to linearity of these three atoms. Thirdly, the planarity of the amide group must be maintained. Several configurations which meet these requirements have been formulated; two are helices. The one which appears most important is the α-helix, containing very nearly 3·7 amino-acid residues per turn of the helix, the translation per residue in the direction of the axis of the helix being calculated as 1·49 ± 0·04 A. Precise values for the co-ordinates of the atoms in this helix have been given, and X-ray intensities for scattering from such a structure have been calculated and compared with observed values. The most striking piece of evidence suggesting the existence of the α-helix in proteins was the observation of Perutz of an X-ray reflexion at 1·47–1·50 A., corresponding to a repeating distance along the fibre axis, in all proteins and synthetic polypeptides having the α-configuration. The discovery was made in 1951, following the formulation of the α-helix; it was later recognized that the same reflexion had been observed in certain types of keratin by I. MacArthur in 1943; but its possible implications were not then apparent.

If the helix is to form part of a repeating unit in a crystalline structure, an integral number of residues must be obtained after a reasonable finite number of turns; Pauling has suggested eighteen residues in five turns, or eleven residues in three turns, as probable repeating units within the limits 3·6–3·7 residues per turn. In particular, he proposed an α-helix with eighteen residues in five turns as the basis for the structure of the synthetic substance poly-γ-methyl-L-glutamate, giving a unit length along the fibre axis of 27 A.

Another possible helix, the γ-helix, has about 5·15 residues per turn, and a fibre axis length per residue very near 1 A. This helix has a hole down the centre large enough to admit water molecules; there is at present little evidence, however, to suggest that such a structure exists in Nature, and there are reasons for believing it to be unstable.

Finally, Pauling and Corey have formulated three different kinds of 'pleated sheets'—briefly denoted as the polar, the parallel and the anti-parallel—consisting of sets of peptide chains, more fully extended than in the helices, linked by hydrogen bonds between the chains, rather than within the chain, as in the helix models. The polar pleated sheet they believe to be an improbable structure; the other two, with a length per residue along the chain direction of 3·34 A., are suggested as models for the β-keratin structure.

For collagen they have proposed an elaborate structure, involving three intertwined polypeptide chains, held together by lateral hydrogen bonds. In each chain two *cis* residues are followed by one *trans* residue; every third residue may be proline or hydroxyproline. However, it is now admitted that this structure requires modification.

The principal debate at the meeting centred around the validity of the α-helix. Besides the Perutz–MacArthur spacing at 1·5 A. in many proteins, Pauling cited the recent calculations of W. Cochran and F. H. C. Crick[1] on poly-γ-methyl-L-glutamate in its favour, as well as the radial distribution functions calculated by D. P. Riley and U. W. Arndt[2] for bovine serum albumin from X-ray data on the powdered protein. The latter work was discussed briefly at the meeting by Dr. Riley himself.

On the other hand, some grave difficulties for the α-helix were pointed out. The calculated density of α-keratin, for example, as Astbury pointed out, should be about 1·15 if it is assumed to be composed of α-helices in hexagonal packing. Modification of the packing could give a somewhat higher density, but not nearly enough to explain the observed density near 1·3. The characteristic X-ray spacing at 5·1 A. in α-keratin and other α-proteins should not be given by the α-helix, which instead should give a repeating spacing in the range 5·22–5·62 A. The 5·1-A. reflexion has been interpreted by V. Schomaker (as reported by Pauling) as due to an abnormality in background intensity of poorly crystallized material; but this explanation was obviously not considered satisfactory by some who were present. Moreover, Dr. C. H. Bamford reported new X-ray studies on poly-γ-methyl-L-glutamate, carried out at the Courtauld Laboratories, Maidenhead, which indicate that the repeating unit along the fibre axis is at least 43·2 A., and may be twice as great. If this is correct, it would rule out the view that the fundamental repeat is that of an α-helix with eighteen residues in five turns, as proposed by Pauling. (Attention may be directed at this point to the recent report of Yakel, Pauling and Corey[3] on fibres of the same substance. They find a hexagonal unit cell with $a = 11·58$ A., $c = 26·33$ A., the latter value being in excellent agreement with that expected for an α-helix having eighteen residues in five turns. Moreover, the intensities of the X-ray reflexions agree extremely well with those calculated for the α-helix, the β-carbon atoms being assigned to position 2, in the notation of Pauling and Corey. This evidence, together with the striking calculations of Cochran and Crick[1], strongly supports the view that poly-γ-methyl-L-glutamate fibres have the α-helix structure, or something very close to it (see also Bamford *et al.*[4]). It would require only a very small distortion of the helix to give a large change in the repeat distance along the fibre axis, and such distortions may well occur in certain cases, depending on the method of preparing and drawing the fibre. Further work is certainly needed to resolve the puzzle completely; but the balance of the evidence on these synthetic polypeptides seems to be in favour of the α-helix.) Dr. Bamford favours a structure for α-proteins in which there are only two amino-acid residues for a repeating distance of 5·1 A. along the fibre axis, instead of three, as in the Pauling–Corey α-helix or in another structure proposed earlier by Astbury. However, this hypothesis has serious difficulties also, which some consider to be fatal.

One of these difficulties was brought out in the report by Dr. K. M. Rudall on the elastic properties of myosin, epidermin and fibrin. Films and fibres of these proteins were stretched under conditions in which they were fully converted into the β form, and then caused to shorten into the α form. The maximum contraction in all cases seems to be about 55 per cent of the stretched length. This figure corresponds closely with what would be expected on the Pauling–Corey hypothesis—contraction from a pleated sheet with 3·34 A. per residue to an α-helix with 1·50 A. per residue—but could also fit the Astbury model for α-keratin. It seems irreconcilable with a model involving only two residues in a fibre axis distance of 5·1 A., unless the α–β transformation is supposed to be far less complete than it appears.

The Pauling–Corey collagen structure—which the authors themselves now state requires revision—was criticized by Prof. J. T. Randall, who objected to the mixture of *cis* and *trans* residues involved, and to the failure of the structure to explain the infra-red dichroism. Prof. Randall proposed an alternative structure, which appears to avoid these difficulties, and which he believes to give a better fit with the X-ray data (see *Nature*, June 21, p. 1029).

Work of Dr. Barbara W. Low at Harvard University (reported to the meeting by J. T. Edsall) on crystals of acid insulin sulphate, indicating the presence of oriented polypeptide chains, has recently been published[5]. Dr. Low also reported a new type of helical model, intermediate between the α- and the γ-helix; each amide group is hydrogen-bonded to the fourth one beyond it, and the distance per residue along the fibre axis is about 1·13 A. This model requires slight distortion of the bond angle of the α-carbon; calculations on the model are still in a preliminary stage. Dr. Dorothy Crowfoot Hodgkin presented Fourier projections of the phenylalanyl (*B*) chain of insulin, using the sequence of amino-acid residues determined by F. Sanger, and assuming the chain to be coiled in an α-helix.

A. Elliott discussed the infra-red absorption and dichroism of synthetic polypeptides in the α and β forms. The parallel dichroism in oriented specimens of poly-γ-benzyl-L-glutamate shows that the C=O and N—H bonds are directed along the chain axis rather than across it, and that the chains are folded. However, the dichroic ratio of the C=O frequency is much less than that of the N—H frequency. The significance of this finding for bond angles and distances in the structure was considered at length; one important point, brought out by W. C. Price, is that the dipole moment change in the C=O vibration may involve also the adjoining C—N linkage, on account of resonance in the amide group and of the 'orbital-following' effect. Hence, the infra-red dichroism may not give a correct indication of the orientation of the C=O bond. Studies on simple substances of known structure are needed; Elliott and his associates are now studying acetanilide, the crystal structure of which is partly but not yet fully known.

Sir Lawrence Bragg and Dr. Perutz presented their latest work on the structure of hæmoglobin; the study involves an attempt to determine a complete Fourier projection of the hæmoglobin molecule from a study of the *h0l* reflexions, using all the data obtainable by varying the water and salt content of the crystals, and the chemical nature and species of the hæmoglobin. The pattern of the molecule should be resolvable within about 7 A. when the signs of all terms have been determined. Dr. C. H. Carlisle and Prof. J. D. Bernal discussed the crystal structure of ribonuclease. Dr. Carlisle discussed Patterson projections, inferring that parallel polypeptide chains appear to be present in the structure, but that these do not have the right packing and cross-section for α-helices. Prof. Bernal attacked the problem by a very different approach, selecting constellations of 'significant reflexions' as the starting-point for Fourier computations; the method does not lend itself to brief exposition and can only be mentioned here [see *Nature*, June 14, p. 1007].

Dr. K. Bailey reported his work[4] on the size and shape of the very asymmetric molecule, tropomyosin, which appears to be about 385 A. long, with an axial ratio about 22 : 1, and a molecular weight of 53,000. It contains no free α-amino group, and one free α-carboxyl. It is composed probably of two more-or-less parallel polypeptide chains.

H. E. Huxley reported low-angle X-ray studies on living muscle, which reveal the presence of very long molecules, packed in hexagonal array, and 450 A. apart. The relative intensities of the first- and second-order transverse reflexions from this spacing are completely reversed by removing adenosine triphosphate from the muscle. Along the fibre axis there is a repeating unit 420 A. in length; this seems to be due to the actin component, rather than to the myosin. Surprisingly, this spacing does not change on stretching the muscle. The axial and transverse patterns are still clearly observed in glycerol-extracted fibres (Szent-Györgyi's technique). This opens the possibility of studying contracted fibres by X-ray methods.

Although many topics were discussed at the meeting, the prime emphasis was on the underlying structural pattern of the polypeptide chains in proteins. As Dr. Corey remarked near the end, structures such as those proposed by Pauling are precisely defined; they lead to definite predictions about physical properties, and critics can attack these structures where they fail to fit the facts. Revised and improved models can then be put forward, and progress in this supremely important field should proceed with increasing rapidity.

JOHN T. EDSALL

KODAIKANAL OBSERVATORY

By DR. A. K. DAS

Director, Kodaikanal Observatory

THE Kodaikanal Observatory completed fifty years of astrophysical work in March 1951. The occasion was celebrated by a simple function held on September 18 over which His Highness Maharajah Sir Krishnakumarsinghji Bhavsinghji of Bhavnagar, Governor of Madras, presided, and a souvenir pamphlet describing the activities of the Observatory during the half-century was issued to commemorate the occasion.

Kodaikanal Observatory has its roots in the fairly distant past, for it is really the continuation of the Madras Observatory which was started in 1792 by the East India Company "for promoting the knowledge of astronomy, geography and navigation in India". Mr. N. R. Pogson, who was in charge of the Madras Observatory during 1861–91 and whose work in positional astronomy is well known, was the first astronomer to conceive the idea of establishing a branch of the Madras Observatory in the Palni or the Nilgiri Hills especially for photographic and spectroscopic observations of the sun and the stars. But it was in the time of Mr. Charles Michie Smith that the idea took practical shape, and a site at Kodaikanal (elevation 7,688 ft. above mean sea-level) in the Palni Hills was chosen for this branch. The foundation stone of the new Observatory at Kodaikanal was laid in 1895, and by 1901, when systematic solar observations were begun at Kodaikanal, the astronomical work of the Madras Observatory had almost completely ceased and practically all its equipment, except the historical meridian circle, had been transferred to Kodaikanal. However, the astronomical observatory at Madras still existed, though only in name; and Mr. Michie Smith's official designation was "Director of Kodaikanal and Madras Observatories", a designation which continued until 1932, when Kodaikanal Observatory's connexion with Madras came to an end.

Mr. John Evershed, who succeeded Mr. Michie Smith as director, joined the Kodaikanal Observatory in 1907 as assistant director. In 1909 he discovered the phenomenon of radial motion in sunspots which is commonly known as the Evershed effect. When Mr. Evershed became director in 1911, Dr. Thomas Royds joined as assistant director, and their fruitful collaboration continued until Mr. Evershed's retirement in 1922. A very considerable part of the accurate spectroscopic work for which this Observatory is noted was done during the period 1907–22. The tradition of high-dispersion spectroscopic work built up during this period has continued until the present day. But Dr. Royds, during his directorship, which lasted from 1922 until 1937, placed a good deal of emphasis also on the observational study of solar prominences and dark markings. Dr. A. L. Narayan, who was assistant director during 1928–37, succeeded Dr. Royds as director and remained in charge of the Observatory until about the middle of 1946. He was responsible for a considerable amount of work in atomic and molecular spectroscopy. Dr. A. K. Das, who as assistant director between 1937 and 1942 made theoretical studies of the motion of gases in the sun's atmosphere, returned to the Observatory after the Second World War and succeeded Dr. Narayan as director. Dr. R. Ananthakrishnan joined the Observatory as assistant director towards the end of 1946.

Since 1946 the spectroscopic equipment of the Observatory has been greatly improved by the construction of a number of high-dispersion spectrographs, siderostats, cœlostats, etc., and work on various problems of solar physics is in progress. It is expected that a 100-ft. solar spectrograph, a polarizing monochromator and a Lyot coronagraph will shortly be added to the equipment of the solar physics section. The most notable post-war developments in the activities of the Observatory have been, however, the addition of a magnetic and ionospheric branch and

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[1] Cochran, W., and Crick, F. H. C., *Nature*, 169, 234 (1952).

[2] Riley, D. P., and Arndt, U. W., *Nature*, 169, 138 (1952).

[3] Low, B. W., *Nature* [169, 955 (1952)].

[4] Bailey, Tsao and Adair, *Biochem. J.*, 49, 27 (1951).

[5] Yakel, Pauling and Corey, *Nature*, 169, 920 (1952).

[6] Bamford, Brown, Elliott, Hanby and Trotter, *Nature*, 169, 357 (1952).

of a section of stellar physics. The magnetic observatory, which was started towards the end of 1949, is now in full operation and is equipped with a set of Watson magnetographs, a set of La Cour magnetographs and the usual accessories; the equipment of the magnetic observatory will shortly be further strengthened by the addition of an Askania magnetic field balance, as well as a set of *QHM* and *BMZ* instruments. The principal instrument of the ionospheric observatory, which started functioning from the beginning of 1952, is an automatic multifrequency ionosphere recorder of the latest type designed by the U.S. Bureau of Standards. The magnetic and ionospheric section naturally has an electronics laboratory attached to it. Recently an equipment for the study of solar radio radiation in the 100 Mc./s. region has been built in the electronics laboratory and has been brought into regular use. Mr. B. N. Bhargava, who had his specialized training in radio-physics in the United States, is in charge of the magnetic and ionospheric section. The stellar physics section has made a modest beginning with a 20-in. Cassegrain reflector by Grubb as its principal instrument. Though old, it is an excellent and very versatile telescope which originally belonged to the now disused Observatory of Poona called after His Highness Maharajah Takhtasinghji of Bhavnagar. This telescope was presented to the Kodaikanal Observatory many years ago, but had remained unused and dismantled. Recently it has been installed for regular use after reconstructing several of its missing or damaged parts, and has been named the Bhavnagar telescope. Work on planetary spectra and some aspects of stellar spectroscopy is being begun with this instrument. Our plans for the development of the stellar physics section include the acquisition of a large Schmidt–Cassegrain telescope and a large reflector of about 100-in. aperture as soon as the necessary funds become available.

The developments that have already taken place have necessitated considerable improvements in our workshop facilities. The Observatory machine shop is now equipped for meeting most requirements of a modern astrophysical observatory; an optical workshop for the Observatory is also one of our projects.

PASTURE AND FODDER DEVELOPMENT IN MEDITERRANEAN COUNTRIES

THERE are a number of countries in the south of Europe and the north of Africa which have sufficient in common to be grouped as the Mediterranean area but in which there is also diversity of topography and, to some extent, of climate: the rainfall varies from 200 to 1,000 mm. a year. The prevalence of limestone rock with soils derived therefrom is a characteristic of this area; but there are considerable areas of igneous rocks, although here, too, practically all the overlying soils are directly related to these rocks. The olive and the evergreen oak are characteristics of the area; indeed, it may be said that a map of the olive and evergreen oak is a map of the typical Mediterranean area. The past history of these countries—invasions, wars and tribal movements—have necessarily affected the people's way of life and the agricultural traditions that have come to be established, but the influence of the past is not now easy to diagnose in its entirety.

There are some specialized crops, particularly the vine and the olive, that are long established and the management of which is generally good; but the cultivation of the more utilitarian crops is mostly unsatisfactory, and arable work on a rotational basis is very weak. Wheat is a dominant crop, and an alternation of wheat and fallow is the chief rotation.

Except in some parts of the south of France, there is a very great deal of pressure on the land to secure the livelihood of the people, and this arises to a considerable extent from the deterioration that has put some areas completely out of cultivation. There has in the past been a good deal of forest destruction, not only to make room for arable cultivation but also to provide wood for buildings and for ships; in consequence, there has been considerable denudation and erosion, and over-grazing has intensified this decline.

The keeping of small animals, particularly sheep and goats, is very common. The keeping of one or two animals by a family is quite normal, but there are also professional shepherds with their flocks. None of the stock, however, is developed for one primary purpose; almost every animal is a multiple-purpose animal to produce whatever labour, milk, meat, skin and so forth it can.

In addition to the defects in crop husbandry itself is the lack of integration between crop and animal husbandry. There is very little pasture specifically cultivated for grazing. Grazing is largely a random affair, and the stock graze in areas that are inaccessible for ploughing or on crop residues. The shepherds who keep flocks of sheep have little grazing ground which is their own, and these shepherds make financial arrangements wherever they can for their flocks to graze.

The Mediterranean farmer has for a long time followed tradition without receiving much inspiration for the development of new ideas, but it does seem that these people are amenable to help and guidance in raising the level of their farming. The pasture and forage problems are crucial to the progress that can be made, and in this connexion the Organization for European Economic Development has produced a report, entitled "Pasture and Fodder Development in Mediterranean Countries"*, which should be the means of big developments and considerable transformation. For some time now the Food and Agricultural Committee of the Organization has been concerned with the development of grassland in Europe, and, following a conference in Paris during May 1950, it published "Farm Advisory Methods for Grassland Improvement". It was during the Paris conference that the need for studying pasture and fodder production in the Mediterranean area was stressed and, in preparation for a conference on the matter, the countries concerned were surveyed by a number of experts from the United States, Australia, South Africa and Great Britain. Each of these experts worked with suitable colleagues in the country concerned, and reports on the various countries are published in Part 2 of the present publication of the Organization for European Economic Development. The reports were discussed first with representatives of the various countries and then at a conference in Rome in June 1951, when a number of important recommendations were agreed.

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* Pasture and Fodder Development in Mediterranean Countries. (Technical Assistance Mission No. 58.) Pp. 176. (Paris: Organization for European Economic Co-operation; London: H.M. Stationery Office, 1951.) n.p.

A fundamental consideration in pasture and forage development is necessarily the climate and its effect on the growing season. Information about climatic conditions is essential if experience in one area is to be helpful in another, and if the introduction of plants from one region to another is to be carried out rationally. It was therefore recommended in the report that studies of climate and the keeping of reliable meteorological records must be undertaken, and suggestions for the minimum necessary undertakings are made.

A few of the indigenous plants in these countries have been developed commercially; but for the most part they have not been systematically studied and assessed, although this is work that provides essential data for pasture improvement and, as the report points out, can be effective in a very short time. The conference also urged that each country should, in due course, introduce and test species and strains from other countries, and that a systematic programme of seed production should be made possible.

Following systematic study in a country of plants involved in pastures, the integration of pastures and fodder for grazing with its whole scheme of arable farming must be studied and developed. It is suggested that a first step in this matter might be the incorporation of an annual fodder crop into the familiar cereal/fallow rotation, and that, where the climate permits, the fallow be replaced by an appropriate legume, so that in due course this might be developed into a wheat/legume/legume rotation, with wheat every third year, or, in the drier parts, the rotation might be wheat/legume/fallow. The lengthening of rotations in this way should, where it is possible, bring in grazing animals. This will admittedly be difficult in some areas of small holdings where there is no communal grazing, but it is a programme to be aimed at. Moreover, at the present time animal production is very much affected by seasonal food production, and an appropriate development of the continuous production of fodder all the year round is a vital matter.

There are many other lines of work suggested for the improvement of pasture and forage; but the conference has not been unmindful of important economic aspects. Improvements in production will be justified only when and where there are appropriate markets, and in some cases potential markets will need development. The need for increasing the consumption of milk in these countries is one important matter in this connexion. Better farm implements are required; and it is realized, too, that there must be a development in the use of fertilizers (at present much of the land is very poor, particularly in phosphate and nitrogen), and a definite price policy in the development of fertilizers will be required. The need for credit facilities also received the attention of the conference.

The conference expressed the hope that the interest of pasture and fodder developments in the Mediterranean countries will justify the establishment of research stations and pilot farms, and also of a journal and a Mediterranean grassland committee.

A number of technical papers bearing on the subject of the conference were read at the Rome meeting and are produced in Part 3 of the report.

N. M. Comber

NEWS and VIEWS

Directorship of the Lister Institute:

Sir Alan Drury, C.B.E., F.R.S.

The retirement is announced of Sir Alan Drury from the directorship of the Lister Institute, London, which he has held since 1943. Sir Alan assumed the directorship at a difficult period in the history of the Institute, the work of which had been much disorganized by the War. He brought to his task not only his outstanding personal qualities of patience and quiet efficiency, but also a wide knowledge of many aspects of medical research which he had acquired through long service on the scientific staff of the Medical Research Council. His experience included clinical research with the late Sir Thomas Lewis, many years of distinguished work in experimental pathology at Cambridge and a period of most valuable service during the War in the Council's headquarters office. Under Sir Alan's guidance, the Lister Institute has been restored to its position as a centre of active medical research, sustaining its earlier reputation for work in immunochemistry and becoming well known for investigations of blood groups and blood products; it has also taken on new and important responsibilities in connexion with the preparation of sera and vaccines. During his directorship Sir Alan has served as a member of the Medical and the Agricultural Research Council, and both bodies owe much to his help and advice. It is inevitable that the many administrative burdens which Sir Alan has had to shoulder should have greatly restricted his opportunities for personal research at the Lister Institute. It is good, therefore, to know that after his retirement such opportunities will be restored to him when he takes up his work in the Agricultural Research Council's Institute of Animal Physiology. Sir Alan's personal qualities and scientific attainments ensure that the research in experimental pathology which is to be under his care in this Institute will develop on sound lines.

Dr. A. A. Miles

Dr. A. A. Miles, who is to succeed Sir Alan Drury as director of the Lister Institute, has been, since 1946, director of the Division of Biological Standards at the National Institute for Medical Research; for the past five years he has also been deputy director of the Institute. Before his appointment to the scientific staff of the Medical Research Council, Dr. Miles had become recognized as one of the leading bacteriologists in Great Britain. He had had fruitful periods of work at the London School of Hygiene, at Cambridge, at the Postgraduate Medical School in London, and as professor of bacteriology at University College Hospital Medical School, London, where he showed himself to be an outstandingly successful teacher. During his tenure of the latter appointment he had, throughout the War, the responsible position of sector pathologist within the Emergency Medical Service. As director of the Division of Biological Standards at the National Institute for Medical Research, Dr. Miles has had the task of continuing and developing the work so admirably built up by Sir Percival Hartley. The international appreciation which his efforts have met with is shown by his election as chairman of the Expert Committee on Biological Standardization of the World Health Organization. Dr. Miles has not allowed his official duties to diminish his enthusiasm for investigation. He has been throughout, and he continues to be, an active research worker, being best known for his immunological studies of *Brucella* and, more recently, for his investigation of factors affecting the spread of infection within the animal body. In him the Lister Institute acquires a director of wide knowledge and experience, under whose energetic leadership research work will have every encouragement.

Bacteriology in Leeds:

Prof. J. W. McLeod, O.B.E., F.R.S.

James Walter McLeod, who is retiring from the Brotherton chair of bacteriology in the University of Leeds, has profoundly influenced the development of his subject during the past thirty years. Born in January 1887, he received his early education at George Watson's College, Edinburgh, in Lausanne, and at Mill Hill School, and entered the University of Glasgow in 1903, graduating M.B., Ch.B. in 1908. He showed early that his interests lay in laboratory medicine, and, after a year of clinical training in the wards of John Cowan and Sir Kennedy Dalziel, he commenced research in bacteriology with Sir Robert Muir, and was appointed lecturer in pathology at Charing Cross Hospital, London, in 1909; during the First World War he served with distinction—mentioned in dispatches four times and awarded the O.B.E.—in the R.A.M.C. as officer commanding a mobile laboratory. On demobilization McLeod was appointed lecturer in bacteriology at the University of Leeds and became the first incumbent of the Brotherton chair in 1922. During thirty years his contributions to the subject of bacteriology have been notable for their quality and diversity: the pathogenicity of streptococci, the problems of bacterial nutrition and respiration, study of the anaerobes, of the gonococcus, of diphtheria (both as a problem of bacteriology and of epidemiology), have among many other subjects claimed his attention, and in no instance have his findings failed to stand the test of time. Combining the outlook of a general biologist with the exactitude of a physicist and the humanity of a physician, it was but natural that the most notable influence which his work has exerted has been to integrate the study of bacteriology as a subject *per se* with its application to medicine. The honours which he has so rightly deserved—fellowship of the Royal Society, honorary D.Sc. of the University of Dublin, presidency of the Society of General Microbiology—have been a source of very real pleasure to all who know him, and his friends wish him every happiness in his retirement.

Dr. C. L. Oakley

Dr. Cyril Leslie Oakley, who succeeds Prof. McLeod, was born in 1907 and graduated in medicine from University College, London, in 1930, taking a first-class honours B.Sc. in zoology at the same time; three years later he took his M.D. in pathology. After three years as Graham Scholar at the University College Hospital Medical School, he was appointed experimental pathologist at the Wellcome Research Laboratories, Beckenham, in 1934, becoming head of the Immunology and Experimental Pathology Department in 1947. He was elected a Fellow of University College, London, in 1950. During the Second World War he was responsible for the organization of a subsidiary unit of the Laboratories, at Carshalton, where part of the very large production of antitoxin and prophylactics for the Army was carried on. While a Graham Scholar, Dr. Oakley worked on the rate of regeneration of red cells after repeated bleedings. In his first years at Beckenham, besides being responsible for all the morbid histology work of the Laboratories, he worked on virus diseases, particularly influenza, setting up his own unit for making Elford membranes. He then became interested in the pathogenic *Clostridia* and, with his collaborator, Dr. G. H. Warrack, added greatly to the knowledge of the complex antigenic constitution of this group, discovering a number of new toxins and enzymes. He has of recent years, by the use of an ingenious method of immunization with two toxoids simultaneously, furthered very considerably our knowledge of the site of origin of antitoxin. One of the most remarkable observations in this work was the demonstration that aluminium hydroxide adsorbs tetanus or diphtheria toxoid when injected into omental or perirenal fat, and leads to a local production of antitoxin. Dr. Oakley has never abandoned his early zoological interest, and one of his hobbies has been a serious research into the anatomy and systematics of parasitic copepods.

University of Aberdeen

The honorary degree of LL.D. of the University of Aberdeen has been conferred on the following, among others: Prof. Niels Bohr, professor of theoretical physics, University of Copenhagen; Prof. H. Butterfield, professor of modern history in the University of Cambridge since 1944; Prof. James Ritchie, professor of natural history in the University of Edinburgh since 1936; Prof. H. E. Shortt, professor of medical protozoology in the University of London and head of the Department of Parasitology in the London School of Hygiene and Tropical Medicine; and Prof. David Landsborough Thomson, professor of biochemistry in McGill University, Montreal, since 1937.

Medicine and the Mind

For his Rede Lecture, given to the University of Cambridge this year and now published (pp. 30; Cambridge: At the University Press, 1952; 2*s*. 6*d*. net), Sir Russell Brain, president of the Royal College of Physicians, chose as his subject "The Contribution of Medicine to Our Idea of the Mind". Sir Russell pointed out that from an early stage of his training the medical practitioner is made aware of the intimate relationship between the body and the mind, that is, he is always dealing with a body–mind unity, though his chief concern may be with one or the other. The great advances in neurophysiology, neurology and psychiatry during the present century have given us a much more detailed knowledge, enabling us to correlate brain disturbance with mental changes. Disease has made a great contribution to our knowledge of the normal brain–mind relationship, and research has been facilitated by the use of the electro-encephalograph, a machine for amplifying and recording the minute electrical brain-rhythms. It is now known that certain people who behave abnormally have abnormal brain rhythms. Independently of the work of the neuro-physiologists and neuro-psychiatrists, a school of psychological thought has developed which seeks to give a psychological explanation of many forms of mental abnormality, and again the abnormal has thrown light on the normal. The pioneer work of Freud in this field, continued Sir Russell, has been as revolutionary in the interpretation of the mind as was the work of Darwin in the interpretation of the body. Freud did not discover the unconscious mind, for many thinkers deduced it from a study of human thought and behaviour; but he developed the idea practically and produced evidence to show that experiences involving strong emotions might continue to influence behaviour though they had been forgotten, and that feelings such as anxiety might persist divorced from the original ideas. Certain philosophical questions are involved; for example, why is consciousness necessary at all, and why is it associated with some functions of the brain and not with others? The recent contribution of medicine to our ideas of the mind have been, like most of modern science, analytical. But, as Sir Russell emphasized, medicine is also an art, and as an art must realize that the whole man is more than the sum total of parts. It is necessary, more than ever, to find a way of harmonizing logic, philosophy and humanity.

FAO MEMO: New Leaflet of the United Nations Food and Agriculture Organization

THE accounts of the activities of the Food and Agriculture Organization of the United Nations, available as yearbooks and other official publications, are often beyond the scope of the non-technical reader, who nevertheless is interested in the practical steps being taken to overcome hunger and raise the standard of living in various parts of the world. To meet the need of this section of the public, the Organization has started a new illustrated leaflet, *FAO MEMO*, which gives, in semi-popular form, short authentic accounts of its very varied work. In the first issue, which appeared in March, one learns of the success of the publicity campaign in Santiago for encouraging the production and consumption of fish, and in the following number of the project for turning the Jizan region of Saudi Arabia, liable to disastrous extremes of drought and flood, into a flourishing agricultural district by controlling the water supply. Accounts are also given of the useful work being done in the development of rural community life in the Pátzcuaro Lake region of Mexico, and of some occasions, notably that of the recent hurricane in Jamaica, when valuable technical assistance was provided. The *MEMO* is published monthly by the Informational and Educational Services in Rome of the Food and Agriculture Organization, and by the Regional Information Offices in Bangkok, Cairo, New Delhi, Mexico City, and Washington, D.C. Copies of the European edition can be obtained from the Documents Service, Food and Agriculture Organization, Viale delle Terme di Caracalla, Rome, and of the other editions from the appropriate regional offices.

Food and Agriculture Organization: David Lubin Memorial Library

AT a formal ceremony on June 10 the library of the Food and Agriculture Organization of the United Nations was inaugurated in Rome by the director-general, Norris E. Dodd, in the presence of the Council of the Organization, the American Ambassador to Italy, the Italian Minister of Agriculture and representatives of members of the Food and Agriculture Organization. The children and the secretary of David Lubin, founder of the Institut International de l'Agriculture and of its library of some 350,000 publications, which now forms the most substantial and important part of the Food and Agriculture Organization's library of some 400,000 works were among the guests at the opening ceremony. Housed in the modern building generously made available by the Italian Government, the library contains reading rooms, reference, photostat, microfilm services and eighteen kilometres of shelves. In opening it to the public, Mr. Dodd said, "It is a living resource for the service of the world's agriculture. We wish to make it as open as possible to all scholars and technicians and research workers".

Scientific and Technical Periodicals Published in East Asia

THE East Asia Science Co-operation Office, Manila, has issued a list, compiled in 1950, of scientific and technical periodicals published in South-East Asia. The periodicals are listed separately under the Philippines, Indonesia, Malaya, Thailand, Indo-China and Hong Kong, but for each country they are arranged in fourteen broad categories and are also entered in an index by categories covering all six countries. The list covers 142 periodicals and includes particulars of publishers and rates of subscriptions. There is, in addition, an alphabetical index to periodicals arranged under countries. The Office has also issued a supplement to the list, which gives details of some 119 Chinese periodicals. This was compiled in the Shanghai bureau of the Office at the end of 1950 and was revised in the summer of 1951. The supplement is considered incomplete, especially for periodicals published outside Shanghai. Titles are listed alphabetically and also classified by subjects, and particulars of publishers, language, frequency, subscription and commencement of publication are included. The co-operation of scientific workers and librarians in repairing omissions and correcting errors in the list as a whole is invited.

British Thomson-Houston Engineering Research Fellowships

THE British Thomson-Houston Co., Ltd., has instituted the award (annually) of engineering research fellowships. The award is open to honours graduates who are in their last year of apprenticeship with the Company. The holder of a fellowship will engage in engineering research for a limited period (one to three years) either wholly within the Company or partly within the Company and partly at a university. He will work under the supervision of a senior engineer of the Company and under the guidance of a Research Fellowship Panel set up for the purpose. The Director of Research and Education is chairman of the Panel, which includes other senior executives of the Company and, in addition, Prof. E. B. Moullin and Prof. Willis Jackson. This year (1952) fellowships have been awarded to P. H. G. Allen and P. C. McNeill. Mr. Allen was educated at King Edward VI Grammar School, and the City College, Norwich. During the War he served with the Royal Engineers and was a prisoner-of-war in Japan for three and a half years. On demobilization, he studied at King's College, London, and obtained his degree in electrical engineering with first-class honours in 1950. His research will be concerned with heat flow in large transformers. Mr. McNeill was educated at Loretto School, Midlothian. During the

War he served with R.E.M.E. and was demobilized in 1947 with the rank of captain. He then studied at Queen's University, Belfast, and graduated with first-class honours both in electrical and in mechanical engineering in 1950. His research will be on the secondary emission coefficients in magnetrons.

Ramsay Memorial Fellowships

THE Ramsay Memorial Fellowships Trustees have made the following awards of new fellowships in chemistry for 1952–53: Mr. D. Clark, a British Fellowship of £500 a year at the University of Birmingham; Mr. R. F. Webb, a British Fellowship of £500 a year at the University of Cambridge; Dr. G. S. Trick, a Canadian Fellowship at King's College, London; Mr. Juan Llopis Mari, a Spanish Fellowship at King's College, London; Mr. R. O. Steiner, a Swiss Fellowship at the Imperial College of Science and Technology, London; Mr. David R. Lide, a United States Fellowship at the University of Oxford. The Trustees have renewed the following fellowships for the same year: Mr. L. E. Lyons (British Fellowship) at University College, London; Mr. James Jack (Glasgow Fellowship) at the University of Cambridge; Dr. Serafin Novoa (Spanish Fellowship) at the University of Oxford.

Botanical Society of Bengal: Annual General Meeting and Officers

THE annual general meeting of the Botanical Society of Bengal was held on April 27 at the Botany Laboratory, Presidency College, Calcutta. Dr. J. C. Sen Gupta, principal of the College, who is also the president of the Society, pointed out in his address that the physiology of plants with which we are at present familiar is a physiology of the plants of the temperate climate of Europe and North America, and he stressed the importance of a thorough research on the physiology of tropical plants. This will also help in future plans for research on improvement of agricultural crops, medicinal plants and other plants of economic importance. He also laid stress on the need for enlarging the scope of study in plant physiology at Indian universities and pointed out the great importance of taking necessary steps for the establishment of an institute of plant physiology in or near Calcutta. The chief guest at the meeting, H.E. Dr. H. C. Mookerjee, spoke on the need of research for the betterment of crop yields and the introduction and synthesis of new fruits, etc.; he also emphasized that there should be more members of the Society, and all of them should undertake co-ordinated research. The following officers of the Society were elected: *President*, Dr. J. C. Sen Gupta; *Vice-Presidents*, Dr. K. P. Biswas and Prof. P. C. Sarbadhikari; *Secretary for Foreign Correspondence*, Sri A. K. Ghosh; *Councillors*, Dr. H. K. Nandi, Dr. S. M. Sircar, Dr. P. N. Bhaduri, Dr. H. L. Chakravorty, Dr. B. K. Kar, Prof. B. K. Mitra and Dr. P. N. Nandi; *Editor of Publications*, Prof. S. R. Bose; *Honorary Secretary*, Dr. N. K. Sen (35 Ballygunge Road, Calcutta 19); *Honorary Treasurer*, Sri P. K. Bose; and *Honorary Librarian*, J. Sen.

Symposium on Combustion

AN international symposium on combustion is to be held at the Massachusetts Institute of Technology during September 1–5. It is expected that about a hundred papers will be presented, from Great Britain, France, Holland, Belgium, Germany, Japan and the United States. Emphasis is being placed on the physical aspects of combustion, particularly wave phenomena and turbulence, treated from both the experimental and theoretical points of view. The complete papers will appear later in a single volume, like that issued after a similar symposium held in 1948. Further information can be obtained from the Summer Session Office, Combustion Symposium Committee, Massachusetts Institute of Technology, Cambridge 39, Massachusetts, or from Prof. Hoyt C. Hottel, professor of fuel engineering at the Institute, who is co-chairman of the symposium.

Forthcoming Congresses associated with International Scientific Unions

THE following meetings associated with international scientific unions are taking place in the next few months: the Royal Society, through its British national committees, is the adhering body for Britain to each of the unions, and available information of these congresses may be obtained from the Assistant Secretary of the Royal Society (Burlington House, Piccadilly, London, W.1). *Astronomy:* Eighth General Assembly of the International Astronomical Union (Rome, September 4–13); *Geography:* Eighth General Assembly of the International Geographical Union (Washington, August 8–15, to coincide with the seventeenth International Geographical Congress); *Theoretical and Applied Mechanics:* Third General Assembly of the International Union of Theoretical and Applied Mechanics (Istanbul, August 20–28, to coincide with the seventh International Congress of Applied Mechanics); *Scientific Radio:* Tenth General Assembly of the International Union of Scientific Radio (Sydney, August 11–23); *Analytical Chemistry:* First International Congress on Analytical Chemistry (Oxford, September 4–9); meetings of the Analytical Chemistry Section of the International Union of Pure and Applied Chemistry will take place during the period of the Congress; *International Council of Scientific Unions:* Sixth General Assembly of the International Council of Scientific Unions (Amsterdam, October 1–3).

University of London

DR. F. L. WARREN, reader in biochemistry in University College, has been appointed to the University chair of biochemistry tenable at London Hospital Medical College. Dr. Eric Neil, senior lecturer in physiology in Middlesex Hospital Medical School, has been appointed to the University readership in physiology tenable at Middlesex Hospital Medical School. Dr. W. S. Bullough, honorary lecturer in the University of Sheffield, has been appointed to the University chair of zoology tenable at Birkbeck College.

Colonial Service: Recent Appointments

THE following appointments have recently been made in the Colonial Service: R. B. Allnutt (director of agriculture, Leeward Islands), assistant director of agriculture, Nigeria; R. Aribisala, J. A. Carter, R. F. S. Hainsworth, D. R. E. Jackson, J. O. I. Longe, R. Miller and P. Mulholland (agricultural superintendents, Nigeria), agricultural officers, Nigeria; E. J. Gregory (senior agricultural officer, Jamaica), deputy director of agriculture, Jamaica; R. B. Jagoe (senior botanist (time scale), Federation of Malaya), senior botanist (superscale), Federation of Malaya; G. B. Kennard (marketing officer, British Guiana), senior field officer, British Guiana; E. W. Leach (director of agriculture, Trinidad), director of agriculture, Gold Coast; E. W. Momber (senior agricultural officer, Nigeria), principal agricultural officer, Nigeria; J. T. Moon (senior agricultural officer, Kenya), assistant director of agriculture, Uganda; B. A. O'Connor (entomologist, Fiji), senior entomologist, Fiji; H. T. Pagdon (senior entomologist (time scale), Federation of Malaya), senior entomologist (superscale), Federation of Malaya; M. M. Lucie Smith (agronomist, Trinidad), assistant director of agriculture, Gold Coast; I. R. Dale (senior assistant conservator of forests, Uganda), deputy conservator of forests, Uganda; L. R. Hutson (chief veterinary officer, Antigua, Leeward Islands), deputy director of agriculture (animal husbandry), Trinidad; H. K. Littlewood (deputy director of veterinary services, Nigeria), principal veterinary officer, Western Region, Nigeria; J. McCulloch (senior veterinary officer, Nigeria), principal veterinary officer, Eastern Region, Nigeria; J. K. H. Wilde (chief veterinary research officer, Tanganyika), assistant director of laboratory services, Nigeria; E. Buckley (assistant principal, Technical College, Kuala Lumpur), principal, Technical College, Kuala Lumpur; C. J. Morrison (supervisor grade 2, Agricultural Society, Jamaica), senior soil conservation officer, Jamaica; T. J. Taverner (agricultural assistant, Tanganyika), superintendent of agriculture, Tanganyika; G. W. Arnott, agricultural chemist, Federation of Malaya; P. Class, T. R. Dickinson and D. M. Fordyce, agricultural officers, Federation of Malaya; A. R. Dunbar and W. Hadlow, agricultural officers, Uganda; C. R. Dunton, agricultural officer, Aden; D. F. Edwards and F. Miller, agricultural officers, Gold Coast; R. T. Ellis, plant breeder, Nyasaland; J. T. Hall, agricultural officer, Northern Rhodesia; Miss M. Hayward, plant pathologist, Nyasaland; N. B. Joy, plant pathologist, Tanganyika; A. K. Murray, agricultural officer, Sierra Leone; E. L. Neil, agricultural officer, Nigeria; W. P. Panton, soil chemist (geologist), Federation of Malaya; C. W. R. Pearse, agricultural officer, Tanganyika; S. A. Elks, chemist, Federation of Malaya; E. R. W. Fogden, chemist, Tanganyika; J. A. G. Ellis, assistant conservator of forests, Gold Coast; O. Kerfoot, assistant conservator of forests, Northern Rhodesia; J. F. Watson, assistant conservator of forests, Federation of Malaya; D. A. Eaton, agricultural cocoa survey officer, Gold Coast; G. English, geologist, Nigeria; T. Gorazdowski, fisheries officer, Hong Kong; K. Marshall, prehistorian, Geological Survey Department, Uganda; Miss J. Redwood, assistant adviser on aborigines, Federation of Malaya; D. J. Watson, fisheries officer, Tanganyika.

Announcements

Dr. E. B. Chain, professor of biochemistry and director of the International Research Centre for Chemical Microbiology, Rome, has been elected a foreign correspondent of the Paris Academy of Medicine.

The Dr. W. S. Bruce Memorial Prize for 1952 of the Royal Society of Edinburgh has been awarded by the Joint Committee of the Royal Physical Society, the Royal Scottish Geographical Society, and the Royal Society of Edinburgh, to G. de Q. Robin, for his initiative and resource in carrying out glaciological and biological researches in the Antarctic while with the Falkland Islands Dependencies Survey (1946–47) and with the Norwegian–British–Swedish Expedition (1950–51).

The Secretary of State for War has appointed Mr. H. A. Sargeaunt to be scientific adviser to the Army Council with effect from July 1. Mr. Sargeaunt has held the appointment of deputy scientific adviser to the Army Council since April 1950, and was previously the superintendent of the Army Operational Research Group.

During the recent European Congress for Chemical Engineering, in Frankfurt am Main, the Council, representing seventeen countries, decided to make the congress a permanent annual feature. At the Council's meeting on May 20, a standing committee of four members was elected as follows: Dr. Francis A. Freeth (United Kingdom), M. Jean Gérard (vice-president, Société de Chimie Industrielle, France), Dr. Luigi Morandi, president (Italy), Dr. Herbert Bretschneider, vice-president of the Dechema (Deutsche Gesellschaft fur chemisches Apparatewesen, E.V.), Frankfurt am Main. The next European Congress will take place during June 1953 in Paris.

The twenty-seventh annual conference of Aslib will be held at The Hayes, Swanwick, Derbyshire, during September 19–22, under the chairmanship of Sir Stephen Tallents. The opening address will be given by Prof. T. U. Matthew, professor of the principles of engineering production in the University of Birmingham, who will speak on "The Significance of Information in Present-day Industrial Society". Further information can be obtained from Aslib, 4 Palace Gate, London, W.8.

A meeting was held in the rooms of the Royal Entomological Society of London on March 12, at which, in response to a request from Prof. Grassé and others, the proposal to form a British branch of the Union Internationale pour l'Étude des Insectes Sociaux was discussed. Dr. J. D. Carthy, of Queen Mary College, Mile End Road, London, E.1, has agreed to act provisionally as secretary, and would be glad to hear from any British biologist who would like to join such an organization. If the necessary response is received, steps will be taken to put the organization on a permanent basis and to nominate officers.

A students' essay prize for 1952 has been awarded by the Council of the Institute of Metals to Mr. John C. Wright, of the Development and Research Department, Mond Nickel Co., Ltd., Birmingham, for an essay on "The Metallographic Investigation of Failed High-Temperature Components". In 1953, the Council will award two students' essay prizes of twenty guineas each. The competition is open to student members of the Institute and to associate members of local sections who are eligible for student membership of the Institute, and between the ages of seventeen and twenty-five. The choice of subject is left to the competitors, except that subjects relating exclusively to extraction and ferrous metallurgy are excluded. Entry must reach the Secretary, Institute of Metals, 4 Grosvenor Gardens, London, S.W.1, not later than January 1, 1953.

Erratum. In *Nature* of June 21, p. 1042, in the article on "A Diffraction Corona near the Centre of the Spiral Nebula NGC 4216", by Prof. Bertil Lindblad and Aina Elvius, the blocks for Figs. 3 and 4 have been inadvertently interchanged. The legends are correct as printed.

COSMIC RAYS AND THE SUN'S MAGNETIC FIELD

Apparent Absence of Low-energy Cosmic-ray Primaries

THE purpose of this communication is to examine critically present evidence on the intensity of cosmic rays above and near the top of the atmosphere at high latitudes. It is concluded that low-energy primaries are absent to a significant extent, and that there exists, therefore, near a geomagnetic latitude of 58°, a flattening of the primary momentum spectrum, commonly referred to as a 'knee'.

(*a*) Rocket measurements[1] above the atmosphere at geomagnetic latitude (λ) 58° N. (Gulf of Alaska) yielded a total directional intensity of charged particles of $0 \cdot 29 \pm 0 \cdot 03$ sec.$^{-1}$ cm.$^{-2}$ steradian^{-1} in the vertical direction. The amount of material in the Geiger tube telescope system was 3 gm./cm.^{2} of copper and 0·7 gm./cm.^{2} of aluminium—thus excluding protons[2] of kinetic energy less than 60 MeV. However, the minimum magnetic rigidity of a charged particle for arrival at 58° N. and zenith angle zero is $pc/Ze = 1 \cdot 17 \times 10^9$ V., which corresponds to a kinetic energy of 560 MeV. for protons[3]. Thus, the measured intensity presumably corresponds to the intensity of primary protons (see paragraphs (*f*) and (*g*)) of energy greater than 560 MeV., where the term 'primary' is taken to refer to radiation in the general vicinity of the earth's orbit.

(*b*) Balloon measurements of a similar nature by Pomerantz[4] near the top of the atmosphere at λ = 69° N. (Fort Churchill, Canada) gave a vertical intensity of $0 \cdot 25 \pm 0 \cdot 02$ sec.$^{-1}$ cm.$^{-2}$ steradian^{-1}, a value slightly less than, but within the combination of experimental uncertainties closely equal to, the rocket measurements of ref. 1. However, in the measurements of Pomerantz, the low-energy limit is due to absorption of the residual atmosphere above the apparatus and of the apparatus itself. This may be seen as follows. The magnetic rigidity cut-off at 69° N. and zenith angle zero is $pc/Ze = 0 \cdot 25 \times 10^9$ V., or a proton kinetic energy of 32 MeV. But the residual atmosphere and the balloon-borne telescope totalled about 16 gm./cm.^{2} of air, glass and copper, an amount of material sufficient to stop 130-MeV. protons (cf. table).

Geomagnetic latitude	58°	69°
Measured flux (part. cm.$^{-2}$ sec.$^{-1}$ ster.$^{-1}$)	$0 \cdot 29 \pm 0 \cdot 03$	$0 \cdot 25 \pm 0 \cdot 02$
Min. magnetic rigidity in vertical direction	$1 \cdot 17 \times 10^9$ V.	$0 \cdot 25 \times 10^9$ V.
Corresp. kinetic energy : proton	560 MeV.	32 MeV.
α-particle	670 MeV.	32 MeV.
Instrumental and atmospheric absorption		
Rocket experiment	3·7 gm./cm.^{2}	
Balloon experiment		16 gm./cm.^{2}
Lowest accepted energy (if permitted by geomagnetic field)		
Rocket experiment : proton	60 MeV.	
α-particle	240 MeV.	
Balloon experiment : proton		130 MeV.
α-particle		520 MeV.

(*c*) Thus, from (*a*) and (*b*), it appears that there is a negligible intensity of primary protons in the energy-range 130–560 MeV.—certainly a far lower intensity than would be obtained by extrapolation of the primary spectrum as obtained experimentally in the rigidity range $2 \cdot 6 \times 10^9$–15×10^9 volts[1,5].

(*d*) It may also be noted that the total absorbing material in Pomerantz's experiment, 16 gm./cm.^{2}, is only about one-fourth of the mean free path for nuclear interaction, making the extreme assumption of geometrical cross-section. The attenuation of primaries by processes other than ionization should be small. Thus conclusion (*c*) is not essentially affected by these considerations.

The energy-range of conclusion (*c*) is relatively insensitive to inaccuracies in knowledge of the residual pressure at the maximum balloon altitude. For example, if the minimum residual atmosphere were as great as 20 gm./cm.^{2} instead of the reported value of 11 gm./cm.^{2}, the range of energy would be reduced only slightly, to 170–560 MeV.

(*e*) The above does not exclude, but does tend to make unreasonable, a large intensity of primary protons of energies less than 130 MeV.

(*f*) Various observers[6] have reported that the primary radiation contains 15–35 per cent of alpha-particles. It is therefore of importance to apply similar considerations to these. For alpha-particles, the geomagnetic cut-off kinetic energies corresponding to the previously mentioned magnetic rigidities are 670 MeV. and 32 MeV. at geomagnetic latitudes 58° and 69°, respectively. The rocket apparatus at 58° would exclude alpha-particles of energy less than 240 MeV., and the balloon apparatus and residual atmosphere at 69° would exclude alpha-particles of energy less than 520 MeV. (cf. table).

Thus, it appears that there is a negligible intensity of primary alpha-particles in the energy-range 520–670 MeV. In view of the lower absolute intensity of alpha particles, the narrowness of the deduced energy-range, and possible uncertainties in the balloon altitude, this result is less conclusive than that for protons.

(*g*) Due to the short range of low-energy primary nuclei of Z greater than 2, and their low intensity, the present considerations are of no significance in the determination of a possible 'knee' in their spectra.

The conclusions of this note are in agreement with those of Carmichael and Dymond[7]; but they are perhaps more definitive. We are, however, unable to support the conclusion of Pomerantz[4] that there is no sharp low-energy cut-off in the primary spectrum. Nor can we agree—using the same conventional argument—that the cosmic-ray evidence places as low an upper limit on the sun's magnetic moment as $0 \cdot 6 \times 10^{34}$ gauss-cm.^{3}. The essence of the disagreement is the fact that our measurement of primary intensity at latitude 58° shows that the whole of the increase of intensity observed by Pomerantz between 52° and 69° has already occurred at 58° (see spectral plot in ref. 1). Therefore, the knee of the integral-number spectrum of the primary radiation occurs south of 58° and not north of 69°.

Contradictory evidence has been reported by Staker, Pavalov and Korff[8], indicating an increase at all altitudes by a factor of 2 in the neutron intensity at 69° as compared with 54·7°; however, the extensive neutron measurements made by aircraft by Simpson[9] show practically no increase between the same two latitudes at 30,000 ft. when measured within a short time interval, thus giving support to our conclusions. In fact, recent measurements[10] on the time dependence of the intensity of the nucleonic component lead to an attitude of restraint in the interpretation of intensity differences of the order of 10 per cent, unless measurements are made simultaneously or are normalized by means of an appropriate, continuously operating monitor instrument.

In order to clarify the cause of the 'knee' and in particular to decide between the hypothesis of a solar magnetic field and an inherent change in the form of the primary spectrum due to the mechanism of generation or propagation of cosmic rays, the present measurements should be extended to answer the questions:

(i) Is there complete absence of low-energy primaries at all times? In other words, does the slope of the primary spectrum beyond the 'knee' become zero, or merely very close to zero?

(ii) Do primary alpha-particles and heavier components of the primary radiation exhibit a low-energy cut-off corresponding to the same magnetic rigidity as the proton cut-off ($\sim 1 \cdot 5 \times 10^9$ V.)?

Suitable apparatus which will admit protons of energies down to 5 MeV. is available, but because of the great practical difficulty of getting balloons above a pressure of 10 gm./cm.^{2} it is likely that further extension of the empirical primary spectrum to lower energies can best be done by rocket flights above the atmosphere at northerly latitudes.

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[2] Smith, J. H., *Phys. Rev.*, 71, 32 (1947).

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[4] Pomerantz, M. A., *Phys. Rev.*, 77, 830 (1950).

[5] Winckler, J. R., Stix, T., Dwight, K., and Sabin, R., *Phys. Rev.*, 79, 656 (1950).

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[9] Simpson, jun., J. A., *Phys. Rev.*, 81, 639 (1951); 83, 1175 (1951).

[10] Simpson, J. A., Fonger, W., and Wilcox, L., *Bull. Amer. Phys. Soc.*, 26, 24 (1951), and private communication.

Diurnal Variation of Cosmic Rays and the Sun's Magnetic Field

IF the latitude cut-off described in the preceding communication is indeed due to a solar magnetic field, then the value of the solar magnetic dipole moment would be $0 \cdot 65 \times 10^{34}$ gauss-cm.^{3}. (This dipole moment can be expressed as $8 \cdot 75 \times 10^9$ V. × (sun–earth distance)^2 and corresponds to an empirically observed[1] proton cut-off momentum at the earth's orbit of $1 \cdot 5 \times 10^9$ eV./c.) In addition, such a magnetic dipole field is expected to lead to a diurnal variation[1] of the low-energy part of the primary cosmic radiation incident on the earth. (In particular, the allowed solar cone would be completely open for particles of magnetic rigidity of $8 \cdot 75 \times 10^9$ V. and completely closed for particles of $1 \cdot 5 \times 10^9$ V. ($= (1 + 2^{1/2})^{-2} \times 8 \cdot 75 \times 10^9$ V.) according to the Störmer theory of the allowed cone.) The experimental absence[3] of this diurnal variation has been used for supporting the view that the sun's field must be at least an order of magnitude smaller than the value given above. (This would then be in accord with modern astronomical measurements of the Zeeman effect of solar absorption lines which give a magnetic field essentially zero[4].)

It may be perfectly true that the sun has no appreciable dipole moment, and we do not wish to imply that this is not the case. However, without questioning the validity of the conventional arguments employed, we merely wish to show here that their correct application does not lead to the same conclusion, since even with a magnetic moment of magnitude sufficient to explain the latitude cut-off, the diurnal variation to be expected would be so small as to be practically undetectable. This assertion is based essentially on a detailed recalculation of the diurnal variation using the basic results of Kane, Shanley and Wheeler[5], and the explicitly and very clearly presented methods of Dwight[6]. In particular, we make use of a dipole moment of $0 \cdot 65 \times 10^{34}$ (instead of 1×10^{34}) gauss cm.$^{-3}$ and a primary rigidity spectrum corresponding to the empirically observed integral spectrum[1,6] which has an exponent of $- 1 \cdot 1$ in the region sensitive to latitude (instead of $- 1 \cdot 75$). Both changes tend to reduce the diurnal variation.

(*a*) In order to deal with an actual situation, we will attempt to analyse the experiments of Bergstralh and Schroeder[3] performed at lat. 56°, near the optimum latitude for observing the diurnal variation[6]. To obtain the maximum diurnal spread, one first computes the exact shape of the diurnal variation for a particular solar magnetic moment and rigidity spectrum[6] (cf. columns (3) and (4) of the table).

DIURNAL VARIATION OF PRIMARY COSMIC RADIATION AT LAT. 56° Calculated for various values of the solar magnetic moment and the exponent of the integral primary rigidity spectrum

Solar magnetic moment (gauss-cm.^{3})	Fill-up, φ, of trapped orbits (per cent)	Max. diurnal spread for exponents of −1·75 and −1·1 of primary rigidity spectrum with orbits empty		with orbits filled	
		−1·75	−1·1	−1·75	−1·1
		per cent	per cent	per cent	per cent
$1 \cdot 0 \times 10^{34}$	92*	92·5†	75	7·4	6
$0 \cdot 65 \times 10^{34}$	95‡	60‡	55	3	2·5
$0 \cdot 42 \times 10^{34}$	96·5*	45†	35	1·6	1·2
(1)	(2)	(3)	(4)	(5)	(6)

* Deduced from Fig. 4 of ref. 5;
† Scaled from Fig. 3 of ref. 2;
‡ Interpolated values.

(*b*) It is next necessary to take account of the filling-up of forbidden orbits (that is, 'trapped' orbits which do not come from infinity and are therefore outside of the allowed cone). Alfvén[7] first pointed out that these orbits might be filled up to an appreciable extent with particles which, although forbidden to enter them, have been scattered by the earth's magnetic field into trapped orbits. More refined calculations have been performed by Wheeler *et al.*[5] for two solar moments (1×10^{34} and $0 \cdot 42 \times 10^{34}$ gauss-cm.^{3}). By considering the scattering effect of the earth's field which, so to speak, 'punches a hole' into the magnetic screen produced by the sun, and taking into account removal of these particles by collisions with the earth and other planets, they have computed the percentage, φ_{diff}, to which the forbidden orbits are filled up, as a function of the magnetic rigidity of the primaries. From their results we have deduced the values of φ in column (2) of our table by some numerical integrations and a reasonable interpolation. It is to be noted that the 'average' φ of 90 per cent used by Dwight[2] gives values for the diurnal variation which are too high by a factor of 2–3 for the lower values of solar magnetic field. (This sensitive dependence on φ arises because the values of actual diurnal variation in columns (5) and (6) are obtained by multiplying (3) and (4) by $(100 - \varphi)/100$.)

(*c*) The final value for the calculated maximum variation, 2·5 per cent, must be reduced somewhat when comparing it with experimental results; a 'smearing-out' of the peaks of the variation occurs, as it is necessary to average over time intervals sufficiently long to give a statistically significant number of counts.

(*d*) We must therefore compare a calculated variation of 2 per cent (rather than 9 per cent) with the experimental value of 0 ± ~1 per cent[3]. We do not believe that they differ significantly.

(*e*) In combination with the conclusions of the preceding communication, it would appear then that none of the present ***experimental*** results in cosmic rays can be used reliably as evidence against the existence of a solar dipole moment up to a limit of about $0{\cdot}65 \times 10^{34}$ gauss-cm.^{3}.

The present investigation is perhaps of more than academic interest since, on one hand, it has been suggested that the sun's magnetic field undergoes a periodic variation[4]; on the other hand, the validity of drawing any conclusions about a general magnetic field of the sun from measurements of the Zeeman effect in the turbulent absorbing regions of the solar atmosphere has been questioned[4]. It is of importance, therefore, to examine critically all cosmic-ray evidence which purports either to deny or affirm a solar magnetic field.

Additional Considerations. The calculated diurnal variation can be reduced even further when it is noted[5] that the population of the trapped orbits is increased if planets, in particular Mars and Venus, possess a magnetic moment, as appears very reasonable. In addition, further holes can be punched in the magnetic screen by solar corpuscular streams carrying magnetic fields outward through the planetary system. Their rate of occurrence is appreciable compared to the time constant of the trapped orbit particles, which is about 5,000 years[5]. By means of these additional influences, particles may be admitted into the vicinity of the earth which have energies lower than the helio-magnetic cut-off. Such particles, which could enter the earth only at high latitudes, have not been observed in appreciable numbers. This objection may perhaps be met by noting that (i) they might be few in number originally; and (ii) if admitted they will be removed very quickly through ionization loss in interplanetary matter, an effect which can be neglected at higher energies[6]. (For example, a proton having a rigidity of $0{\cdot}5 \times 10^9$ V. possesses kinetic energy of $0{\cdot}12 \times 10^9$ eV., corresponding to a range of 10 gm./cm.^{2}. The average[6] path-length is 25 gm./cm.^{2} and may well be longer at low energies.)

These considerations again point to the importance of conducting cosmic ray measurements at high altitudes and high latitudes on a continuous basis, preferably correlated with similar measurements at intermediate latitudes.

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Feb. 9.

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[2] Dwight, K., *Phys. Rev.*, **78**, 40 (1950), and references therein.

[3] Bergstralh, T. A., and Schroeder, C. A., *Phys. Rev.*, **81**, 244 (1951); the diurnal variation described by Elliot, H., and Dolbear, D. W. N. (*J. Atm. and Terr. Phys.*, 1, 205; 1951), refers to cosmic rays of very much higher energies and is presumably due to another mechanism.

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[5] Kane, Shanley and Wheeler, *Rev. Mod. Phys.*, **21**, 51 (1949); this paper contains a particularly lucid account of the whole problem of trapped orbits.

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AN UNUSUAL TRANSFORMATION OF ISOMERIC FORMS OF TETRAACETYL D-RIBOFURANOSE

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1 : 2 : 3 : 5-Tetraacetyl D-ribofuranose was first prepared by Howard, Lythgoe and Todd[1] by hydrogenolysis of 1 : 2 : 3-triacetyl 5-trityl D-ribose, followed by acetylation of the resulting 1 : 2 : 3-triacetyl D-ribose. The compound had melting point 58°, $[\alpha]_D^{15°}$ + 20° (c = 0·645 per cent in chloroform). Later, Bredereck and Hoepfner[2] obtained a tetraacetyl D-ribose of melting point 56°, $[\alpha]_D^{20°}$ − 3·6° (in methanol) by treatment of 1 : 2 : 3-triacetyl 5-trityl D-ribose with acetyl bromide in acetic anhydride solution. There is no reason for doubting the identity of this compound with that obtained by Howard, Lythgoe and Todd. In 1950, Zinner[3] reported that direct acetylation of ribose yielded a mixture of 1 : 2 : 3 : 4-tetraacetyl D-ribopyranose and a new tetraacetyl D-ribofuranose, melting point 82°, $[\alpha]_D^{24°}$ − 12·6° (c = 12·83 per cent in chloroform), $[\alpha]_D^{24°}$ − 15·4° (c = 7·227 per cent in methanol), which was named 'β-tetraacetyl D-ribofuranose'. The present communication is concerned with its relationship to the previously known isomer.

In 1949, one of us (J. Davoll) prepared several batches of tetraacetyl D-ribofuranose by Bredereck and Hoepfner's method. While the first three of these preparations had melting point 56–58°, the fourth run yielded a compound of melting point 85°, $[\alpha]_D^{23°}$ − 12° (c = 2 per cent in chloroform), $[\alpha]_D^{23°}$ − 13·5° (c = 5 per cent in methanol). This compound had the composition of a tetraacetyl ribose (found: C, 49·25; H, 5·75; acetyl, 53·9; calc. for $C_{13}H_{18}O_9$: C, 49·05; H, 5·7; acetyl, 53·9 per cent) and proved to be identical with a specimen of 'β-tetraacetyl D-ribofuranose' prepared by Zinner's

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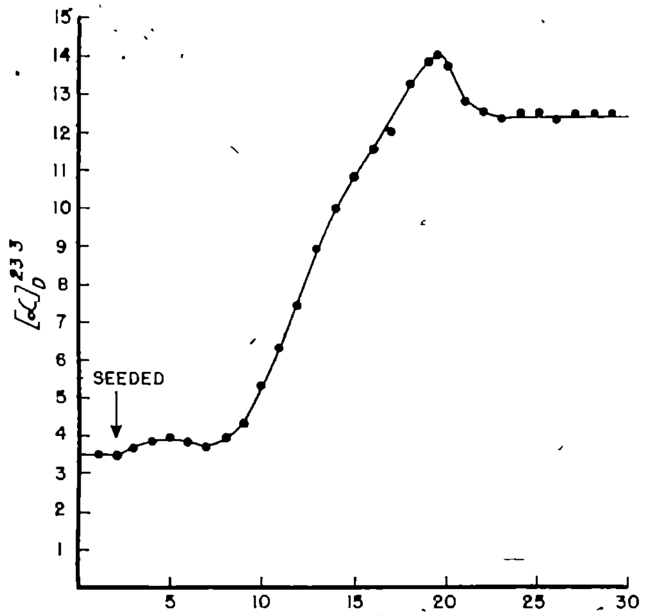


Changes in specific rotation accompanying transformation of the form of melting point 56° to that with melting point 85° in methanolic solution

method[3]. Its furanose structure was proved by its conversion, through the acetochloro compound, to adenosine[4], in yields similar to those obtained from the tetraacetyl ribofuranose of melting point 56–58°.

It was now found that the melting points of samples of the earlier preparations had risen to 85°, and it proved impossible to prepare the form of lower melting point. When a sample of melting point 56°, obtained from Prof. Todd's laboratory, was exposed to the air in a laboratory inoculated with the form of higher melting point, the crystals rapidly became opaque and their melting point was then found to be 85°. (We wish to thank Dr. S. Trippett for providing this sample. Prof. Todd, whom we wish to thank for his criticisms of the manuscript, has informed us that the transformation to the isomer of higher melting point has now been observed at Cambridge.) Dr. Visser has studied the catalytic effect in the solid state under more controlled conditions. Inoculation of a dried sample (1 gm.) of melting point 57° with 1 mgm. of that with melting point 85° (obtained from the Sloan-Kettering Institute) raised the melting point to 75–77° within two hours, and to 77–79° overnight; this was further raised to 84–85° by recrystallization. An odour of acetic acid was noted during the transformation.

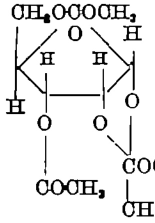
Dr. Visser has also shown that the catalytic effect operates in methanolic solution. Immediately after opening the sample of the isomer of melting point 85°, a previously prepared methanolic solution (c = 2·94 per cent) of the isomer of lower melting point in a polarimeter tube was inoculated with a minute amount of the higher melting form. The subsequent changes in optical rotation of the solution, confirmed in a duplicate experiment, are shown in the accompanying graph.

A satisfactory explanation of these observations must account for: (a) a structural change in the molecule to account for the alteration in optical rotation; (b) the catalytic effect, in solution and in the solid state, of the form of higher melting point; and (c) the complexity of the change in specific rotation shown in the graph, which indicates the presence of at least three molecular species.

If the isomer of melting point 56° is denoted by A, and that of melting point 85° by B, the catalytic effect might be explained by a reaction (probably involving acetyl migration) between A and B to give a compound which might then become rearranged and dissociated to give two molecules of B:

$$A + B \rightarrow A\,.\,B \rightarrow B + B.$$

We have been unable to determine the nature of the difference between the two isomers. The closeness in specific rotation of the two forms, and the facility of the conversion of the 56° into the 85° isomer, are against simple α, β isomerism. It is also possible that one form has the orthoacetate anhydride structure shown (which, like the acetylated carbohydrate methyl orthoesters[5], might be expected to give rise to a normal acetyl glycosyl halide), though this structure is difficult to reconcile with the stability of both forms to water and ethanol. Only one compound of the same type appears to have been prepared, namely, an amorphous octa-acetyl maltose[6], the properties of which have not been reported.



The difficulty of again obtaining the lower melting isomer in either of these laboratories has prevented further study of this remarkable transformation.

This investigation was supported by grants from the National Cancer Institute, of the National Institutes of Health, Public Health Service, and from the Atomic Energy Commission, Contract AT(30–1)–910, to the Sloan-Kettering Institute, and from the United States Public Health Service to the University of Southern California.

[Jan. 9.

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MANAGEMENT IN SCOTLAND

IN a paper submitted to the Scottish Management Conference which was held at Gleneagles during April 25–27, Mr. B. A. C. Hills, controller of S. Smith and Sons, Ltd., suggested that what is most urgently needed in industry to-day is the realization that behind high-sounding labels lie ordinary actions which not only can be applied to businesses but also should be. Line production, for example, is too often only associated with mass production of cars and refrigerators, whereas it could, in fact, be used in the majority of factories.

The principles of economic manufacture demand the maximum output of finished goods from the minimum total resources in material, labour, equipment, time and money, or, more simply, the reduction of costs. The main principles should be, first, the need for the constant inter-relation of all costs; a reduction in total costs may involve a deliberate increase in some items, such as the use of larger components, for example, to reach a higher degree of standardization. Secondly, the standardization of materials, sizes and shapes of components; excessive variety is one of the most common causes of high costs. Thirdly, a higher degree of mechanization. There should be a national policy to transfer labour to the production of capital goods. Fourthly, the establishment of methods-time measurement; this is a new and potent weapon in the achievement of economic manufacture which will be of particular value to the medium-sized firm not necessarily engaged in large-scale production. Fifthly, the indirect operation should be eliminated or reduced to the minimum; the siting of machines in correct sequence, instead of departmentally, can also help to reduce the indirect operation. Sixthly, a sales and design policy should be employed to produce the degree of variation in quantitative demand and of variety of products needed to keep the flow of work as regular as possible. Lastly, Mr. Hills suggested that use should be made of control data to see that costs are kept within bounds.

In his paper on the human factor in management, Sir Richard Lloyd Roberts appealed to management to "identify itself with the inevitable and welcome the employees genuinely as associates and collaborators in the joint industrial enterprise". This change in outlook is necessary because, for the first time, the problem of industrial management is now set against a background of free men in a free society.

Surveying existing man-power situations, Sir Richard suggested that personal fitness should be the only test for employment and not some arbitrary age; existing apprentice arrangements should be reviewed and better training facilities should be provided at all levels, including the young manager.

For practical application, the new concept of the status of the employee requires, first, the careful selection and placing of the individual and the provision of an induction course on entry into the firm. Secondly, his interest in the enterprise should be secured by explaining the problems involved in production, even to the extent of making him aware of the firm's plans and policies. Thirdly, working to create this new 'climate' involves management in a serious educative campaign to combat the misunderstandings that exist about the structure of industry, the role of the investor, the reasons for profit, the responsibilities of directors and management. Foremen, no less than management, must change their traditional attitudes and methods of control. Much-needed attention is now being given to the selection and training of foremen; but there is too much hesitancy about giving them adequate staff status and remuneration in relation to the men under them.

Sir Richard forecasts that piecework will ultimately disappear since its appeal is to the financial cupidity of the individual and, in the role of collaborator, this spur will not be necessary to ensure a fair day's work. The trade unions have a share in the hindrance of the full development of the human factor. Their conventional belief is that the natural alliance of any group of work-people in a given firm is with their fellows of the same craft or industry employed elsewhere. This attitude is understandable in the light of past experience; but under modern conditions it should be recognized that the full value of any human factor can only be fostered in the individual works, factory or mine by the collaboration between man and management in that unit.

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LYSENKO'S LATEST DISCOVERY—THE CONVERSION OF WHEAT INTO RYE, BARLEY AND OATS

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A FEW months ago Academician T. D. Lysenko produced an interesting paper entitled "New Developments in the Science of Biological Species", an English translation of which has been recently published by the Foreign Languages Publishing House, Moscow[1].

The first half of the paper is devoted to a consideration of the concept of genus and species. In the latter half Lysenko first refers to V. K. Karapetian's[2] observation of 1948 that if 28-chromosome durum wheat (*Triticum durum*) is sown late in the autumn some of the plants are converted in two or three generations into 42-chromosome soft wheat (*T. vulgare*). This prompted Russian workers "to search for grains of soft, 42-chromosome wheat in the spikes of experimentally grown durum wheat. As a result, individual grains of soft wheat were quite easily observed in the spikes of durum wheat, i.e., *grains of one botanical species were found in the spikes of another species*" (italics mine).

That the abnormally arising grains really belonged to *T. vulgare* was confirmed by sowing the seeds which "produced, *as a rule* (italics mine), soft wheat plants". It is not mentioned as to what they produced in the remaining cases; but it may be presumed that they either did not germinate or produced durum plants.

Encouraged by this discovery, Russian botanists instituted in 1949 a vigorous search for rye grains in wheat spikes in the fields of the foothill districts sown with winter-wheat. Their efforts were amply rewarded. "V. K. Karapetian, M. M. Yakubtsiner, V. N. Gromachevsky and a number of other research workers as well as a number of agronomists and students found single grains of rye in durum- and soft-wheat spikes, i.e., in the spikes of two wheat species which grew in the fields of various foothill districts. Over 200 such grains of rye were found in 1949. . . . From these grains of rye, which had developed in spikes of durum and soft wheat, a diversity of plants was grown. These plants, *with few exceptions* (italics mine), were nevertheless typical rye. Only in a very few cases were wheat plants obtained from ryelike grains." No mention is made of the range of variability in the offspring of the rye-like grains, nor are we told the type of wheat—$2n$, $4n$, or $6n$—which arose from them in exceptional cases.

"In all the above cases where grains of one species of plant were found in spikes of another species neither the plants themselves nor their threshed spikes showed any signs whatever of being intermediate forms. They seemed to be typical, ordinary spikes of durum or soft wheat. But the internal state of these wheat plants was no longer the usual one, was no longer qualitatively homogeneous in respect to species."

Other interesting facts follow. Plants of *Avena sativa* were observed to bring forth individual grains of *A. fatua*. Branched wheat (*Triticum turgidum*), grown on the experimental plots of the Lenin Academy of Agricultural Sciences of the U.S.S.R. and in a number of other localities, showed "admixtures of soft and durum wheat, oats, 2- and 4-rowed barley and also spring rye". It is stated that the original source of these admixtures was the branched wheat (*Triticum turgidum*) itself, and that this was not a consequence of the use of impure seed.

"In 1950 it was discovered in several cases that barley plants which were growing as an admixture in branched wheat crops had developed from grains which in external appearance could not be distinguished from branched wheat grains."

It is emphasized that these new facts were obtained "*in a systematic way* or as the result of *a systematic search*". The supposition that the seeds may be of hybrid origin is rejected, and it is stated that similar results can be obtained "by cultivating plants specially sown under experimental conditions for this purpose".

The paper contains a good deal more, mostly in the nature of the usual diatribe against Malthus and in praise of Timiryazev and Michurin. Stalin's name is also mentioned; but leaving the political issue aside and taking only the scientific part into consideration, the present position is considerably different from that a few years ago when stray rye plants were mentioned as appearing in wheat fields. Geneticists in Britain and the United States explained such an occurrence as caused by sowing mixed seed. Now our Russian colleagues claim that there is no question of mixture, for rye grains are said to have been found *within* wheat spikes and "could not possibly have been introduced into these spikes from without by either birds or man in any other way".

The possibility of hybridization or the influence of foreign pollen is rejected in the following words: "The supposition that these seeds might be of hybrid origin also goes by the board. It is a known fact that wheat can be crossed with rye, though seldom. However, in these cases the product obtained is an obvious rye–wheat hybrid which can readily be distinguished from wheat and rye by its external appearance. Besides, rye-wheat hybrids, as a rule, are self-sterile; they yield no seeds unless they are pollinated with the pollen of one of their parents, preferably the wheat. In the case at hand the grains of rye from the wheat spikes produced ordinary rye plants with normal fertility. The said plants manifested no hybrid properties whatever".

Academician Lysenko thinks that so far as plants are concerned the problem of speciation has therefore been solved, and a change in environment is the key to its solution. With regard to animals also he is quite hopeful as the following quotation will show: "We do not yet have the data essential to demonstrate how species are formed in the animal world. But we may rest assured that before long the development of the theory of Michurinist biology will make it possible to accumulate data also for zoological objects analogous to the data taken from the world of plants".

This much about Lysenko's science. As the result of the work of Kihara, Sears and others, enough is, however, known of the cytology of wheat, rye, barley and oats to make one extremely sceptical of his claims about the conversion of one into another. Some of these doubts are mentioned below.

(1) Lysenko says that grains of soft wheat found in spikes of durum wheat *as a rule* produced soft wheat plants. What did they produce in other cases?

(2) How did wheat plants arise from a few of the rye-like grains? Does this mean that rye can in turn become converted into wheat? Were these wheats diploid, tetraploid or hexaploid?

(3) Since rye has 14 chromosomes, by what method could a vulgare wheat ($2n = 42$) give rise to rye? Not only is the number of chromosomes different in the two cases but also the morphology of the chromosomes. For example, pines have $n = 12$ chromosomes and so have the lilies; but it is not possible to convert one into the other.

I think that there is no possibility whatever of changing tetraploid wheat into a hexaploid type as the result of environmental influences only, although the Russians claim to have accomplished it many years ago. Conversion of wheat into rye, barley and oats is fantastic and even more unbelievable. To understand this, we must have a mechanism for the deletion of the three genomes, *A*, *B* and *D*, present in *T. vulgare*, or *A* and *B* present in the emmer wheats and the appearance of a new rye, barley or oat genome. This, most people will agree, is not possible by environmental changes.

However, this is not the first time that such reports have appeared. Many years ago Virgil and Pliny wrote how farmers planted wheat and barley only to discover to their annoyance that some of the seed produced wild oats. Thomas Johnson[2] in 1633 reported the occurrence of a grain of oat in an ear of wheat, and Ole Worm[3] in 1655 claimed to have seen a rye grain in an ear of barley.

Most botanists outside the U.S.S.R. are inclined to dismiss all such reports as errors of observation or as faked. Judging from the exaggerated nature of Russian reports and the lack of proper data for an evaluation of their claims such a surmise is not unnatural. However, if rye grains do occasionally occur in wheat spikes, the only possible explanation is that the stigmas of some of the wheat flowers become pollinated by rye pollen. In most cases, perhaps, such pollen tubes would fail to reach the ovules. If they did it is possible that either the eggs may be stimulated to develop parthenogenetically; or there is a fusion of the female nucleus belonging to the wheat parent with the male nucleus contributed by the rye parent, resulting in hybrid progeny; or the male gamete develops 'androgenetically' inside the embryo sac, seed coat and pericarp of wheat. In the third case the offspring would be a haploid rye, but if chromosome doubling took place at some stage in embryogeny the mature grain would produce a normal diploid rye plant. The so-called 'conversion' of wheat into barley or oats could also be understood as occurring in the same manner.

Such 'androgenesis' is already known to occur in *Nicotiana* and *Crepis* (see Maheshwari[4] for references; also Darlington and Mather[5]), and the work on *Crepis* was done by a Russian botanist, Helen Gerassimova[6]. Lysenko is either not acquainted with the literature on cytology, embryology and genetics or is unable to take this into account because of a blind faith in environment.

It is hoped that other botanists who see this note will express their opinions on this wheat–rye conversion and that meanwhile Russian botanists will themselves present a cytological analysis of the converted wheat or rye plants.

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[1] Lysenko, T. D., *Agrobiologia*, **6** (1950). English translation, "New Developments in the Science of Biological Species", Foreign Languages Publishing House, Moscow (1951).

[2] Karapetian, V. K., *Agrobiologia*, **4** (1948).

[3] Dunn, L. C., "Genetics in the Twentieth Century" (1951).

[4] Maheshwari, P., "An Introduction to the Embryology of Angiosperms" (1950).

[5] Darlington, C. D., and Mather, K., "The Elements of Genetics", p. 168 (1949).

[6] Gerassimova, H., *Planta*, **25** (1936).

MICRO-MAGNETIC VARIATIONS DURING THE SOLAR ECLIPSE OF FEBRUARY 25, 1952

By Prof. N. F. ASTBURY

University College, Khartoum

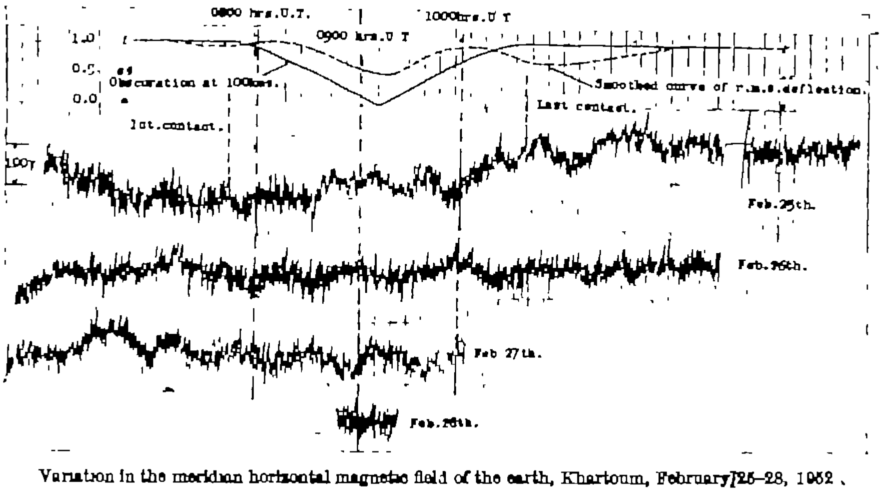
THE occurrence this year of a solar eclipse the totality zone of which crossed the magnetic equator provided a special opportunity for the observation of variations of small amplitude in the earth's magnetic field. During the Second World War, I was able to observe (but not to publish for security reasons) variations in the earth's field in the frequency-range 0·005–200 c./s. in northern auroral latitudes. In the stress of war-time conditions it was not possible to investigate causes of or possible cyclic changes in these variations, so that the opportunity of examining corresponding phenomena near the magnetic equator, especially during a total eclipse, was particularly interesting.

The observations planned for the total eclipse of February 25 were necessarily very simple, because of the short time available for preparations. The plan was to observe changes in the meridian horizontal component of the earth's field, and the site chosen was in the grounds of University College, Khartoum, about 5 km. north-east of the centre line of the ground totality zone. Through the kindness and great expedition of the Royal Naval Scientific Service, recording gear was sent to Khartoum and put into working order a few days before the eclipse. The detector used was a coil of about two metres diameter, carrying 540 turns, set up in a vertical plane with its axis in the magnetic meridian. This was connected to an integrating D.C. amplifier and to a low-frequency thermionic amplifier with a frequency range of 5–200 c./s. The time-constant of the D.C. amplifier and associated circuits was about 40 sec., so that its response to a sinusoidally varying flux was a maximum for changes of about this period, falling to about 90 per cent for periods of 5 sec. and to about 60 per cent for periods of 200 sec. For signals near the optimum period a displacement of 1 mm. on the recorder trace corresponded to a field change of 10 gamma. Such preliminary experiments as were possible showed at once that while it would be satisfactory to work with the D.C. gear in this condition, heavy and variable industrial interference made the operation of the low-frequency amplifier unreliable. For the eclipse work this had therefore to be abandoned, but it will be set up outside the town later.

For the eclipse observations, the recorder was run with a paper-speed of 1·25 in. per min. to secure high resolution. Observations were started half an hour before sunrise (0330 hr. U.T., 0530 hr. L.T.) and were continued until half an hour after sunset. The record showed a marked change in character during the eclipse, variations of amplitude about 100 gamma and period 20–30 sec. giving way to disturbances of half the amplitude or less and of much longer period. The concise presentation of such a record is a matter of some difficulty, and two methods have been attempted. In one, the mean square deflexion has been computed for every four-minute interval of the record, and the resulting curve smoothed. In the other, a mechanical copy has been made of the whole record in which the paper-speed has been reduced to about one inch per minute, the deflexion being at the same time amplified about one and a half times. The accompanying chart is a copy of such a reduced record, together with the smoothed curve of root-mean-square deflexion and the obscuration curve for the 100-km. level. On the same chart are reproduced copies of control records taken on succeeding days at relevant times.

On the day of the eclipse, there is a region of minimum disturbance about ten minutes after totality, and although the descent to the minimum follows in a general way the occultation of the sun's disk, the restoration is prolonged ; and it is not until four or five hours after the last contact that the disturbances have built up to their pre-eclipse level.

Concurrently with these observations, ionospheric recordings were made on the same site by Mr. C. M. Minnis and Mr. Clarke, of the National Physical Laboratory, using an automatic recorder of N.P.L. design. While the full analysis of both magnetic and ionospheric records has yet to be completed, there can be little doubt that changes in the variations of the horizontal magnetic field at the earth's surface were



Variation in the meridian horizontal magnetic field of the earth, Khartoum, February 25–28, 1952.

associated with changes in the ionosphere. It is suggested that the magnetic variations are due largely to plasma oscillations in the lower levels of the ionosphere.

Subsequent 24-hr. recordings taken with a paper-speed of 1 in. per hr. have shown the existence of a marked diurnal effect, together with a curious major disturbance about an hour before sunset. It is planned to extend the work to include the vertical component of the field and to make continuous ionospheric recordings over the more significant times, and a full report will be published elsewhere. [April 27.

RESEARCH COUNCIL OF ISRAEL

ANNUAL REPORT FOR 1950–51

THE second annual report of the Research Council of Israel, covering the year ended March 31, 1951, has recently been published*. In place of the original five advisory committees, committees have now been established for fundamental research (including the utilization of the natural resources of Israel), chemical industry, textile industry, agriculture, nutrition, food industry, and building (including roads). The membership of these committees is given, with lists of publications and research papers issued during the year.

The work of the Geological Survey has been facilitated by the establishment of a palæontological laboratory. The search for additional sources of water has continued, deposits of peat have been discovered and the search for petroleum reserves continued. The Citrus Concentrates Producers Association completed successful pilot-plant trials on a process for the preparation of dry pectin of high jelly units from orange peel without the use of organic solvents, and has used ion-exchange resins to obtain a completely demineralized sugar syrup from limed citrus-peel juice. Research on pectolytic enzymes is a major activity in this laboratory, while the Ceramics Research Association has overcome difficulties experienced in slip casting due to the poor quality of the plaster by changing the conditions of fixing. The Textile Research Association has continued work on the shrink-proofing of wool with acid bromates. Medical research has included studies of the mechanical fragility of erythrocytes in the presence of sulpha-drugs and of the intestinal flora of the newly born. Biological research has covered ticks and tick-borne diseases, vole research and the mode of action of germination inhibitors. The hydrochemistry of the Sea of Galilee was studied to determine the origin of the salts in the Dead Sea, and satisfactory yields of naphthenic acids have been obtained by oxidation of kerosene containing 18 per cent of aromatic acids after removal of the latter with sulphuric acid. A survey of the source of raw materials for the manufacture of cellulose has been undertaken, and a study made of micro-organisms responsible for the retting of flax.

Building research has been done on a number of topics which include: a study of the influence of all types of roof structures and of the effect of the design, finish and material of wall structures on the internal climate; the efficiency of housing schemes for immigrants; solar heating of domestic water supplies; and the ageing of bitumen. Dew and water condensation in upper layers of soil and evaporation from open surfaces have also been investigated, solar radiation in the visible and infra-red regions was being measured, and field trials made of a number of fibre-yielding plants. A study of the population dynamics of the Mediterranean fruit fly, *Ceratitis capitata*, was initiated and also of the biological factors affecting the yield of legumes, while investigations of weeds and a study of the nutritional deficiencies of fruit trees were continued.

AMERICAN PHILOSOPHICAL SOCIETY

REPORT FOR 1951

THE year book for 1951 of the American Philosophical Society covers the year ended December 31, 1951*, and, besides a brief history of the Society by E. G. Conklin, biographical memoirs, lists of members and the auditor's report, includes the customary reports of the standing committees on finance, the library, meetings, publications and research. The report on research, which occupies most of the year book, details the ninety-six grants, totalling 85,305 dollars, which were awarded from the Penrose Fund during the year and gives an analysis of the distribution of grants from this Fund by subjects during 1949–51. Also detailed are five grants, totalling 9,950 dollars, from the E. R. Johnson Fund, two, totalling 4,750 dollars, from the J. Daland Fund for Research in Clinical Medicine, two from the Miclaux Fund, and twenty-eight, totalling 30,245 dollars, from the Reserve Fund for Post-war Expenditures, all of which were for research.

Among the more detailed of the reports from recipients of grants which are included (arranged alphabetically under subjects) in the report, mention may be made of that by H. Friedmann on the life-histories of the honey-guides (Indicatoridæ) and the parasitic weaver-birds (Ploceidæ) of Africa; S. M. Rose's study of induction of regeneration in limbs of lizards; C. A. G. Wiersma's investigation of the patterns of innervation of the legs in the higher crustacea, with special emphasis on the inhibitory innervation; H. E. Evans's taxonomic and biological study of the spider wasps of Mexico belonging to the sub-family Pompilinæ (Hymenoptera, Pompilidæ); W. Hovanitz's amphi-Atlantic study of *Colias hecla*, *Colias nastes* and *Colias palæno* and J. A. G. Rehn's detailed field study of the Orthoptera of the United States.

G. L. Kreezer reports on the development of methods for the determination of the components of biological systems on the basis of the mathematical analysis of transient response curves; D. C. Smith on studies in Bermuda on the thyroid glands of the parrot fish; C. L. Markert on the biochemical basis of cell differentiation; H. N. Andrews on the anatomy of *Botryopteris*; W. R. Taylor on his survey of the marine algæ of Bermuda; L. M. Langdon on a comparative survey of inflorescence characteristics in the Castaneæ; and H. P. Hansen on the study of post-glacial forest migrations and climate in Western Canada and Alaska by means of pollen analysis of peat sections. Reports are also included of W. H. Camp's study of the relative virulence of beech bark disease on the several types of forest beech in eastern Canada and Maine; of B. Howe's investigation of caves, shelters and other sites where it is expected that Neolithic, Mesolithic and Palæolithic remains are to be found in stratigraphic relation; of E. Murray's case study of colour-vision deficiency; and R. B. Singer's clinical and physiological investigation of disturbances of the acid–base balance of the blood, with particular reference to the effects of intravenous alkalinizing or acidifying solutions.

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* Research Council of Israel. Second Annual Report for the Year ending 31 March, 1951. Pp. 32. (Jerusalem: Research Council of Israel, 1952.)

* American Philosophical Society. Year Book 1951; January 1, 1951–December 31, 1951. Pp. 452. (Philadelphia, Pa.: American Philosophical Society, 1952.)

METROLOGY LABORATORY OF THE COLLEGE OF TECHNOLOGY, BIRMINGHAM

IN the College of Technology, Birmingham, the Production Engineering Section of the Department of Mechanical Engineering for the past five years has been developing the teaching of production techniques, particularly in the fields of machine tools, jigs and tool design, and fine measurement. In the last-named case, the new Metrology Laboratory of the College, which has been equipped at a cost of nearly £5,000, is now complete.

The functions of this Laboratory are threefold. First, it provides students with an opportunity for undertaking experimental work, and determining fine measurements using modern general and specialized equipment, the laboratory work being closely related to the lecture course. Secondly, the Laboratory is intended to provide local industry with an approved centre in which specified gauges may be measured. This project should be of particular interest to small engineering firms with only limited measuring equipment. In order to achieve this aim, the layout of the Laboratory has been supervised by the Metrology Division of the National Physical Laboratory, which has certified the equipment provided as satisfactory for an approved gauge testing centre. Further, a member of the staff who has maintained contact with the National Physical Laboratory during the development stage has qualified to act as the authorized supervisor. The gauge testing scheme is an arrangement whereby an educational establishment possessing specified measuring equipment may undertake the inspection of certain classes of gauges on behalf of the National Physical Laboratory. Inaugurated by the Ministry of Education, the scheme has the support of the Ministry of Supply, and as a result it covers the same classes of work for the Aeronautical Inspection Department. The Metrology Laboratory is authorized to undertake the inspection of parallel plain plug and parallel ring gauges; taper plain ring gauges; parallel plain gap gauges; taper plain gap gauges, and simple plain length, height, depth and thickness gauges; parallel screw plug gauges up to 4 in. diameter, of Whitworth, metric and B.A. forms of thread; profile gauges; and simple angle gauges.

The third function of the Laboratory is that its equipment, which is in excess of the requirements of the National Physical Laboratory scheme, has been designed to promote additional facilities for research — a relatively new venture, upon which staff members are now engaged. These investigations are concerned with the study of the characteristics of fine metallic surface-finishes with reference to mechanical methods of production, which has led to further studies of the influence of surface finish on friction and wear.

The Metrology Laboratory is electrically heated and thermostatically controlled at 68° F. (20° C.). Fluorescent lighting is installed. The majority of the equipment, which is almost exclusively of British design and manufacture, has generally been purchased; but certain firms have presented apparatus to the College. Apart from the essential standard gauges and measuring tools, the equipment includes measuring machines for the determination of errors in screw threads, including optical projection apparatus; a 7–36 in. end-measuring machine with accessories; and a taper diameter-measuring machine, all of which are based on National Physical Laboratory designs. Comparator-type measuring equipment representing mechanical, electrical, pneumatic and optical forms of operation are available. The issue of "Acceptance Test Charts for Machine Tools", prepared by the Institution of Production Engineers, and published in collaboration with the Institution of Mechanical Engineers, has led to the provision of equipment necessary for machine-tool alignment-tests. This includes optical instruments such as the 18-in. 'Microptic' auto-collimator, reading directly to 0·5″ of arc, and an alignment telescope and target, reading to 0·0005 in., both manufactured by Messrs. Hilger-Watts, Ltd. A standard 'Angle-Dekkor', reading to 1′ of arc, is also available. Experimental apparatus for preliminary surface-alignment tests has been constructed in the Laboratory, but work of an advanced nature is carried out on standard machines in the various machine-tool laboratories. A tool-room microscope with accessories, by Messrs. Cooke, Troughton and Simms, Ltd., has been provided for the measurement of angles, thread forms, linear displacements, and for the comparison of enlarged projected images.

Surface-texture measurements may be carried out using the latest Taylor Hobson 'Talysurf' Model 3. This machine measures the roughness of surfaces by traversing a stylus across the surface and electrically amplifying its movements. The result of the examination may be shown in the form of a graph indicating the nature of the surface undulations. Alternatively, an average number may be recorded indicative of the degree of roughness. A model of the well-known 'Tomlinson' mechanical surface-recorder, in which a trace is made on a smoked glass, provides an alternative method of surface measurement.

As the Laboratory is for the use of senior students taking the craftsman's course, as well as for students in advanced professional courses, apparatus in the form of gauges in common use has been constructed for examination. All experimental work is based on instruction sheets giving details of the equipment to be used and the procedure to be followed. The theory underlying the particular experiment is also shown. Students prepare full records of all work done and are expected to develop logical conclusions. In the case of direct measurement, particular emphasis is laid on the errors of determination. The application of British Standard specifications is an important aspect of the lecture work. Copies of pertinent specifications, and other relevant publications, are available in the Laboratory, and students are urged to study them with reference to the apparatus being used. In conclusion, it is not suggested that the development of metrological studies in the College is now complete; on the contrary, it is hoped that future developments will allow the work to expand considerably.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Selection of the Genetic Basis for an Acquired Character

THE experimental results reported recently by Prof. C. H. Waddington[1] seem to make explicit in an important way what some zoologists, not professional geneticists, may have felt for long as something unsatisfying in many of the translations of evolutionary problems into Mendelian terms with which we are all familiar. He has reminded us once more that artificial selection, and so by presumption natural selection, acts upon animals having qualities, such as crossveinlessness, and not upon genes. He has shown that there are more genetic ways than one of being a crossveinless fruit-fly, and that, if crossveinlessness is selected for, then crossveinlessness will become established in a relation to the underlying genetic structure about which it is not clear that anything can in principle be predicted.

This most significant work seems to point once more to an element of insecurity in those approaches to the evolutionary problems of biology which by implication or statement rest upon the belief that these problems would be solved if we knew all about the distributions of genes in populations through time. Prof. Waddington has shown that again in his example the relation between the gene and the character is of just such a kind as will *not* enable us to say anything at all about genetic mutation-rates, or, indeed, genetic situations in any sense, in populations of which we know only the appearance through time. May it not also be true that this relation is of such a kind as will *not* enable us to say anything at all about the appearance through time of a population of which we know only the genetic make-up ? Have we not been forced to ascribe to the genes qualities and potentialities which impair the biological relevance of any knowledge of them to which we can in principle attain ? Part of the population of crossveinless flies at Edinburgh has changed the genetic basis of its crossveinlessness ; but could future workers, examining them dead, in principle know this ? A genetic situation at Edinburgh has become established by selection, in a relation (supposedly new) to crossveinlessness ; but could future population geneticists, seeking to calculate what must have been the frequencies of all genes in Edinburgh, have said anything about the way in which this would happen, or about the new relation which was to be established ? Possible future positions in a game of chess can be predicted from a given position, but only, in any practical sense, if the rules are kept. If a pawn can become a queen we must know what makes it a queen : for example, arrival at a certain place on the board. Procedural difficulties seem likely in making a prediction if what makes a pawn into a queen is its relation to other pieces *and* the necessity that white should win.

Much important recent work has given us a view of the widely differing rates of change through geological time in different groups of animals. Prof. Waddington has surely reinforced the impropriety of saying, and still more of implying, that this information is information about genetic change, whether by mutation, recombination, or of any other kind. We may not say that lampshells have low rates of genetic change ; we may only say that they look alike through long periods. Whether or not the success of a lampshell now is in any intelligible sense a consequence of the same genetic situation as made a lampshell similar to look at, and apparently equally successful, in different conditions a long time ago, is simply unknown, and now looks a little more unknowable. Perhaps Prof. Waddington has made us understand that to ask such a question is not sensible, and to answer it vain.

It may perhaps be urged that Prof. Waddington's example is exceptional, and that possibly argument from, for example, the homology of mutations, may show that, in general, characters are, have been, and will remain, 'due' to genes in a way that will justify translation of thought about populations into thought about genetics, and *vice versa*. But is this now, remembering again the warning of Harland[2], that "there are as many ways of making petal spot as there are species", more than a gratuitous judgement ? Does it even save the phenomena in a Ptolemaic sense ? Does it really save anything ? Does it not rather reduce the Mendelian concept to tinkling symbols in circumstances where they may not be the most appropriate ?

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Department of Zoology,
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Hull. May 19.

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[1] Waddington, *Nature*, 169, 278 (1952).

[2] Harland, Proc. Seventh International Genetic Conference (1939).

Recent Echo Sounder Studies

HODGSON[1] has shown that shoals of several species of fish give rise to traces on echo-sounders, and that a species may be identified by the shape of its trace. Echo-sounder records taken more recently by research vessels of this and other laboratories have shown that traces can be caused by an increasing variety of organisms covering a wide range of sizes, and that physical discontinuities in the water column are often associated with pronounced traces. For example, in August 1951 traces were obtained over a wide area off Whitby by the R.V. *Platessa*, using a Marconi sounder. They were found to be at a depth corresponding to that of a sharp thermocline, and small whiting about 3 in. in length, large medusæ, herring and *Ammodytes* larvæ were caught with a pelagic trawl at the depth of the trace. As the thermocline persisted outside the area in which the traces were recorded, the echo could not have been caused by the thermocline itself.

At about the same time, the R.V. *Ernest Holt*, working in the neighbourhood of Hope Island in the Barents Sea, found up to five simultaneous, relatively thin, horizontal traces in the upper 40 fathoms. These echoes persisted through other dense traces, which were associated with fish and other organisms ; their depths coincided with those of marked temperature gradients obtained on bathythermograph records ; and they exhibited oscillations due to internal waves. The traces were obtained on a Kelvin and Hughes *M.S.*24 30-kc. sounder using a 1,500-volt output and a 3-stage amplification, and on a Kelvin and Hughes *M.S.*21*b* 10-kc. sounder with a 2,000-volt output and a similar amplification. Similar traces were also recorded off southern Spitsbergen, where, as in the Hope Island area, relatively warm Atlantic

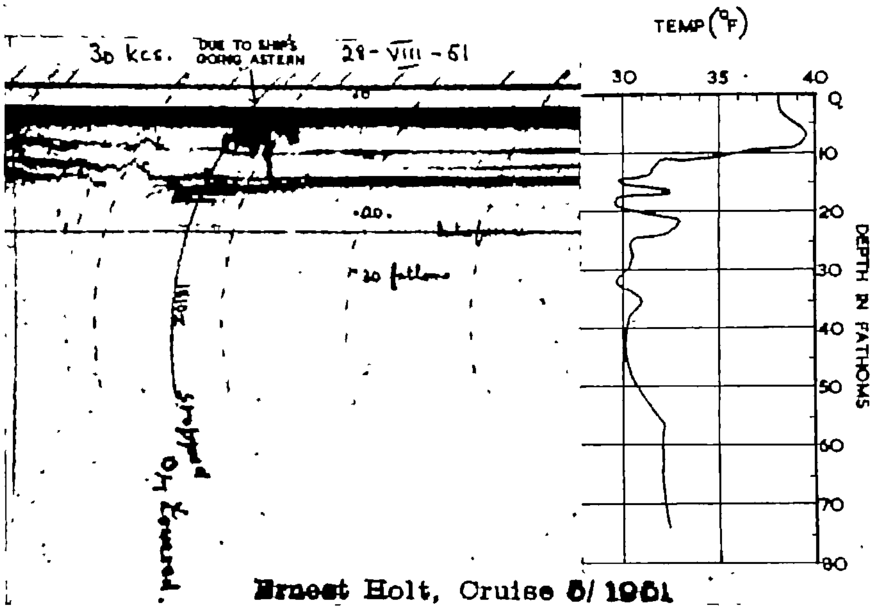

Fig. 1. Vertical temperature profile as recorded by the bathythermograph superimposed on the echo-sounder record

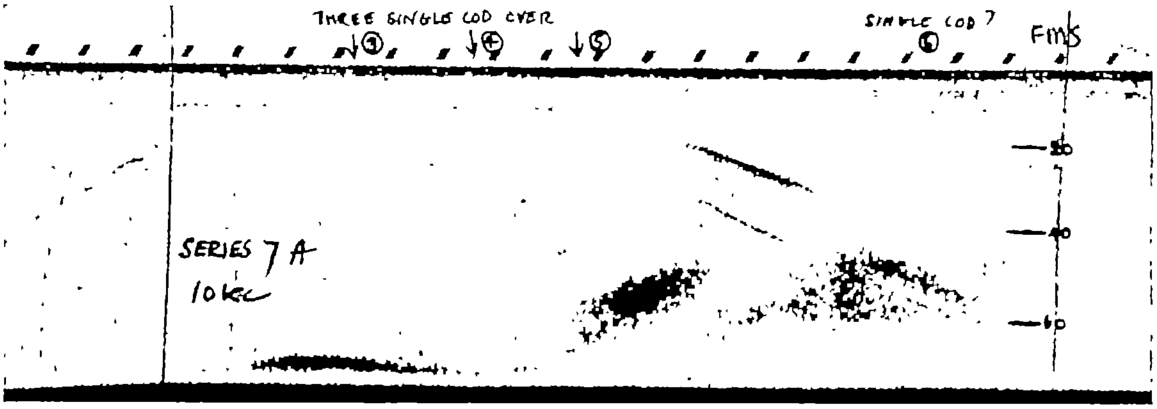

Fig. 2. 10-kc. Echo-sounder record from same cruise showing traces of individual cod, each of approximately 80 cm. length

water and cold Arctic water meet and give rise to a marked but complicated layering of the water. The nature of this hydrographical structure and the multiplicity of the traces suggest that the echoes could not have been caused entirely by planktonic organisms. Joseph[2] has shown, however, that sharply demarcated zones of high turbidity may exist in the sea. In the absence of more direct evidence, such factors cannot be excluded, and the traces cannot be attributed entirely to the structure of the water column. Further work is planned to determine the cause of these traces.

Hodgson and Richardson[3] have demonstrated the value of the echo-sounder as a means of studying shoal behaviour under varying stimuli. Traces obtained by the R.V. *Ernest Holt* suggest that sensitive echo-sounding equipment may also be used for studying the reactions of single fish. Single live cod of mean length 80 cm. were released from the lee rail and followed to 60 and 35 fathoms depth using full gain on the 10-kc. and 30-kc. sounders respectively. Similar depths were obtained using air-free cod, from which the air bladder and all tissue that might trap air had been removed. The sea was calm, but strong tidal streams were experienced; and it is not known whether the cessation of the traces at the depths stated above was due to the movement of the fish out of the sound cone or to the return signal strength of a single fish being below the threshold of sensitivity of the instruments. Comparisons between the depths to which cod could be recorded on each of the two frequencies cannot be made because of the different output of each machine.

Some of the live fish were seen to halt at the 'discontinuity trace' for a short time—one or two minutes—before continuing their descent. This reaction was not invariable and requires further investigation. It was observed when the temperature discontinuity was of the order of 3° C. in 10 ft.

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[1] Hodgson, W. C., Fish Invest., Ser II, 17, No. 4, London (1950).

[2] Joseph, J., *Deutsche Hydrogr. Z.*, 3, No. 69 (1950).

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Trematode Life-Cycle enacted in a London Pond

IT is well known that the larval trematode "*Diplostomum volvens* Nordmann, 1832" may cause impaired vision, and even blindness, in certain fishes. Rushton[1] and Baylis[2] have reported the presence of this diplostomulum in the eyes of rainbow trout in Britain. The presence of 20–40 parasites in the lens of each eye may favour completion of the life-cycle, because the fish then falls an easier prey to water birds. The definitive hosts of this trematode, *Diplostomum spathaceum* (Rudolphi, 1819), are various species of gulls, and the usual location is the intestines[3].

The eggs of this trematode hatch in water and the forthcoming miracidia penetrate water snails, generally *Limnæa stagnalis*, giving rise to colourless sporocysts from which the fork-tailed *Cercaria C* Szidat[4] emerge and promptly leave the snail. These pelagic larvæ float at various levels in the water in a highly characteristic posture; the furcal rami are divaricated and held uppermost, and the proximal region of the tail-stem is flexed so that the elongate body is held almost parallel with one of the rami. The cercariæ come in contact with fishes by chance, and after penetration they lodge in the eyes, getting into the lenses. Gulls obtain the trematode by devouring infected fishes.

I have recently observed that the entire life-cycle of *Diplostomum spathaceum* is being carried out in and on a very small, gravelly pond in London, not more than four miles from Charing Cross. The pond, often used for sailing model ships, contains much blanket-weed, decomposing leaves and other jetsam, and it accommodates various ducks and gulls. From it I obtained many large *Limnæa pereger*, most of which were heavily infected with trematode larvæ, double and triple infections being fairly common. The presence of dead and dying snails testifies to the intensity of the infections. By isolating living snails I have obtained daily several broods of cercariæ of stylet, fork-tailed and echinostome types. The fork-tailed larvæ were readily identified as *Cercaria C* Szidat, a study of which enables me to confirm most the behavioural characteristics outlined by Szidat[5] in Germany and Wesenberg-Lund[6] in Denmark. I have also noted the marked pathogenic effect of this cercaria on fishes.

Nearly every one of thirty three-spined sticklebacks more than 2 cm. long taken from this London pond had about twenty *Phyllodistomum folium* (v. Olfers, 1817) in the ureters and twenty to forty "*Diplostomum volvens*" in the lens of each eye. The re-infection of some of these fishes with *Cercaria C* revealed within a few hours both well-developed diplostomula and tailless cercariæ in the eyes. Such mixed infections as this illustrate the fact that the type of metacercaria which we call the diplostomulum undergoes considerable development in the fish host. The metacercariæ of a trematode such as *Fasciola hepatica* which encyst on herbage in the open do not develop further until they are taken in by the definitive host. At the other extreme, as it were, the metacercariæ of *Diplostomum spathaceum*, which are nourished at the expense of lens tissue, develop a completely transformed fore-body, which comes to have all the characters of the adult's body, and a rudimentary pouch-like hind-body which reaches full size in the final host only after the gonads have come to full development.

In my experiments, which will be reported fully elsewhere, I have determined that penetrating *Cercariæ C* kill minnows, goldfish, common carp, bitterling carp, tench, stone loach, perch and small sticklebacks overnight, and tadpoles within fifteen minutes. The fact that a few hundred cercariæ (which is only a fraction of the daily emission from one snail) will kill half a dozen fishes illustrates the intense pathogenic effect. From the eye of one minnow exposed for only a few hours to *Cercaria C* I have recovered nearly two hundred metacercariæ. The crucian carp seems to have greater powers of resistance than other fishes used in these experiments, but it cannot withstand three successive infections at two-day intervals. The nature of this severe pathogenicity is being investigated. One suggestion regarding the death of fishes is cerebral hæmorrhage caused by penetrating cercariæ.

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Moonlight and the Pregnancy of Malayan Forest Rats

DURING the past four years, records have been kept of the state of pregnancy of a large number of rats and squirrels of various species collected and killed in connexion with scrub-typhus investigations. While studying the relation between rainfall and breeding season[1], it was found that the rates of pregnancy of the nocturnal forest rats showed a bi-monthly rhythm which appeared to be in phase with the moon, and which suggested that the greatest number of conceptions occurred near the time of full moon.

To investigate this further, the distribution of intra-uterine litters in the lunar month was calculated. Litters were classed as 'young' or 'old' according to whether the mean weight of the embryos was below or above the median of such weights for all litters of that species. There is some evidence[2] that, although intra-uterine mortality occurs, it affects individual embryos rather than whole litters; and if the loss of litters can be neglected, then the median (that is, the central) value for all litters will be the best estimate of the value at the mid-point of intra-uterine life. We do not know the gestation period for any of these animals, but by analogy with other members of the same family (white rat, black rat, white mouse, wood mouse, deer mouse, vole[3]) it is likely to be about twenty days, so we shall probably not be far wrong if we allow ten days for the life of a 'young' embryo and a further ten for the 'old'.

The dates on which the various litters were examined were then recalculated on a lunar calendar, as number of days from the new moon, and the results were grouped for the whole period for nearly four years. The result for one of the giant rats, *Rattus mülleri*, is shown in Table 1, grouped by five-day periods. There is, in fact, an excess of 'young' litters in the middle of the lunar month and excess of 'old' ones at the end; but the numbers involved are too small to eliminate the possibility of such differences

Table 1. Numbers of 'young' and 'old' litters of a forest giant rat, *Rattus mülleri*, by five-day periods of the lunar month (new moon = 1, full moon = *c.* 16) consolidated for the whole period April 1948–December 1951

Lunar dates	1–5	6–10	11–15	16–20	21–25	26–30
'Old'	2	1	1	0	4	4
'Young'	3	0	2	4	0	3
Total	5	1	3	4	4	7

Table 2. Same information as Table 1 consolidated for forest rats of the species *R. mulleri*, *R. sabanus*, *R. whiteheadi* and *R. rattus jalorensis*

Lunar dates	1–5	6–10	11–15	16–20	21–25	26–30
'Old'	10	10	8	8	15	21
'Young'	12	12	16	14	5	13
Total	22	22	24	22	20	34

$\chi^2 = 16 \cdot 7$. $P < 0 \cdot 01$.

being due to random variation. In Table 2, therefore, similar results for 144 specimens of the four most common species of rat from the forest, *R. mulleri*, *R. sabanus*, *R. whiteheadi* and *R. r. jalorensis*, are grouped. Since the classes 'old' and 'young' have been chosen to make them equal, and since sampling in the trapping register shows that the numbers examined in each period of the lunar month have been approximately equal, the number of litters expected in each box of the table is the same, namely, twelve. For the first two periods this is approximately true, for the next two there is an excess of 'young' litters, and for the last two a similar excess of 'old' litters. A χ^2-test gives a probability of less than 1 per cent that such differences are due to chance variations.

As a litter spends some ten days in the 'young' group, it is evident that there must be a burst of conceptions in the period immediately before the full moon, roughly coinciding with the sudden increase in effective moonlight which occurs at about the tenth of the lunar month.

That this phenomenon is likely to be a direct effect of the moonlight is shown by similar figures for the diurnal squirrels trapped in the same localities (Table 3). The numbers are rather smaller and have been grouped by ten-day periods; but it is clear that they do not differ significantly from the expected equality, whereas they do differ sharply from the figures which would be expected on the basis of Table 2. The probability that they differ from the proportions of Table 2 by chance variation alone is less than 2 per cent. Evidently the squirrels are not affected by moonlight, as would be expected of diurnal animals.

Table 3. The same information, but grouped by ten-day periods, for the common diurnal forest squirrels, *Callosciurus notatus*, *C. nigrovittatus* and *C. caniceps*

Lunar dates	1–10	11–20	21–30
'Old'	11	9	8
'Young'	11	7	10
Total	22	16	18

$\chi^2 = 1 \cdot 48$. $P = 0 \cdot 5$.

During the same period, 284 pregnant house rats (*R. r. diardii*) were examined (Table 4). Here there is the same tendency as with the forest rats, but to a much lower degree. The probability that the difference from equality is due to chance is between 5 per cent and 10 per cent, a level of significance below the conventional standard. This result agrees with the suggested effect of moonlight, since house rats are, presumably, exposed to it far less than are forest rats.

It seems probable, therefore, that in the nocturnal rats the onset of the period of bright moonlight near the time of full moon has some stimulating effect on conception. There are, no doubt, other examples of this or related phenomena which I have not heard about. I should be most interested to know of any other observations which may provide some explanation of the phenomenon.

Table 4. The same information, by five-day periods, for the house rat, *Rattus rattus diardii*, from the town of Kuala Lumpur

Lunar dates	1–5	6–10	11–15	16–20	21–25	26–30
'Old'	23	30	20	24	26	19
'Young'	26	23	32	20	19	22
Total	49	53	52	44	45	41

$\chi^2 = 10 \cdot 3$. $P = 0 \cdot 07$.

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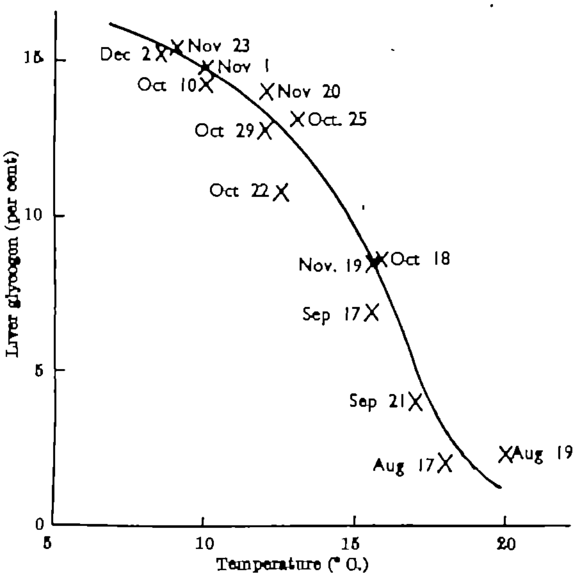
Environmental Temperature and the Glycogen Content of the Frog's Liver (*Rana temporaria*)

It has been generally concluded by previous workers that the glycogen content of the frog's liver in the autumn increases steadily as the season advances[1]. While this is probably true for the female, examination of the results for liver glycogen estimations made on fourteen samples which were caught between August and early December in 1948, 1949 and 1950, showed that this is not the case in the male frog.

Sometimes relatively low values were found in November and unexpectedly high concentrations in October. Some of these samples had been kept for three to five days in a tank-room at approximately atmospheric temperature, while others were actually killed in the field and the livers frozen in solid carbon dioxide for subsequent analysis in the laboratory. The temperature of the environment was recorded in each case, and it was found that when this was plotted against the mean glycogen content of the livers of the male frogs in the samples, the above-mentioned anomalies disappeared. This can be seen from the accompanying graph, where the observed points all lie reasonably close to a regular curve. Statistical analysis of the results shows a very significant correlation between glycogen content and temperature ($r = -0 \cdot 934$). From the graph it can be seen that the region of most rapid change lies between 12° and 17° C., as the slope of the curve decreases at lower temperatures. Glycogen attains its new level in the liver quite rapidly following a change of temperature. For example, on November 19, 1948, five male frogs were killed after being in captivity and unfed for three days. The temperature when this group was killed was 15·5° C. and the mean liver-glycogen content was $8 \cdot 5 \pm 0 \cdot 49$ per cent. On the following two days, when the average temperature had fallen to 10·5° C., six more males from the same sample gave a mean of $14 \cdot 4 \pm 0 \cdot 55$ per cent. Despite the small sample numbers, this difference is highly significant ($P < 0 \cdot 001$). The main temperature change occurred during the night of November 19, and the liver-glycogen content had reached its new level on the morning of November 20.

This relation between liver-glycogen content and temperature is apparently peculiar to the male and restricted to the period August to early December. In January, for example, a high glycogen content appears to be maintained despite a rise in temperature, unless precocious sexual activity supervenes, when the glycogen disappears quite rapidly even at low temperatures[1]. In the case of the female the amount of glycogen in the liver is low in August and September, and high in October, November and



Mean liver-glycogen content (percentage wet weight of liver) of male frogs, killed on the dates indicated, plotted against the temperature of the external environment

December, there being no obvious relation with the recorded temperatures. For example, in one September sample, the females contained 2·8 per cent liver glycogen at 15·5° C., while an October sample showed 9·5 per cent at 16·0° C. It would seem, therefore, that not only is the maximum glycogen content attained lower in the female[1], but also that it is not thermolabile.

It seems possible that the site of this action of temperature is at the level of the liver cells themselves, since adjustment of the liver-glycogen content takes place so rapidly. There may, however, be changes in the general endocrine system, perhaps of the type envisaged by Kepinov[2], occurring about the middle of August and December. A problem which still requires elucidation is the nature and source of the precursor of the not inconsiderable quantity of glycogen which appears in the livers of fasting male frogs without there being any regularly associated changes in the blood-sugar level. Experimental work on the action of temperature on glycogenolysis is at present in progress in this Department.

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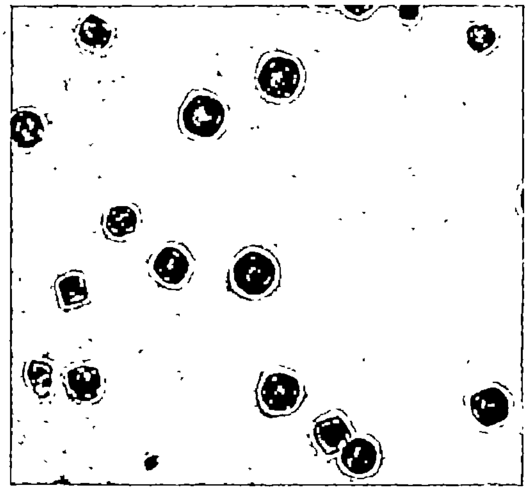
Presence of Ferritin in a Marine Elasmobranch, *Scyllium canicula*

FERRITIN has been isolated in the crystalline state from various organs of man, horse, pig, jackal, rat, mouse and guinea pig. On the other hand, the characteristic crystals have not been obtained from the tissues of the ox, sheep, deer and chicken. In the liver and spleen of the latter animals there is present some non-hæmin iron and some ferric iron bound to a protein component; but no crystals of ferritin are obtained with cadmium sulphate. Data on the distribution of this protein on the zoological scale are not complete; since it has an important function in the metabolism of iron, knowledge of its presence in other organisms would be very valuable.

We have observed in the liver of a marine elasmobranch, *Scyllium canicula*, the presence of a protein containing non-hæmin iron. The iron is present as ferric iron reducible to ferrous, like that of ferritin, with sodium dithionite. Applying the technique of Granick[1], we have obtained dark red crystals in the form of octahedrons, isotropic under the polarizing microscope.



The liver was homogenized in a Waring blendor with two parts of water (w/v) because of the high content of glycerides. The crystals show the characteristics and properties of those of ferritin. Apart from the liver, we have also obtained the same crystals from the intestine, although we have not succeeded in obtaining them from the spleen, perhaps because there is too small a quantity. The presence of ferritin in the liver and intestine of this elasmobranch suggests that the metabolism of iron in this animal is analogous to that in the animals listed above. Attempts to obtain crystals from the liver of teleostean fish have proved unsuccessful.

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A New Species of the Mystacocaridea (Crustacea)

AMONG the numerous microscopic Crustacea brought back by the Lund University Expedition to Chile during 1948–49 was a new species of the sub-class Mystacocaridea, established by Pennak and Zinn[1] and recently discovered also in Europe by Chappuis, Remane and Delamare Deboutteville[2]. The species was obtained in the Pacific near the Island of Guafo in lat. 43° 33′ S., long. 74° 49′ W. on coarse sand in a depth of 25 m.

A comprehensive description of the new species, which belongs to the genus *Derocheilocaris* Pennak and Zinn, and its general anatomy, will appear in the reports of the expedition[3].

The head dorsally has what appears as a segmental border delimiting the part containing the protocerebrum (the so-called "rostral plate" of Pennak and Zinn) from the remainder of the cephalon. I consider this as a secondary development and not as a sign of a primitive segmentation of the acron (cf. refs. 4, 5). The antennæ, probably also the maxillulæ and the maxillæ, have a three-segmented protopodite, the mandible a two-segmented one. The occurrence in particular of two segments in the protopodite of the mandible—by far the most primitive found throughout the Crustacea—contradicts the opinion of Heegaard[6] that an unsegmented protopodite should be regarded as a primitive condition (cf. refs. 7, 8).

The nervous system is very primitive, although the peculiar position of the protocerebrum, deutocerebrum and tritocerebrum, which are widely separated, is probably due to the unusual shape of the acron. Anteriorly the acron is deeply cleft and each fronto-lateral projection carries two setæ, the nerve fibres of which can be traced to their entrance into the protocerebrum. On the lateral margins of the acron occurs one similar seta the nerve fibre of which can also be traced to the protocerebrum. The four anterior setæ are interpreted as probably representing the medial, originally unpaired, frontal organ, the nerve of which is always paired[9], the lateral ones as the paired (dorsal) frontal organ. There are generally two eyes of nauplius type at the base of each of the frontolateral projections, one situated more dorsally than the other. Probably the medial element of the nauplius eye has split into two which have gone one to each side together with the lateral element of the respective side. The splitting of the medial frontal organs and nauplius eyes is probably caused by the deep cleavage of the acron. The antennæ nerves come from the posterior part of the œsophageal commissure. The ganglion labrii is very large. Throughout the ventral nerve chain the longitudinal connectives are free. There is a free tritocerebral commissure and in each of the following segments a double free commissure is present. The ganglia touch in the medial line but without coalescing. The ventral chain is much more primitive than that of any other Crustacea excepting the Phyllopoda (for example, *Triops*) which it closely resembles.

The intestine resembles that of the Harpacticoida[10]. The stomodæum is very long and with a chitinous intima, the midgut begins in the hind part of the cephalothorax with an area with large, apparently secretory cells and is short and wide; the proctodæum occupies at least half the length of the abdomen. No cæca were observed.

The sexes are separate as in the European species[2]. In both sexes I have found the genital pore on the ventro-lateral side of the fourth segment (counting the maxilliped segment as 1), that is, I have seen the opening in the hypodermis but found no external pore. I have never seen more than one gonoduct and in three males and two females investigated it opens on the right side. The "yolk sac" of Pennak and Zinn, interpreted by Armstrong[11] as a spermatheca, undoubtedly represents a vitellarium. The yolk in immature females is formed by disintegration of cells probably from the posterior part of the ovarium. In mature females it is filled by eosinophile granules and surrounded by a membrane. The eggs, which are few and large, are obviously nourished by means of diffusion of dissolved substances. The testes are very large, occupying most of the dorsal part of the male thoraco-abdomen. Although there is only one ductus deferens, the testes are obviously of a paired origin and are provided with two longitudinal series of broad lobes. Sperm is produced in large quantities. There are no spermatophores. No copulatory organs have been observed.

With Pennak and Zinn[1] and against Armstrong[11], I maintain that *Derocheilocaris* cannot be referred to the Copepoda, but that a taxonomical group of the same order as the Copepoda must be created for it. The Entomostraca being ruled out as a natural group, the Mystacocaridea will obtain the status of a sub-class. From their nearest relatives, the Copepoda, they differ mainly in the greater primitiveness of the mouth parts, the location of the genital pore, the primitive structure of the genital organs and the nervous system. With regard to the latter organ systems, they approach the Phyllopoda or, rather, a generalized primitive Crustacean type. In several respects they are more advanced than the Phyllopoda.

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Amino-acids in Legumes

In the course of analyses of vegetable foods with the view of evolving an entirely vegetable dietary which would be optimal in respect of protein, determinations of essential amino-acids were carried out on two legumes, Mysore dhal or lentil (*Lens esculenta*), and green gram or mung (*Phaseolus vulgaris*, Roxburgh). The determinations were carried out by microbiological assay. *Leuconostoc mesenteroides* and *Streptococcus fæcalis* were used with various media[1] in the assay of lysine, methionine, *iso*leucine and phenylalanine, and *Streptococcus fæcalis* in the assay of valine, leucine and threonine.

In view of current interest in the substitution of vegetable products for animal foods in nutrition[2], this preliminary communication may be of interest. Figures for *Phaseolus vulgaris* L. and soya bean calculated from published data are included for comparison.

Essential Amino-acids in Legumes
(Figures given are amino-acid nitrogen as percentage of total nitrogen)

Amino-acid	*P. vulgaris* L. (ref. 3)	Soya bean (ref. 4)	Lentil	Green gram
Lysine	7·2	7 9	7 9	8 7
Threonine	3·7	2 8	2·7	2 6
Methionine	0 4	0·8	0·4	0·7
*iso*Leucine	—	3·4	3·2	2·2
Leucine	8 8	5·1	4·6	5·2
Valine	4 0	4·0	4·1	4·8
Phenylalanine	2 9	2·7	2 6	2·7
Tryptophane	0·9	1 1	—	(1·1) (ref. 5)

Details of these investigations will be published elsewhere.

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Serological Properties of Human Blood Group *A* and *B* Substances

During the course of the isolation and characterization of the human blood group *B* substance from some ovarian cyst fluids, it was observed that certain fractions of the mucoid materials obtained were relatively inactive in the usual iso-agglutination inhibition tests using naturally occurring β-agglutinin. The materials were, however, found to possess high activity when similarly assayed against human immune anti-*B* sera, which arose as a consequence of an incompatible transfusion or as a direct result of immunization with human group *B* substance or through an injection of horse serum. Rabbit immune anti-*B* sera which were produced by means of an artificial antigen made from human blood group *B* substance, and the serum of a chicken which contained a potent anti-*B* agglutinin after immunization with *Shigella shigae* and absorption with *O* and *A* cells, were also found to behave as did the human immune anti-*B* reagents. In these experiments, in which saline alone was used as diluting medium, all materials which inhibited the naturally occurring β-agglutinin also inhibited the immune anti-*B* sera.

The *B* substances in the *AB* materials isolated from three cyst fluids obtained from 'secretors' belonging to group A_1B behaved as did the selected mucoid materials mentioned above, and were found to possess negligible activity when tested with natural β-agglutinin but were highly active when tested against immune anti-*B* sera.

Materials with these restricted serological characters can be produced artificially from an essentially homogeneous human group *B*-substance (nitrogen, 5·8 per cent; fucose, 18 per cent; hexosamine, 20 per cent), which inhibits, at a dilution of 1 in 10^6, two to three completely agglutinating doses of either the natural β-agglutinin or the immune anti-*B* sera, by heating in an autoclave a 1 per cent solution of the purified *B*-substance in borate buffer (*p*H range 7·7–8·0) at 120° for about 45 min. Other weakly alkaline buffers within this *p*H range can also be employed. The *B* substance in fresh human saliva is similarly changed serologically after heating under these conditions.

The modification in serological properties of a group *B* substance which before treatment reacts with both natural and immune anti-*B* agglutinin is associated with a loss of viscosity and with the development of a capacity to give an 'N-acetylglucosamine' colour when treated with Ehrlich's reagent[1]. After heating under the conditions described, about 20 per cent of the material is found to diffuse through a 'Cellophane' membrane, and the diffusible material contains the whole of the chromogen and shows the changed serological character. The chromogen is not associated with the serological activity, however, since it is soluble in ethanol whereas the serologically active component of the diffusate is insoluble in this solvent. The indiffusible portion of the mucoid is found to possess a somewhat higher nitrogen and L-fucose content than the original material. Both the serologically active diffusible and indiffusible components react weakly or not at all with natural β-sera but show full activity when tested against immune anti-*B* agglutinin.

The serological specificities of human β- and rabbit anti-*B* sera have been studied in considerable detail[2], and it appears that human β-agglutinin contains two components, β_2 and β_3 and sometimes a third agglutinin designated β_1. Human group *B* erythrocytes contain receptors B_1, B_2 and B_3 corresponding to the three kinds of agglutinin, whereas rabbit red blood cells possess the specific receptors B_2 and B_3 only, and therefore in this species β_1 agglutinins alone can be formed. We have examined, by the methods of Friedenreich and With, some of our natural and immune human sera and have found that, regardless of whether or not our natural sera contain β_1, they are not inhibited by the selected mucoid materials or by the artificially modified *B* substance. The results suggest that the serological behaviour observed for the *B* substances is not related to the agglutinins β_1, β_2 and β_3 but is associated in some way with the normal or the immune character of the agglutinin. By postulating a further 'partial receptor' in the *B* specific complex, the antibody to which is found in human immune and animal immune sera only, our observations can be brought into line with the earlier views. This additional partial receptor is presumably more stable to the action of alkali than are the structures associated with the characters B_1, B_2 and B_3.

We have examined the activity of the two types of *B* material by means of the normal β-agglutinins obtained from persons belonging to groups A_1, A_2 and *O* and from an individual believed to be A_4. In one instance only, of twenty-one sera tested, did the anti-*B* agglutinin behave as an immune agglutinin, and it was afterwards found that the individual from whom this serum was obtained had received repeated injections of T.A.B., A.T.T., anti-typhus and anti-yellow fever vaccine. Thus it would appear that the differences in the heat of the antigen–antibody reaction reported by Wurmser, Armand and Wurmser[3], and believed by them to be related to the *ABO* genotype of the person producing the antibody, are apparently not associated with the differences in the reactivity of the natural and immune agglutinin described by us.

The examination of the behaviour of human *A* substance before and after treatment at *p*H 8 and 120° for different periods of time up to 45 min. revealed no definite differences in the behaviour of the materials with natural and immune anti-*A* agglutinins when A_1 cells were used in the inhibition test. After a longer period of heating, the *A* activity was considerably reduced or completely destroyed, and when the activity was destroyed for one anti-*A* serum it was destroyed for all the other sera examined. The replacement of A_1 cells in the test by A_2 cells, a procedure considered to increase the sensitivity of the test for the detection of *A* character[4], revealed that materials which possessed little or no activity when A_1 cells were used were fully active in the presence of A_2 cells. These results were obtained when both normal and immune anti-*A* agglutinins were used in the inhibition tests.

The *A* substance in the three active A_1B cyst fluids reported above appears to be of the type which shows low activity when examined in inhibition tests using A_1 test cells. Assayed against the same sera but using A_2 cells, the material showed considerable activity. Materials which possess a serological behaviour similar to that induced by heat treatment of fully active *A* substance can therefore be encountered in native cyst fluids[4].

These results indicate clearly the importance of examining serologically preparations of blood-group *B* substance or their partial degradation products, with both natural and immune group agglutinins, before concluding that the original serological specificity has been completely lost. Similarly, inhibition tests made to determine the activity of *A* preparations should employ A_2 as well as A_1 test cells. By these means important differences in the serological characters of preparations of the *A* and *B* substances can be revealed. The effect of different reagents, including enzymes, on the purified substances is being examined in greater detail in the light of these findings and will be reported elsewhere.

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A Relationship between the Secretion of the Blood Group Antigens and the Presence of anti-*O* or anti-*H* in Human Serum

HUMAN and animal sera exist which agglutinate red blood cells of group *O* and A_2 more strongly than those of other groups; these have been known for many years as anti-*O* sera. In 1948 Morgan and Watkins[1] divided such sera into two kinds: those which could be inhibited by saliva from secretors of all A_1 A_2 *B* *O* groups, anti-*H*, and those which could not be inhibited, anti-*O*. Both types are found in human serum.

In this Unit it has been felt for some time that, apart from this clear distinction, the two types of antisera are indistinguishable in their reaction with red cells of the different *ABO* and *Lewis* groups. It occurred to me that one antibody (anti-*H*) if developed in a non-secretor person might be susceptible to inhibition *in vitro* by 'secretor' saliva, while the same antibody (anti-*O*) if developed in a secretor person might be immune to inhibition.

No information about the saliva of donors of anti-*O* and anti-*H* sera was available to test this possibility; there was, however, information about their *Lewis* groups, and these groups, as Grubb[2] and subsequent workers have shown, are closely correlated with secretion of the *A*, *B* and *H* antigens in the saliva. (All *Le*(*a*+) persons so far tested are non-secretors, and more than 98 per cent of *Le*(*a*−) people are secretors[3].)

Miss E. W. Ikin and Dr. A. E. Mourant very kindly provided fifteen samples of undifferentiated anti-*O* or anti-*H* sera, together with the *Lewis* groups of the donors. These sera, together with four others, were then classified by inhibition tests with saliva from secretor persons of group *O*. In each case, saliva from non-secretor persons of group *O* was used as a control. Details of two further examples of anti-*H* were kindly provided by Prof. Morgan[4]. The total count is:

		Red cells of donor	
		Le(*a*+)	*Le*(*a*−)
Antibody in serum of donor	anti-*H*	8	0
	anti-*O*	1	12

The probability that this lack of proportion is due to chance is 1 in 22,610.

Since 22 per cent of Europeans are *Le*(*a*+), the disturbance is mainly in the top row of the 2 × 2 table; from these results it would seem that when anti-*H* is made it is made by *Le*(*a*+) people.

Conversely, it may be that anti-*O* is usually made by *Le*(*a*−) persons, though the existence of the exception shows that this is not always so. The collection of sufficient data to show any significant disturbance in the second row of the 2 × 2 table may take a long time, for much larger numbers of donors of this rather rare serum, anti-*O*, will be needed.

It is difficult to imagine that the presence of the *Le*(*a*+) character on the red cells determines that the antibody in the serum is to be anti-*H*; the decisive factor is more likely to be the non-secretor environment in which the antibody is made.

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Acetylcholine Esterase of the White Components of Blood

A PAPER by Zajicek and Datta[1] describing the presence of a high concentration of acetylcholine esterase or 'true' cholinesterase in the thrombocytes of rat blood recently came to my attention. I have known for some time that considerable 'true' cholinesterase is to be found in the white layer of centrifuged rat blood, and while I was working at the Medical Research Laboratories of the Defence Research Board, Ottawa, Canada, I showed by substrate and inhibitor studies that this is a typical 'true' cholinesterase. It was my opinion at that time that the enzyme was in the leucocytes rather than in the platelets; but in all other respects my work with rat blood confirmed the findings of the above authors.

After coming to England, I extended these observations to other species and found that the enzyme was present in very high concentration in the white layer of centrifuged mouse blood which consisted almost entirely of platelets, and in the same layer of cat blood; but I have not found any comparable activity in the white layer of the blood of man, or in that of the ox, sheep, pig, dog, rabbit or guinea pig. Species differences are characteristic not only of the true enzyme, but also of the 'pseudo' cholinesterase[2]. If the enzyme has any real function, it is difficult to understand what takes its place in the organs or cells of those species in which there appears to be no activity.

I am now making investigations to find out where the enzyme is localized in the active bloods, and if any function can be assigned to it.

I should like to acknowledge the help and encouragement of Dr. M. L. MacFarland, of the Defence Research Medical Laboratories, Ottawa, who supervised the research done in Canada, and of Prof. R. A. McCance, under whose direction the work is being continued in Cambridge.

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Retinal Colour Processes caused by Intermittent White Light

It is a well-known fact that colour sensations can be produced by intermittent white light (the so-called subjective colour phenomenon of Fechner[1] and Benham[2]). This phenomenon has been investigated by us by means of a physiological method described in detail in a previous paper[3]. The electrical sensitivity of the dark-adapted eye was measured at varying intervals after exposure for 2 sec. of the central fovea to a pre-illuminating patch of 1° in visual angle. After removal of the light stimulus, the excitability recovers very rapidly, becomes supernormal and then decreases to the initial level. The maximum of supernormality lies at 1, 1·5, 2 and 3 sec. when red, yellow, green and blue lights are used for pre-illumination. The broken curves in Fig. 1 are examples of excitability curves for white light, which have a maximum at about 2 sec.

The curve for white light is increased in height and shifted to the right when yellow light is presented prior to the white light. Since this curve is similar in shape to that for blue light, the successive stimuli, yellow and white, may be taken as equivalent to a blue light stimulus. A group of such phenomena has been studied extensively in a previous paper[1] and termed 'retinal colour induction'.

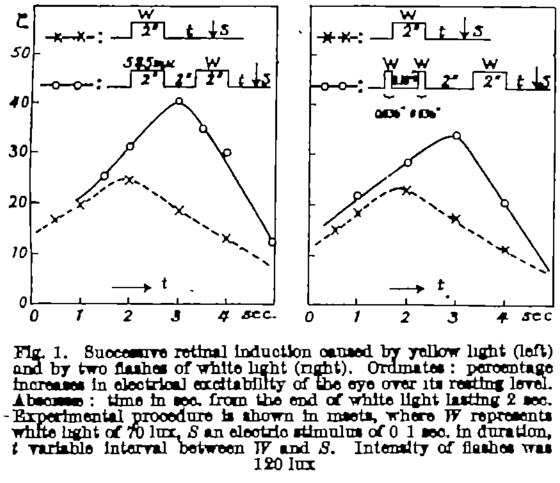

Fig. 1. Successive retinal induction caused by yellow light (left) and by two flashes of white light (right). Ordinates: percentage increases in electrical excitability of the eye over its resting level. Abscissae: time in sec. from the end of white light lasting 2 sec. Experimental procedure is shown in insets, where *W* represents white light of 70 lux, *S* an electric stimulus of 0·1 sec. in duration, *t* variable interval between *W* and *S*. Intensity of flashes was 120 lux

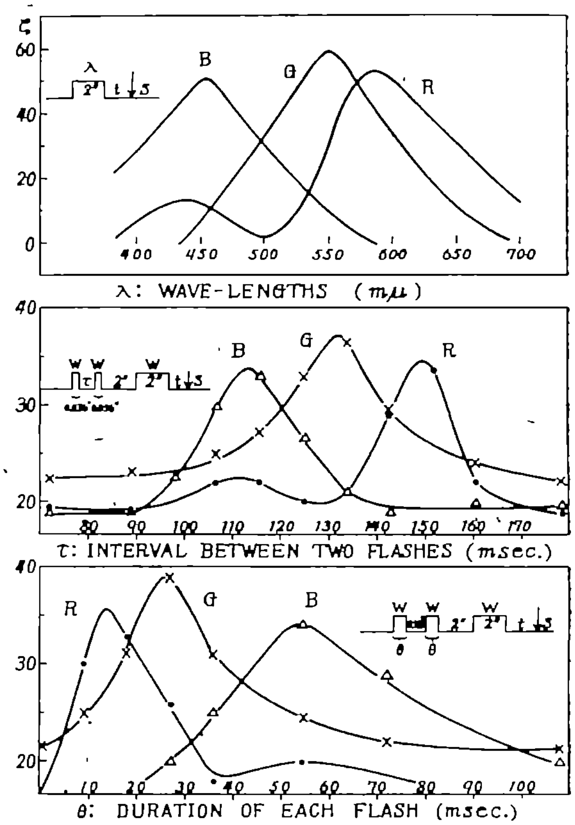

Fig. 2. Response curves for an equal-energy spectrum (upper diagram) and those for intermittent white light (middle and lower diagrams). Experimental procedure is shown in insets, in which τ and θ represent variable interval between two flashes of fixed duration 0·036 sec. and variable duration of flashes delivered at a fixed interval 0·125 sec. respectively

In the present investigation, it was found that two flashes of white light adequately spaced may be used as a substitute for the yellow light used in the experiment mentioned above. The curve obtained in this way is materially different from that for white light alone, showing a maximum at about 3 sec. just like a curve for blue light (Fig. 1). By varying the interval between two flashes, but under otherwise precisely the same experimental conditions, we succeeded in realizing effects of colour induction similar to those caused by spectral lights of various wave-lengths. In Fig. 2 it is demonstrated how this phenomenon depends on the interval between two flashes. For comparison, response curves for an equal-energy spectrum are illustrated in the upper diagram, in which data of electrical excitability at 1, 2 and 3 sec. after illumination are denoted by *R*, *G* and *B* respectively and plotted against the wave-lengths of pre-illuminating spectral lights. For reasons stated in the previous papers[3], the quantities *R*, *G* and *B* represent excitation of red, green and blue receptors respectively. It is to be noted that these response curves, determined by our physiological method, bear a striking resemblance to the fundamental sensation curves obtained by previous workers[4-7] from their colour-mixing experiments. The response curves shown in the middle diagram were obtained in the manner stated above, using two flashes of white light variously spaced and a subsequent white light stimulus of 2 sec. in duration. When the interval was shorter than 90 m.sec. or longer than 170 m.sec., the flashes showed no colour-inducing effect whatsoever, and the excitability curve was found to be the same as that for the white light alone. However, at intermediate intervals from 90 to 170 m.sec., very striking colour induction could be seen; as the interval was increased, the shape of the excitability curve, that is, the relative magnitudes of R, G and B, were systematically altered in such a manner that the induced colour changed from violet to red in the same order as in a spectrum (compare the upper and middle diagrams).

In another series of experiments the duration of flashes was varied, the interval between them being made 125 m.sec. The results are shown in the lower diagram of Fig. 2, which indicates that the induced colour changes from red to violet as the duration increases. Thus, an increase in duration of each flash acts just like a decrease in the interval. The ratios $R : G : B$ were found to change greatly upon varying the intensity of the flashes.

All these features of our physiological observations seem to reproduce well the properties of subjective colours, which are known to depend greatly upon the velocity of the rotating disk of Fechner or Benham and also upon the intensity of illumination. While the properties of the preceding flashes are obviously essential to the production of colours, alterations of the properties of the subsequent white light, such as its intensity, duration and temporal relation to the preceding flash produce no essential change in the results; colour effects can be seen even without the subsequent white light. It merely serves to turn colours caused by flashes into their complementaries.

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Vitamin A Ester and Vitamin A Alcohol in the Serum of the Œstrogenized Immature Pullet

THE vitamin A of mammalian sera appears to be present principally as the alcohol, whereas the vitamin A of the liver is present mainly in ester form. As regards avian species, Neff *et al.*[1] have shown that the vitamin A of hen's egg yolk is present largely as the alcohol. Parrish *et al.*[2] have shown that the alcohol of the yolk is transformed in part to ester during incubation, and that the ester is the principal form in the livers of newly hatched chicks.

Administration of œstrogen greatly increases the level of vitamin A in the sera of immature pullets[3]. The state in which this extra vitamin A exists in the sera of œstrogenized pullets has now been examined. Sera have been collected from control and œstrogenized immature pullets in experiments undertaken for other purposes. These sera have been analysed for vitamin A by drying suitable samples by grinding with anhydrous sodium sulphate, extracting with petroleum ether and analysing the extract by the chromatographic technique of Narod and Verhagen[4].

The relevant results for two sets of observations are presented in Tables 1 and 2. The results for the control groups indicate rather low total vitamin A values, possibly due in part to comparative inefficiency of direct extraction with petroleum ether as compared with saponification and separation of the vitamin with the unsaponifiable.

Table 1. EFFECT OF ŒSTRADIOL BENZOATE ON SERUM VITAMIN A ALCOHOL AND SERUM VITAMIN A ESTER OF THE SEXUALLY IMMATURE PULLET (NEW HAMPSHIRE ♂ × BARRED PLYMOUTH ROCK ♀). AVERAGE RESULTS

Duration of experiment, 14 days. Hormones given by intramuscular route. Age of pullets at end of experiment, 74 days. All birds received same amount of food

Group	*E*	*F*
Number of pullets	5	5
Dosage œstradiol benzoate (mgm.)	nil	7 × 1·5
Dosage testosterone propionate (mgm.)	nil	7 × 1
Oviduct weight (gm.)	0·22	22·9
Serum vitamin A alcohol (μgm./100 ml.)*	3·3	2·6
Serum vitamin A ester (μgm./100 ml.)†	1·3	30·8
Serum vitamin A total (μgm./100 ml.)†	4·6	33·4

* Diff. not significant. † Diff. highly significant ($P < 0·01$)

Table 2. EFFECT OF GONADAL HORMONES ON SERUM VITAMIN A ALCOHOL AND VITAMIN A ESTER OF SEXUALLY IMMATURE PULLETS. (NEW HAMPSHIRE ♂ × BARRED PLYMOUTH ROCK ♀). AVERAGE RESULTS

Duration of experiment, 12 days. Hormones administered intramuscularly on alternate days. Age of pullets at end of experiment 89 days. All birds received same amount of food.

Group	*A*	*B*	*C*	*D*
Number of pullets	6	5	6	5
Dosage œstradiol benzoate (mgm.)	nil	nil	6 × 1	6 × 1
Dosage testosterone propionate (mgm.)	nil	6 × 1	nil	nil
Dosage progesterone (mgm.)	nil	nil	nil	6 × 1
Serum vitamin A alcohol (μgm./100 ml.)*	4·2	4·1	4·0	3·9
Serum vitamin A ester (μgm./100 ml.)†	0·9	2·2	42·8	47·5
Serum vitamin A total (μgm./100 ml.)†	5·1	6·3	46·8	51·4
Serum calcium (mgm./100 ml.)†	11·7	11·4	71·3	72·3

* Diff. between groups not significant.
† Diff. between groups *A* and *B* and between *C* and *D* not significant. Other differences highly significant ($P < 0·01$).

The results, however, provide fairly strong evidence for the conclusion that the increase in serum vitamin A of the immature pullet evoked by œstrogen is largely, if not entirely, an increase in vitamin A ester fraction. If the effect of œstrogen on serum vitamin A operates as a mechanism for the direct mobilization of hepatic vitamin A to the yolk, it would seem plausible to anticipate that œstrogen would enhance the level of the ester form rather than the level of the alcohol form.

It will be remarked from Table 2 that progesterone did not reduce the effect of the œstrogen on either serum vitamin A or serum calcium, although it depressed the hypertrophy of the oviduct evoked by œstrogen. Hertz *et al.*[5] have also remarked on the insignificant effect of progesterone on the response of serum calcium of the chick to œstrogen in experiments where progesterone reduced the effect of œstrogen on the oviduct.

Testosterone propionate by itself did not significantly affect serum vitamin A, a point which has already been noticed in this laboratory[6]. It is of interest to record, however, that testosterone propionate by itself may significantly increase serum carotenoids[6] although not affecting serum vitamin A.

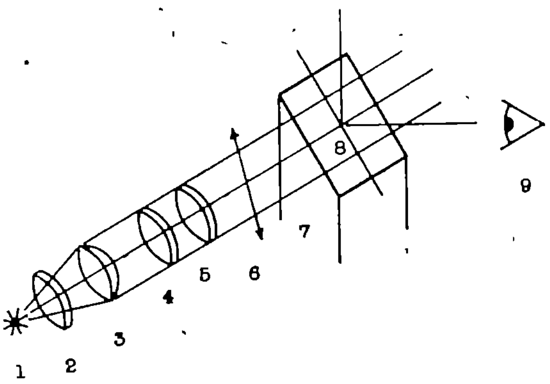

Fig. 1. Apparatus for the photo-elastic determination of surface stresses. 1, High-pressure mercury lamp; 2, heat-absorbing filter; 3, collimating lens; 4, green filter; 5, polarizer; 6, plane of polarization; 7, stressed model; 8, surface region; 9, observer

It is known that the components of a ray of polarized light traversing a stressed plastic model (of suitable material) will suffer relative retardations which are proportional to the maximum effective shear stresses in the path of the ray. These retardations may be seen in the form of interference fringes by viewing the ray through a second polarizer (analyser). Ordinarily, the analyser has been an element (Nicol prism, 'Polaroid', etc.) separate from the model, or use has been made of polarization due to scattering by particles within the model. In the present method for the determination of the stress at a point in the surface of the model, the surface itself is utilized as the analyser. To achieve this, the surface must be left in an as-machined condition, that is, unpolished.

A collimated beam of polarized light is projected through a section of the stressed model which includes the surface region under investigation. The model is aligned so that the tangent plane at the surface point is parallel to the direction of the beam. The plane of polarization of the beam should be adjusted to form an angle of 45° with the tangent plane. As the beam penetrates the model, the rays of the beam inside and adjacent to the surface will graze the tiny surface irregularities. Polarization by reflexion or refraction at these irregularities will result in the surface performing the function of the analyser. If the surface region is viewed from a position perpendicular to the direction of the beam and at an angle of 45° to the tangent plane of the surface point, an interference fringe pattern will be visible. The spacing of the fringes is inversely proportional to the effective shear stresses. It is possible to obtain the principal stresses by taking measurements for three orientations of the surface to the direction of the beam.

A simplified arrangement of the apparatus is shown in Fig. 1. It is usually necessary to immerse the model in a glass tank containing a clear liquid of the same refractive index as the plastic. This procedure reduces the refraction that would otherwise occur at the face of the model. To ensure that the surface fringe pattern will not be obscured by light scattered within the model, a material such as 'Catalin' with negligible scattering properties should be employed. As an illustration of a fringe pattern obtained by this method, a photograph of the tension surface of a beam in pure bending is shown (Fig. 2).

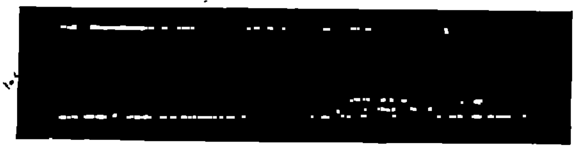

Fig. 2. Surface fringe photograph of the tension edge of a beam in pure bending

Several applications of this technique are now under investigation here.

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Effect of Scopoletin on Indoleacetic Acid Metabolism

SCOPOLETIN is a normal constituent of many plants and is responsible for the blue fluorescence of oat roots[1]. An accumulation of this substance has been observed in tobacco[2] and potato[3,4] plants suffering from certain virus diseases, in topped tobacco[5] and in plants treated with 2,4-dichlorophenoxyacetic acid[6]. When applied to the growing tip of oat rootlets, it was found to be the most active of all the coumarin derivatives tested in causing inhibition of root growth[7]. Coumarin is believed to exert its effect by combining with sulphydryl enzymes concerned with growth[8].

In the presence of potato tissue, scopoletin is oxidized to a blue intermediary which turns yellow on standing. This reaction is inhibited by cyanide, azide, hydroxylamine and accelerated by hydrogen peroxide[3]. During the present work it was observed that the oxidation was also inhibited by diethyldithiocarbamate and manganous ions, but was not affected by carbon monoxide either in the light or dark. The pH optimum lay between pH 6·0 and 6·6. The properties of the scopoletin oxidase appeared to be so similar to those described[9-11] for indoleacetic acid oxidase that it seemed possible that the two were identical. In support of this concept, it was found that indoleacetic acid oxidase extracts prepared by the method of Galston *et al.*[9] actively destroyed scopoletin in the light (Fig. 1) and less actively in the dark. Scopoletin was determined fluorometrically. The colour changes brought about by indoleacetic acid oxidase extracts and scopoletin were identical with those obtained with potato tissue.

While indoleacetic acid did not inhibit the metabolism of scopoletin, scopoletin inhibited the destruction of indoleacetic acid by the oxidase (Fig. 1). The decrease in inhibition with time is attributed to the disappearance of scopoletin from the reaction mixture, since high concentrations or repeated small additions of scopoletin prolonged the period of inhibition. In the absence of the enzyme, scopoletin had no effect on indoleacetic acid, which was determined colorimetrically by the method of Tang and Bonner[10].

By applying the procedure of Lineweaver and Burk[11] to the results, it was found (Fig. 2) that scopoletin acts as a competitive inhibitor. It thus appears either that scopoletin is oxidized by a similar

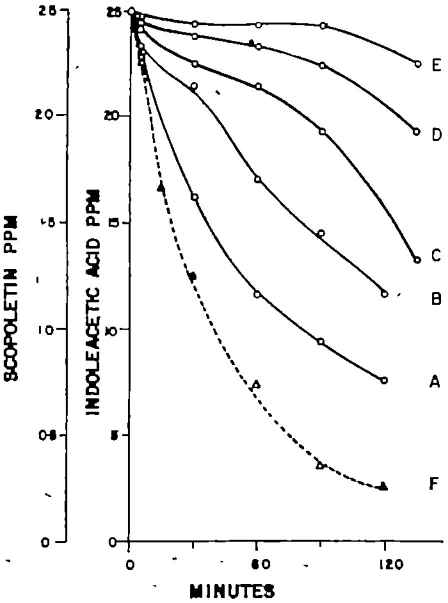

Fig. 1. Effect of scopoletin on destruction of indoleacetic acid by indoleacetic acid oxidase. *A*, no scopoletin; *B*, *C*, *D*, *E*, 2·5, 4, 12, 25 p.p.m. scopoletin respectively; *F*, scopoletin loss in reaction mixture containing 2·5 p.p.m. scopoletin

but different enzyme and competes for hydrogen peroxide, or that the two enzymes are identical and that scopoletin is preferentially attacked. Tang and Bonner[10] showed that *cis*- and *trans*-cinnamic acid and nine other analogues and auxin-like compounds had no appreciable action on the oxidase; we found coumarin also to be ineffective, so that it is not apparent why scopoletin, which is related to the cinnamic acids and to coumarin but not to indoleacetic acid, should show a competitive action.

If scopoletin behaves similarly *in vivo*, then it should simulate an auxin when applied to plants by its auxin-sparing action. It was found that the root-growth of peas soaked in 50 p.p.m. scopoletin prior to germination was temporarily retarded, while soaking in much weaker solutions (1 p.p.m.) resulted in a stimulation. This is analogous to the results of Thimann[13], who observed stimulation of root growth with low concentrations of auxin and inhibition with higher. Presumably with low concentrations of scopoletin, indoleacetic acid accumulates only within the stimulatory range, while with higher concentrations it accumulates in amounts sufficient to depress root growth.

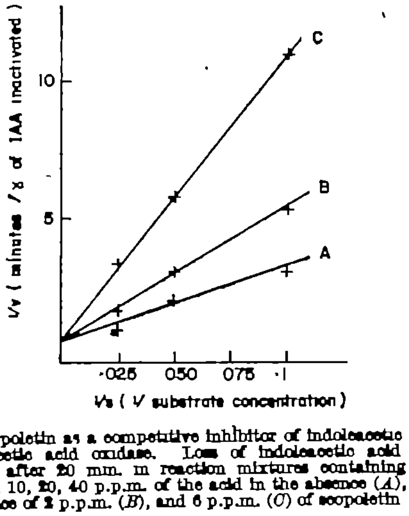

Fig. 2. Scopoletin as a competitive inhibitor of indoleacetic acid by indoleacetic acid oxidase. Loss of indoleacetic acid was determined after 20 min. in reaction mixtures containing the oxidase and 10, 20, 40 p.p.m. of the acid in the absence (*A*), and presence of 2 p.p.m. (*B*), and 6 p.p.m. (*C*) of scopoletin

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Adsorption of Amino-acids on Sparingly Soluble Inorganic Solids

Among chromatographic adsorbents there is continually in progress a search for substances of higher adsorbing capacity and/or increased selectivity of adsorption. We have found that a number of sparingly soluble inorganic solids exhibit a small but definite binding affinity for amino-acids, and have attempted to relate such adsorption to certain physical properties of the adsorbent. The electrokinetic properties of both natural and artificial samples of several such solids have been investigated[1], and from these results it could be expected that such differences would be reflected in comparative affinities for binding amino-acids. Such has been found to be the case for the two amino-acids discussed here, namely, aspartic acid and glycine.

Solids of the type studied possess certain chromatographically desirable properties, such as low solubility and dimensional stability, which render column operation possible[2] in spite of the fact that their acid-combining capacity is low. The amino-acid adsorption by these solids was investigated by both column and static experiments. For the column experiments, 10 gm. of sample (− 52 + 72 B.S.S. mesh) was packed wet into a 7-mm. diameter glass tube. 200 ml. of the amino-acid solution containing 10 mgm. each of aspartic acid and glycine was allowed to percolate through the column at a flow-rate of approximately 1 ml. per min. The percolate was

Table 1. Column Adsorptions

Adsorbent	Amino-acid adsorbed (mgm. per gm. adsorbent)	
	Aspartic acid	Glycine
Natural zinc sulphide	0·41	0·24
,, lead sulphide	0·32	0·33
,, lead manganate	0·05	0 00
,, lead sulphate	0 20	0 34
,, barium sulphate	0·04	0·01
,, lead chromate	0·00	0·00
Fused lead chromate	0·00	0 00
Synthetic zeolite	0·72	0·25

collected and analysed for amino-acid content (Table 1) by a quantitative paper chromatography technique using the spot-area method[3]. For comparative purposes a column of a synthetic zeolite was prepared and used under identical conditions.

Since in any column operation there is a limited adsorption time, the relative adsorption-rates of aspartic acid and glycine for both natural and synthetic samples of the solids used in the column experiments were assessed by means of static experiments. In these experiments 1-gm. samples (– 200 B.S.S. mesh) were placed in 100 ml. of an amino-acid solution containing 5 mgm. of each of the above two acids. After intermittent shaking for an average period of six days, 25-ml. aliquots were removed and their amino-acid contents determined chromatographically (Table 2). A sample of synthetic barium chromate was used as an additional adsorbent.

Table 2. STATIC ADSORPTIONS

Adsorbent	Type	Amino-acid adsorbed (mgm. per gm. adsorbent)	
		Aspartic acid	Glycine
Zinc sulphide	Natural Synthetic	1·96 —*	1·80 0·44
Lead sulphide	Natural Synthetic	0·76 —*	0·61 0·12
Lead manganate	Natural Synthetic	0·84 0·08	0·64 0·00
Lead sulphate	Natural Synthetic	—* 0·28	—* 0·08
Barium sulphate	Natural Synthetic	—* 0·00	0·44 0·00
Lead chromate	Natural Synthetic Fused	0·60 0·40 0·84	0·52 0·00 0·40
Barium chromate	Synthetic	1·20	0·61
Zeolite	Synthetic	5·00	5·00

* Chromatographic irregularity of ninhydrin-developed spots prevented complete analysis of these aliquots.

From an inspection of Table 1 it can be seen that in all cases (except lead sulphate) the adsorption of aspartic acid was greater than or approximately equal to that of glycine. This observation has been confirmed by the results of the static experiments (Table 2), which show that the amounts of aspartic acid adsorbed on both natural and synthetic solids are decidedly greater than the corresponding amounts of adsorbed glycine. Table 2 also shows that in all available comparisons between natural and synthetic solids, the former exhibited higher adsorptive capacities for both amino-acids.

A study of the mechanism of the process of amino-acid adsorption on sparingly soluble inorganic solids and an attempted correlation between adsorptive capacity and the electrokinetic properties of the adsorbents have been made. An account of such results will be presented in a later publication.

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[1] Buchanan, A. S., and Heymann, E., *Nature*, 161, 649 (1948); *Proc. Roy. Soc.*, A., 195, 150 (1948). O'Connor, D. J., and Buchanan, A. S. (unpublished data).

[2] Hamor, G. C. M., *Biochem. J.*, 39, 485 (1945).

[3] Bryant, F., and O'Connor, D. J., *Aust. J. Sci.*, 18, 111 (1951).

Deposition of Metal Films on Jelly-like Materials

SUBSTANCES based on gelatine or agar-agar are used extensively for making moulds, from which replicas can then be made. In order to use the process of electroforming in conjunction with such jelly-moulds, it is necessary to provide the mould surface with a conductive layer. As agar composition, for example, contains about 95 per cent water, it is obvious that the moulds cannot be submitted to drying without causing deformation, and the usual method of coating moulds with aqueous colloidal graphite is therefore inapplicable.

Probably because of the high water-content of the jelly material, it was found to be impossible to produce films by silver-mirror techniques. The metallization by dry metal dust (for example, bronze powder) was rejected as not likely to yield sufficiently accurate reproduction. I have employed various impregnation techniques[1] which are now sufficiently improved to warrant trials in various fields of application.

The surface of the jelly is treated with aqueous silver-ammonio-nitrate made in the usual way. (Note: This preparation, which is widely used by dentists for impregnating natural teeth, is reported to be liable to become explosive. It is inadvisable to store large amounts, and the spent liquid should never be allowed to form crusts or to dry[2].) The liquid is completely evaporated by a jet of compressed air, but a sufficient amount of silver salt is left behind on the surface of the jelly. Instead of exposing this now to gaseous hydrogen sulphide (the resulting silver sulphide is brittle, unstable in acid solutions, and will not adhere to the jelly), the impregnated mould is exposed to *red* selenium, which is dissolved, for example, in carbon disulphide. Immersion in this solution for one to twenty minutes will produce a film of metallic appearance which probably consists of silver or silver selenide. It is transparent to light, conducts an electric current, but may float off when immersed in aqueous media. The film is obviously situated on the surface of the water-soluble silver salt, which was previously left by evaporation on the surface of the jelly. It is sufficiently stable to act as protection for the remainder of the salt, which can now be reduced to metallic silver, trapped as it is between the jelly and the silver selenium film. Suitable reducing media are some photographic developers, hypophosphorous acid (10 per cent), hydrazine-hydrate, etc., in which the treated mould will quickly be covered with a dense opaque film of high conductivity on which electrodeposition may be carried out. As an alternative, nascent hydrogen can be employed, which is evolved at the surface of the mould by making this the cathode in a cell containing acidified water. Apparently the conductivity of the initial silver (or silver selenium) layer is sufficient for this purpose, and soon the bulk of the silver salt is reduced to a dense metallic film.

EDWIN ROSENSTIEL

Dental School,
King's College Hospital Medical School,
(University of London),
London, S.E.5.
June 10.

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[1] Rosenstiel, E., *Dental Record*, 70, 105 (1950).

[2] Upton, P. B., *J. Electrodep. Tech. Soc.*, 22, 45 (1947)

FORTHCOMING EVENTS

Monday, July 14—Thursday, July 17

INSTITUTE OF SEAWEED RESEARCH (in the Department of Zoology, The University, Edinburgh).—International Seaweed Symposium.

Tuesday, July 15

FAUNA PRESERVATION SOCIETY (at the Zoological Society of London, Regent's Park, London, N.W.8), at 4.15 p.m.—General Meeting.

Thursday, July 17

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Symposium on "The New Anti-Malaria Drug—Daraprim" (Speakers: Brigadier J. S. K. Boyd, Dr. G. H. Hitchings, Dr. I. M. Rollo and Dr. L. G. Goodwin).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT, Grade A (with a degree in chemistry, or A.R.I.C.) IN CHEMISTRY at the Coventry Technical College—The Director of Education, Council House, Coventry (July 19).

LECTURER IN CHEMISTRY in the Chemistry and Biology Department—The Registrar, Technical College, Sunderland (July 19).

RESEARCH ASSISTANT (with a degree in physiology, biochemistry or chemistry) IN CHEMICAL PATHOLOGY—The Secretary, Bristol Royal Infirmary, Bristol 2 (July 19).

RESEARCH OFFICER (male; a good honours degree in Science essential, together with a strong horticultural or agricultural background and some aptitude in mathematics or experience in the use of statistical methods) to maintain liaison between the Statistics Section and the N.A.A.S. Experimental Horticulture Stations and Provincial Experiments Committees undertaking experiments on fruit—The Secretary, East Malling Research Station, Maidstone, Kent (July 21).

EXPERIMENTAL PHYSICIST (with an honours degree in physics or its equivalent, and a particular interest in applied electronics) in the Physiology Department—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (July 25).

LECTURER IN AGRICULTURE (with special reference to poultry husbandry)—The Secretary, The University, Edinburgh (July 26).

LECTURER IN AGRICULTURE (with knowledge of farm mechanization, including field engineering and surveying and the principles of construction of farm buildings)—The Secretary, The University, Aberdeen (July 26).

SENIOR LECTURER or READER, and a DEMONSTRATOR, IN THE DEPARTMENT OF PHARMACOLOGY—The Registrar, The University, Leeds 2 (July 28).

ASSISTANT RESEARCH OFFICER/RESEARCH OFFICER IN THE SPECTROCHEMISTRY SECTION of the National Physical Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, August 2).

EXPERIMENTAL OFFICERS at R.A.F. Signals Experimental Establishments in Bedfordshire and near London: SENIOR EXPERIMENTAL OFFICER (Ref. D.17/52A) for the development of calibration procedure for radio test equipment and preparation of calibration publications, etc.; an EXPERIMENTAL OFFICER (Ref. D.18/52A) and ASSISTANT EXPERIMENTAL OFFICERS (Ref. D.19/52A) for the calibration of transfer standards (*a*) involving frequency and pulse measurements, and maintenance of the frequency standard, (*b*) involving bridge and miscellaneous measurements, and (*c*) involving output and attenuation measurements—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No. (August 14).

ASSISTANT IN THE DEPARTMENT OF PSYCHOLOGY (qualifications in educational psychology are essential)—The Assistant Secretary of University Court, The University, Glasgow (August 15).

SENIOR LECTURER IN PHILOSOPHY at the University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

SENIOR RESEARCH OFFICER IN THE PROCESS DEVELOPMENT DIVISION of the National Chemical Research Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, August 15).

SMUTS MEMORIAL FELLOWSHIP of Cape Town for research in botanical work on the South African flora, preferably in the systematics and geographical distribution of the South African flora—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cape Town, August 15).

PROFESSOR OF PHYSIOLOGY—The Registrar, South African Native College, P.O. Fort Hare, C.P., South Africa (August 31).

CHAIR OF PHYSICS at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 18).

POSTGRADUATE SCHOLARSHIP FOR TRAINING IN INDUSTRIAL RESEARCH—The Director, Institute for Industrial Research and Standards, Glasnevin House, Ballymun Road, Dublin (October 31).

ASSISTANT LECTURER IN CIVIL ENGINEERING, a READER or LECTURER IN MINING ENGINEERING, and a RESEARCH ASSISTANT IN THE DEPARTMENT OF MINING AND FUELS—The Registrar, The University, Nottingham.

BOTANIST (woman) in the Department of Agriculture, Tanganyika, for the selection, breeding and general improvement of crops, in particular food crops such as sorghums and maize, conducted mainly at the Ilonga Experiment Station, Kilosa—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27059/323.

CHEMIST in the Ministry of Supply at Chorley, Lancs, to control inspection of (*a*) propellants, powders, explosives, also filling and assembly of associated stores including Service ammunition, rocket charges, etc., (*b*) materials and components used in filler's components and for respirators, etc., (*c*) manufacture of ammunition packing cases including control of wood preservative, and (*d*) metal plating processes—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.463/52A.

EDUCATIONAL PSYCHOLOGIST (with honours degree in psychology; training in recognized Clinic and teaching experience essential) in Child Guidance Clinic—The Medical Officer of Health, Civic Centre, Southampton

ELECTRICAL ENGINEER to the Central Waterpower Irrigation and Navigation Commission, India—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D 567/51-0-A).

GRADUATE IN CHEMISTRY, PHYSICS or ENGINEERING (for the speedy assessment and solution of current problems in industrial packaging the ability to write reports for the layman is essential)—The Printing, Packaging and Allied Trades Research Association, Randalls Road, Leatherhead, Surrey, quoting Ref. DPTO.

INVESTIGATORS (qualified metallurgists, chemists and physicists) to study various problems in the fabrication and use of non-ferrous materials—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

LECTURER IN PHYSIOLOGY—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

LECTURER IN ZOOLOGY to teach up to B.Sc. degree standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

METEOROLOGICAL ASSISTANTS in the Falkland Islands Dependencies Survey, for service either at Port Stanley or in the Antarctic Dependencies—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.28185.E.

PHYSICIST at the Ministry of Supply Chemical Defence Experimental Establishment, Porton, Wilts, to undertake research work in connexion with the application of chemical formulations for the control of pests of public and animal health and agricultural importance—The Under-Secretary of State, Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

POLLUTION INSPECTOR (with a degree in chemistry and, preferably, with experience in the treatment of polluting liquids or in the control of pollution of surface waters) in Uganda—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27106/61/52.

PRINCIPAL—The Registrar, University College of Wales, Aberystwyth.

PRINCIPAL PHYSICIST by the Division of Atomic Energy (Production) Research and Development Branch, Culcheth, Warrington, to be responsible for the research work of a physics laboratory, applying physical methods to the study of metals, and to the development of methods of control of new metallurgical processes—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 331.

SENIOR AGRICULTURAL CHEMIST, Jamaica, for general advisory and investigational work in agricultural chemistry—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27106/60.

SENIOR LECTURER IN TECHNICAL CHEMISTRY—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

SOIL CHEMISTS (Ref. 'Soil Chemist 408'), PLANT BREEDERS (Ref. 'Plant Breeder 422'), and an AGRONOMIST (Ref. 'Agronomist 411'), in the Research Division of the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting the appropriate Ref.

STAFF for experimental work in connexion with combustion and heat transfer in boilers—The Assistant Secretary, British Coal Utilization Research Association, Randalls Road, Leatherhead, Surrey, quoting Ref. A.15.

WELL SUPERINTENDENT (with at least 10 years experience in mining or well-sinking, and accustomed to the use of mechanical equipment and explosive) in the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting "Well Superintendent 1814'.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Fifth Report from the Select Committee on Estimates, Session 1951–52. The Grant in aid of Universities and Colleges. Pp. xx+70. (London: H.M. Stationery Office, 1952.) 4s. net. [75

Proceedings of the Royal Irish Academy. Vol. 54, Section A, No. 22: Rotational Structure of the (1,0), (2,1) and (3,2) Bands of the Nitrogen First Positive System. By P. K. Carroll. Pp. 369–398. 4s. 6d. Vol. 55, Section A, No. 1: Conduction of Heat in a Monatomic Gas. By J. R. Cotter. Pp. 28. 4s. 6d. (Dublin: Hodges, Figgis and Co., 1952.) [75

Proceedings of the Royal Irish Academy. Vol. 54, Section B, No. 9: The Irish Conopidae (Diptera). By Kenneth G. V. Smith. Pp. 203–208. 6d. Vol. 54, Section B, No. 10: A Note on the Influence of Temperature on the Stability of Fatty Acid Monolayers. By W. McD. Armstrong. Pp. 209–216. 1s. Vol. 54, Section B, No. 11: The *Diaptomus* Fauna of some Lakes in S.W. Ireland. By J. N. R. Grainger. Pp. 217–224. 1s. Vol. 55, Section B, No. 1: Antitubercular Substances, 8, The Antituberculai Activity of Branched-chain Fatty Compounds; Diols, Hydroxy-amines, Pyrrolidines and Piperidines. By Vincent C. Barry and Dermot Twomey. Pp. 14. 2s. (Dublin: Hodges, Figgis and Co., 1952.) [75

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NATURE

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HIGHER TECHNOLOGICAL EDUCATION

DURING the discussions on science and industry in the House of Lords on June 11 and 12, considerable attention was given to the proposal to build in Great Britain a technological institute of university standing. The speeches were noteworthy for their practical approach, and a most interesting feature was the change in emphasis on certain aspects. In view of the extent to which the scientific and academic world is divided on the issue of a technological university, the welcome which Lord Woolton's statement received in the House of Lords is impressive. Although he intimated that the Government has not decided exactly how the proposal is to be implemented, the importance of early action was uniformly stressed in the debate, as was the necessity of associating the new institution with the University Grants Committee and ensuring that it has the same freedom and independence as the universities themselves enjoy.

Lord Stamp's suggestion that the University Grants Committee is already too over-burdened to undertake such responsibilities, and that a parallel committee is required to cover technological education, did not imply dissent from this insistence on the academic independence of the new institution. He too, moreover, emphasized the distinction between higher technological education and technical education; indeed, a feature of the debate was the doubt expressed as to the possibility of technological and technical education being carried out in the same institutions, and the necessity for the production of technologists and technicians to be in balance. Lord Falmouth, for example, suggested that in some industries forty technicians are required for every high-grade technologist.

On such issues discussion is obviously handicapped until the Minister of Education makes the promised announcement of the Government's proposals for increased assistance for selected technical colleges and courses, and it appears from her answers to questions in the House of Commons on June 17 and 19 that this will not be forthcoming for a few weeks. From the second reply it appears that only the terms are then to be announced, and that it will be for the colleges themselves to apply for increased assistance. It does not follow from the wording of this reply that the selection is to be made by any one body responsible for the expansion of higher technological education as a whole, and for keeping it in balance with that of university education.

Misgivings as to whether the new proposals will result in the promised aid being spread too thinly over a large number of institutions, instead of being concentrated on four or five carefully selected having regard to national needs and resources, as was urged in this debate and elsewhere, are thus bound to persist at least until the Minister makes her statement. No doubt the observations made in this debate will be carefully noted by Lord Woolton and Lord Cherwell, who should be able to ensure that they receive due consideration when the Government makes its decision. Moreover, the debate should at least help to dispel any misgivings the universities themselves may entertain that the expansion of technological education is being conceived on narrow lines. The need for well-educated men and women was generally recognized, and there was a general agreement that technological education should develop in close association and in balance with the expansion of the universities themselves. Lord Wavell, indeed, frankly challenged the universities to strenuous thinking and perhaps adaptation of their constitutions to meet this need for maintaining a supply of scientific men able to sustain our wealth and influence in the world to-day and yet preserve all our old classical and liberal traditions of learning.

Due weight was given in this debate to the practical problems which attend the establishment of a new technological institution or the expansion of the technological departments of existing universities—the competition for staff and the availability of sufficient teaching staff of the highest calibre. The efficient use of costly equipment is another factor, as is the financing of research involving the use of such apparatus. It was appreciated, too, that the benefits of expansion accrue only slowly: Lord Hankey pointed out that although we have doubled the numbers of science graduates in the universities in five years, it will be some time before the increased numbers have their full effect.

The agreement in this debate on the importance of a wide and full education for the scientist and technologist was accompanied by a remarkable amount of support for the suggestion, which has frequently been made lately, that some reconsideration by the universities of the present distribution between science and arts faculties is required. It was argued in an article in *The Economist* of May 24 that a case appears to exist for some shift in the university population towards a greater emphasis on science and technology, at the expense of the arts. It is implicit in Sir John Cockcroft's article "Technology in the Universities" in the *Universities Quarterly* of May, in which he suggests that a further 50 per cent increase in the number of technological students is possible without upsetting the balance of the universities; Prof. R. S. Edwards reached a similar conclusion in a survey of the future of industrial research and development in Great Britain contributed to *Lloyds Bank Review* last January.

In the Lords debate, Lord Wavell in particular emphasized that by insisting on a broad training for scientific men, a programme involving a thirty per cent increase in graduates trained predominantly in science could be achieved with little or no disturbance of the balance of professors or extra laboratory space. The question is manifestly one calling for examination, and may well point the way to a solution of some of the difficulties to which the Advisory Council on Scientific Policy pointed in its recent report on man-power. It could scarcely fail to increase the supply of administrators with knowledge of science, and might also help to overcome the prejudices which at present appear to hinder some of the ablest talent in the schools turning towards a career in science. Similar views were expressed by Sir John Cockcroft in the *Universities Quarterly*. Welcoming the proposal for a new technological institution of university rank, Lord Waverley urged that it is also necessary to raise a few selected colleges of technology to university rank, and to detach them from the present system of technical education and place them under the University Grants Committee. The remaining technical colleges should be encouraged to develop their work in association with the great local industries. Sir John Cockcroft specified several colleges as suitable for development to university status, preferably in association with university departments, and he also advocated at least one really large college of technology, on the grounds that it would provide the needed increased facilities for post-graduate work. He also believed that the quality of university teaching in technology should be still further improved.

Sir John claimed that by these means the universities could make a further substantial contribution to technological education without increasing appreciably their total numbers. Besides more encouragement and funds for postgraduate research, an improvement in the numbers and status of professorial staff in some of the colleges of technology would be required; but the changes could be made at a cost which need be no more than a fraction of one per cent of our total expenditure on research and development.

Returning to the House of Lords debate, it undoubtedly reflected very fairly the trend of representative opinion on the question of technological education and its bearing on the future of Great Britain. Possibly the debate did not fully reflect the division of opinion in academic circles on one particular issue —that of the technological university—and only Lord Waverley appeared to raise the question of research at the development stage. Lord Falmouth, however, commented, as frankly as Prof. Edwards in the article referred to above, on the bearing of our present taxation policy on industrial research and development. The fact so generally recognized in the debate that the expansion and improvement of technological education in present circumstances must demand sacrifices elsewhere is the decisive reason for insisting that its development should be entrusted to some one body competent to handle it with due regard to that of the universities themselves, and of making the appropriate representations to ensure that technical education itself is kept in balance and enabled to supply the necessary numbers of technicians.

Nor is this a matter for the Government alone; whatever body, whether the University Grants Committee or the Advisory Council on Scientific Policy, is made responsible for handling it, will depend very largely on the co-operation of industry itself if the policy is to have full effect. It is not merely that, as Lord Chorley remarked in the debate, hostility to the university graduate still lingers in some sections of industry, and a major problem in reducing the discrepancy between the output per man in Britain and in the United States (which Mr. P. Hoffmann, formerly the Economic Co-operation Administrator, recently estimated as now two and a half times that of Western Europe) is to convey to the small firms generally a sense of the urgent need for a technological approach to the problems with which they are confronted. That, indeed, must be a first step before there can be any significant change in the situation in which, after allowing for the differences in the sizes of the labour forces and the population of the two countries, the United States are turning out and employing three times as many scientists and technologists as Great Britain. It should be taken while the plans for the expansion of technological education are being completed and put into operation, so that the demand is effective by the time the increased output of trained men is available.

The debate in the House of Lords gives a clear lead to the Government as to what is required and the urgency of the whole matter. Nor was the Government left in any doubt that the measures required will be costly, and that sacrifices will have to be made elsewhere in the national economy if anything effective is to be achieved. Success will not be attained by taking some of the £20 millions already allotted to the universities for the next quinquennium. On this point Lord Cherwell did not give the assurance for which Lord Falmouth had asked. None the less, the Government cannot fail to have noted the perspective in which the whole problem was placed in this debate, or the way in which it was urged that science and invention are unlikely to be harnessed as effectively as our international position demands while fiscal policy curbs so strongly pertinacity and initiative in industrial development. That the debate contributed little that is new does not make it any the less useful a stimulus to the constructive thought required on the part of Government, industry and the universities if an adequate policy for technological education and research is to be formulated and effectively implemented. The debate is also valuable for its contribution to the task of public education, which the Advisory Council on Scientific Policy has recommended as a prelude to the formation of a climate of opinion favourable to the effective utilization of science in industry.

THE AMERICAN GEOGRAPHICAL SOCIETY

Geography in the Making

The American Geographical Society, 1851–1951. By John Kirtland Wright. Pp. xxi+437+31 plates. (New York: American Geographical Society, 1952.) 5 dollars.

THE nineteenth century was a time of great voyages and striking discoveries in all parts of the world. Huge areas of Africa, Asia, America and most of the polar regions were unknown and were a lure to adventurers, prospectors, traders and colonists. The civilized world was eager for knowledge of remote and unfamiliar lands and seas. Both in Britain and the United States, wealthy men were willing to subsidize journeys that promised gain in trade and raw materials. Africa and the polar regions were special attractions to both sides of the Atlantic. The natural outcome was the grouping of these interests into geographical societies in both London and New York.

In its early days, the American Geographical Society was interested mainly in exploration, statistics and descriptions of new lands. Patrons were not wanting, and the Society grew in numbers and influence, and as quickly gave the impetus to American geography. It has had only some three directors in its life-time, and each has made marked impressions on its activities, especially the twenty years of Isaiah Bowman, who was appointed early in the First World War. Bowman tried to apply geographical thought to outstanding human problems. His was no narrow view of geography, and he was not concerned with defining and limiting its scope. One of his avowed aims was an intensified search for authors who would present geography in its diversity. He changed the *Bulletin*, the Society's publication, to the *Geographical Review*, broadened its scope and increased its originality, without reducing its value. In fact, it became one of the chief geographical publications of the day and did much to raise the value of the geographical outlook and the dignity of the subject. But Bowman did more. He started the preparation of research monographs covering a wide field, and, most ambitious of all, the Million Map of Latin America. This was in conformity with the International Million Map and covered 107 sheets. It took twenty-five years to compile the first edition, of which 61 sheets were published during Bowman's administration. The cost was close on half a million dollars.

The Society has no narrow outlook; it has adhered to a few simple leading principles, and has never accepted the doctrine that a sharp line should be drawn between geography and what is not geography, or that its interests should be confined within an academic definition of the subject. It may well claim to have raised the standard of achievement in geography in the past hundred years.

The book under notice, a heavy volume of nearly 500 pages, goes into details concerning the work of most of the officials connected with the Society. It is copiously documented, has a long list of publications and is illustrated by many portraits of officials and other geographers. It is a story of American geography as well as the life-history of the American Geographical Society [see also p. 98].

EXTENSIONS OF THERMODYNAMICS

Thermodynamics of Irreversible Processes

By Prof. S. R. de Groot. (Selected Topics in Modern Physics, 3.) Pp. xvi+242. (Amsterdam: North-Holland Publishing Co.; New York: Interscience Publishers, Inc., 1951.) 17.50 f.

THE laws of 'reversible' thermodynamics lead to relationships between the 'equilibrium' properties of substances, for example, specific heats, compressibility, coefficient of expansion, etc., such relationships following from the consideration that small disturbances of an assembly in equilibrium can, in principle, be regarded as reversible. These deductions can ultimately be justified by appeals to statistical mechanics—that is, they are consequences of the fact that a macroscopic assembly contains a very large number of atoms. It was long regarded as certain that similar relationships between transport coefficients, for example, heat conductivity, diffusivity, etc., could be found from general considerations, without the development of detailed theories for each effect.

This book discusses three distinct lines of approach to this question. Most of it is concerned with developing the consequences of the general results found by Onsager[1] in 1931, which are themselves consequences of 'microscopic reversibility' (sometimes referred to as the principle of detailed balancing). The fact that the equations of classical and quantum mechanics are symmetrical as between past and future time is shown to lead to general relations between the transport coefficients quite independent of their detailed mechanisms. Among many other results one can, in this way, give a proper derivation of Kelvin's thermoelectric relations, which, as Kelvin fully realized, cannot be deduced rigorously by the 'text-book' method of using reversible thermodynamics (because of the impossibility of finding conditions in which the irreversible effects associated with Joule heating and thermal conduction are both small).

Before the discovery of the Onsager relations, some progress in the theory of transport effects had been made along a somewhat different line. The idea was that entropy could be defined for an assembly 'not quite in equilibrium', the irreversible processes leading to a 'creation of entropy' at each point in the assembly, while the reversible processes implied a transfer of entropy from place to place. Such treatments were found to give satisfactory results for small temperature and pressure gradients, but it was not known how far they could be regarded as valid, as they must clearly break down for very large departures from equilibrium. Some indication of the limits of validity of such theories had become very desirable. For gases a quantitative answer has been found by Prigogine, by comparing the results of this 'extended thermodynamics' with those of the Chapman–Enskog kinetic theory—the conclusion being that the two theories agree as far as the second approximation of the latter theory, but that the expected breakdown of 'extended thermodynamics' occurs for cases where the third approximation is significant. The book should serve a useful purpose in directing attention to this interesting work, but a fuller discussion would have been welcome.

A third line of approach is the study of 'stationary states', typified by the flow of a gas through a nozzle or throttle-valve, the pressures and temperatures remaining steady at both ends. The text-book treatments of the Joule–Thomson effect and the 'wire-drawing' of steam illustrate how one can make quantitative deductions about such 'open' assemblies, again granted the possibility of defining entropy. The study of such 'open' assemblies is likely to be of very great importance in biological problems.

A typical biological process is the conversion of carbon dioxide and water into carbohydrates with the aid of sunlight. One may think of the living cells as being supplied steadily with raw material and energy, the products (for example, carbohydrates and oxygen) being carried away at an equivalent rate. Such an assembly is entirely different from the 'closed' assembly normally considered in classical thermodynamics, and it is only gradually coming to be realized that quantitative deductions about such an 'open' assembly can be made without detailed knowledge of the very complex chemical reactions which take place in it. It is a pity that the biological aspect of 'open' assemblies does not receive more attention in the book. (It gets less than a page.)

The book is very nicely printed and has only a very occasional error of spelling or grammar. The index, bibliography and list of symbols have obviously been prepared with very great care, though there is sometimes difficulty in tracing the reference relevant to a specific point in the text. The author implies that he found it impracticable to give 'foot-note' references. I feel that a disproportionate amount of space has been given to the Onsager relations, important though these are, and that more might have been devoted to the other two topics. In a future edition, it might also be worth including a discussion of the paradox that macroscopically irreversible effects do occur, even though the basic processes are microscopically reversible. This matter has been satisfactorily dealt with in a number of published papers, but the time seems ripe for dealing with it in a book.

This book is likely to remain a standard work of reference for some time to come.

H. N. V. TEMPERLEY

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[1] Onsager, L., *Phys. Rev.*, 37, 405, and 38, 2265 (1931).

RECENT PROGRESS IN PHYSICS

Reports on Progress in Physics

Vol. 14 (1951). Pp. iv+412. (London: Physical Society, 1951.) 50*s*. net; to Fellows, 27*s*. 6*d*. net.

VOL. 14 of the "Reports on Progress in Physics" contains eleven articles, four of which deal with optics, three with nuclear physics, two with meteorology, one with microwave spectroscopy and one with the application of nuclear physics in medicine. The emphasis is on recent advances in the various subjects; but, as is customary in the "Reports", a mere listing of the subject-matter of recent research papers is carefully avoided. Each report is a model monograph, and enough background material is introduced to lead the reader by stages to an appreciation of the new advances or of the present established position of the particular branch of physics discussed.

In optics, a brief but important article by W. C. Price on recent advances in ultra-violet absorption spectroscopy deals with the development of new detectors, new sources and improved types of instrument, and, on the theoretical side, with the interpretation of ultra-violet spectra. Though the presence of an emission spectrum of the night sky has been known for a long time, it is only recently, and particularly since the end of the Second World War, with the introduction of improved instruments, that progress has been made in the investigation of the spectrum of the airglow and the aurora. This topic is the subject of a report by A. B. Meinel, of the Yerkes Observatory, University of Chicago. It is interesting to note that some progress has been made in assigning a height to each emission, a matter of some importance in the study of the physics of the upper atmosphere.

The optical properties of thin films, interference filters, the interferometric study of surface structures, Fabry–Perot étalons, interference refractometers and interference microscopes, form the main topics of discussion in the comprehensive report by H. Kuhn on new techniques in optical interferometry. The recent important advances and applications of this branch of physics, as exemplified by the work of Prof. S. Tolansky and others, need no emphasis; but Kuhn's survey, together with his references to new light sources and interferometric methods suitable for measurement of standards of length, is to be commended.

Finally, in this series of reports on optical phenomena, a historical survey of the diffraction theory of aberrations is given by E. Wolf, in which are traced the development of the subject from the early researches of Airy on an aberration-free image and the important advances made since 1940. This is the first article on the diffraction theory of aberrations to be published in the "Reports". However, as the theory is concerned with the study of images formed by actual optical instruments, it is of considerable practical, in addition to theoretical, importance and well merits a detailed report.

The selection of subjects to be included each year under the heading of nuclear physics must be very difficult, for the volume of literature on this branch of physics continues to be extremely large. For Vol. 14, angular correlations in nuclear reactions, nuclear interactions of cosmic rays, and nuclear effects in atomic spectra are chosen for individual reports. As in several other branches of physics, there is scarcely a problem in experimental nuclear physics the solution of which does not involve the measurement of an angle, and in his article on angular correlations M. Deutsch deals with the basic physical processes, experimental techniques and results of many experiments designed to study properties of nuclear energy states. The detailed and informative report which follows, by G. D. Rochester and W. G. V. Rosser on types of nuclear interaction, the properties of nuclear interacting particles and the correlation of nuclear events in the atmosphere and in condensed matter, is best summarized by quoting from the conclusion: "The general picture which emerges is one of rapid progress in the accumulation of empirical facts but little advance in our fundamental theoretical concepts. . . . Much remains then to be done, but the prospects are exciting. If the progress of the past few years can be maintained the coming years will see further rapid advances in this field of research and a solution of many of the problems which still baffle the nuclear physicist". The report by E. W. Foster on nuclear effects in atomic spectra is concerned mainly with results of optical investigations of hyperfine structure, particularly of isotope structure, and a description is given of recent work on the nuclear mass effect in helium. The subjects discussed are all receiving considerable attention by research workers at present, and it is interesting to read that the author considers that the appearance of improved experimental data and theoretical treatment is imminent.

The microphysics of clouds, by B. J. Mason and F. H. Ludlam, and a critical survey by N. C. Gerson of ionospheric temperatures are the two reports dealing with meteorology. In the first, microphysical processes—condensation, droplet growth, ice crystal formation, etc.—are mainly considered, and the results of recent experiments on the supercooling and freezing of water and on the behaviour of ice-forming nuclei are examined. The possibilities and limitations of methods of producing rain by artificial stimulation, a subject of general interest, are briefly discussed. The second report is a critical review of the relations which have been proposed between temperature and the various ionospheric parameters and of the methods for determining temperatures at altitudes of 100–400 km. The author concludes that there are considerable deficiencies in current knowledge, and meteorologists and physicists will be interested to read what these are and how they may be overcome.

The remaining two reports in Vol. 14 are perhaps the most appealing, one—anomalous fine structure of hydrogen and singly ionized helium, by W. E. Lamb—because it deals with microwave spectroscopy, a subject still in its infancy, and the other, some applications of nuclear physics in medicine, by W. V. Mayneord, because of its wider interest. In the former, not only is a clear and concise description given of the work, both experimental and theoretical, of Lamb, Rutherford and Skinner in which microwave methods are used to establish deviations from the Dirac theory of the fine structure, but also a brief review is made of the status of the theory prior to 1947 so that the non-specialist in this field may fully appreciate the problem that has to be tackled.

Vol. 14, like its immediate predecessor, is under the general supervision of the Papers Committee of the Physical Society, and the Committee, together with the executive editor, Dr. A. C. Stickland, are to be congratulated for the excellence of their publication. The criticism, made in the review of Vol. 13, of the absence of abstracts to reports does not now apply to Vol. 14, all the reports in which have useful contents lists and abstracts. S. Weintroub

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PARASITISM AND SYMBIOSIS

Parasitism and Symbiosis

By Maurice Caullery. Translated by Dr. Averil M. Lysaght. (Textbooks of Animal Biology.) Pp. xii+340. (London: Sidgwick and Jackson, Ltd., 1952.) 35*s*. net.

THE second French edition of this book was reviewed in *Nature* (167, 495; 1951), and in that review the hope was expressed that it might be translated into English, a request for which had prompted Prof. M. Caullery to revise his book. The English edition is now available in the shape of this attractive and well-printed book, and the translator, Dr. Averil M. Lysaght, has done her work so well that everyone interested in this fascinating subject will be grateful to her for the care she has bestowed upon it.

The outstanding feature of the book is its synoptic, biological view of the two ways of life with which the work is chiefly concerned. The first three chapters deal with commensalism and with the transitions between this and inquinilism and parasitism. Seven chapters on parasitism follow, and the book concludes with three chapters on symbiosis. It is difficult to say which of these three sections is the most interesting. The author finds no natural distinction between commensalism, parasitism and symbiosis, and considers that these are "only categories created by us", which cannot, once they have been analysed, be delimited. "Under varied aspects they are only manifestations of the struggle for life." Those associations which have permitted the existence and perpetuation of the associated organisms have survived. Many other associations must have arisen, but have not been able to persist. The variety of structural and physiological changes shown by the successful associations are described in considerable detail, and many complex problems requiring further study by modern methods are indicated.

In parasitism these problems are numerous and intricate. This book leaves many of them out, because it purposely omits discussion of bacteriology and the important problems of immunity, which are discussed in other works. An adequate discussion of these aspects of parasitology would, indeed, have been impossible in a book of this size and would have defeated the author's admirable purposes. In symbiosis the problems requiring investigation are, in some respects, even more interesting. The pages of the book that deal with symbiotic organisms associated with insects—for example, with the possible part played by photogenic bacteria in the production of luminescence and with symbiosis among plants—provide fascinating material for extensions of research designed to settle the controversies discussed.

I have not noticed any misprints and only one important error has been noted, namely, the statement on p. 189 that the warble fly penetrates the host "under the same conditions as" the bot fly. This error dies hard. It has been clearly shown that the warble fly larva penetrates the skin of cattle and does not enter through the mouth, as do the larvæ of the bot fly.

A word about the bibliography is necessary. This, the author explains, is not meant to be comprehensive and, indeed, it could, in a book of this size, scarcely be so. The list of 598 references, to which the translator has added nine more, refers to work cited in the book, and this part of the bibliography is valuable. Two other brief sections of it, however, refer to general works and to special periodicals. Both refer chiefly to parasitology, and neither gives an adequate idea of modern parasitological literature. Of the nine general works cited, seven refer to parasites and, with one exception, they were all published in or before 1936. Of the meagre list of special periodicals, eight of the nine given deal with parasites, and many important parasitological journals are omitted. No one would expect a book of this kind to give a comprehensive list of works on parasitology, but, if any list at all is given, the reader is entitled to a modern and representative one.

The book is not, however, injured by this bibliographical fault. Its distinctive merit is its comparative study of parasitism, commensalism and symbiosis, and all students of these modes of life will read it with pleasure and profit.

G. Lapage

TEMPORARY REVERSAL ON BIFROST

The Bridge of Life

From Reality to Mystery. By Dr. Augusto Pi Suñer. Pp. vii+270. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1951.) 28*s*. 6*d*. net.

THE only bridge remotely resembling the one with which Dr. A. Pi Suñer is concerned, and like it mythical, is Bifrost. When last seen, the old Gods were moving steadily along it—out of the world and into Valhalla. This has led most men of science to assume that the process would continue and that the advance of knowledge would automatically restrict the area in which the gods could operate. We have preferred not to discuss whether Nature would ever be totally comprehensible, or indeed whether such a phrase can have any meaning, but have assumed that in our limited fields the gods were in retreat and materialist interpretations were extending.

This complacent attitude suffers jolts from time to time. There is a certain regularity in the process. As a new field of knowledge begins to be co-ordinated, some mystically minded pseudo-scientist thinks of a phenomenon in the middle distance and announces "You have explained so-and-so but you will never explain this". In this book the warnings are issued about instincts, consciousness and a curious mixture of life and time that obtrudes itself here and there. These are referred to as irreducible, and about them it is asserted that science cannot, and never will, tell us anything.

The best part of the book is a survey of various odd pieces of behaviour in animals and odd associations between them. This is interesting and lucid; but the choice of authorities is capricious. It is surprising to find Kipling's "Jungle Book" among them. The treatment of inheritance deals sympathetically with Lamarck and Lysenko; but on the basis of the rather dubious experimentation that held the stage in the 1930 period of this perennial wrangle rather than on the basis of more recent bacteriological evidence. There is some interesting backhanded Marxism in a section here in which the views of Cuvier and Linnæus are associated with their respective modes of acquiring titles. But much of this section is sketchy; it is a series of hints to the expert and confusions to the lay reader.

An examination of the borderland between two accepted and well-established disciplines—for example, between biology and chemistry—is always profitable if made by an expert, and even when it is made normally it is sometimes profitable. But an examination of all the borderlands at once needs more justification. *A priori* it is not likely that the same man could contribute usefully to each periphery. Experience with this book confirms the *a priori* judgment: not only does Dr. Pi Suñer meditate on most of the edges that exist, but he also considers some in which there seems to be little promise. There is, for example, a discussion about the biological significance of the probable use in the solar energy cycle of the biologically important elements hydrogen, carbon, nitrogen and oxygen.

It would be charitable to assume that some of the confusion is due to the translator, for the author has not been too well served by him. There are many infelicities of phrase and some scientific words are given wrong, or at any rate unusual, translations. But most of the fault lies with the author: he pays lip service to the scientific method and comments adversely on vitalism, metaphysics and "word-spinning"; but when the far side of his own medical speciality appears, we find as usual the ugly head of an ineluctible, irreducible god. Dr. Pi Suñer is not building a new bridge, he is simply repairing Bifrost and urging some of the gods to creep back. He may be successful in this, for irrationalism is now rife and books that encourage awe rather than curiosity spread it. We are given a medley of information and many quotations from the writings of the eminent; but the material is not arranged so as to bring out any clear principle. Instead, arbitrary assertions of inexplicability are made about some, at present unexplained, phenomena, and even these are not put very clearly. Such lack of clarity suggests that we may get warning of the return of the gods; the rout will be led by Loki, whose speciality was confusion.

N. W. Pirie

METHANE AND COAL*

By Sir ALFRED EGERTON, F.R.S.

COAL is the main stored source of the energy supplies of the world; every twenty years the world burns a volume of coal equivalent to the volume of Snowdon (a cone of base 8 km. by 1·1 km.). Coals were formed from ancient forests, mainly in the carboniferous era, about 250 million years ago, and the era lasted 30 million years or so. Some of the sources of coal are of later origin, and some is no doubt being formed now from decaying forests and swamps. Coals of all ranks—high and low rank—have a common generic relationship, as shown by the well-known curve of properties, such as the percentages of oxygen and of carbon falling within a fairly narrow band. In the main, coals are derived from the lignins and celluloses of plant debris and still retain some of the original structure of their vegetable origin. They are different chiefly because of the different pressure and temperature to which the material has been exposed; the higher-rank coals, in general, have been subject to higher tectonic pressure.

The Coal Survey has been providing a valuable examination of the coal deposits in Great Britain. Although there have been tremendous upheavals, displacements and folding of strata, the higher-rank coals have their origin in the central regions of the several coal-fields, and the coals of descending rank towards the periphery of the whole area or basin, in which coalification has occurred. Some ascribe this entirely to the effect of the pressure of the overburden, but, from investigations of German coal deposits, it appears that a fairly steep temperature-gradient may also be an important factor. Rock folding is consequent on great depths of sedimentary material, and high tectonic pressures and temperatures and disturbance of the seams result. There has also been modification by igneous intrusion in various regions.

It is dangerous to generalize on these matters; but it seems that study of the further coalification of low-rank material by submitting it to high pressure at various temperatures, carrying forward the work of Berl, Petrascheck, Bode and others, might give further information on what has occurred in past ages. The constitution of coals has been tackled mainly from the other direction—analytically, by looking at their structure or treating them with reagents. These methods, along with X-ray studies, seem to show that, in the bituminous range, coal has a structure of interleaved or randomly oriented layer planes of hexagonally arranged carbon atoms within which lies a still more jumbled, more complex structure with oxygen, sulphur and nitrogen atoms forming some of the links between the ordered carbon structure. These structures seem to provide sub-units of particles ten times larger (about 3×10^{-6} cm. diameter). This picture of coal, composed largely of colloidal particles, as suggested by the late Dr. Bangham of the British Coal Utilisation Research Association, with a very fine pore structure between the particles, fits reasonably with the pore size deduced from the density and from the measured internal accessible surface-area (about 100 sq. m./gm.) obtained both by heat of wetting with liquid methyl alcohol and by adsorption at 25° C. of the vapours of methyl alcohol, *n*-hexane, etc. The internal surface measured by adsorption of nitrogen at low temperatures (about − 200° C.) has given values about twenty times smaller, indicating that the pores are of larger average diameter and implying that the coals should be more porous to gases than they are found to be. The discrepancy between these two methods of measuring the internal surface is one of the most interesting results of recent research at the laboratories of the British Coal Utilisation Research Association and in South Africa and elsewhere, for with the clearing up of a discrepancy new knowledge is always obtained. (The porosity of coals depends, of course, on the nature of the coal and is not directly related to rank; there is in general a minimum for coals of about 89 per cent carbon.)

Dr. Ivon Graham has shown that a certain dried coal dust can absorb about twenty times its own volume of methane at 10 atmospheres; but he also showed that methane absorbed under pressure in a small block of coal is locked inside and can only leak out through the fine pores very slowly; with anthracites, even when finely crushed, the gas leaks out quite slowly from the fine particles. Graham endeavoured to measure the pressure of the methane locked in the pores of the samples of coal taken from the coal face, and the highest figure he got was a little more than 7 atmospheres. Lindsay Wood (1880) obtained the highest figure recorded (34 atmospheres) for the Bensham seam at 1,270 ft. At 1,000 ft. depth, however, earth pressures would still be about twice as great. Graham's measurements of the amount of gas liberated when small lumps of coal are finely crushed showed that 200–600 c.c. are released per 100 gm. for different samples, depending on the type of the coal. On the average, it would not be more than about ten times the volume of the coal—considerably less than 1 per cent by weight. This work tells something about the origin of firedamp. Some of it is gas from the pores of the coal when it is crushed in the process of mining, but probably the greater part is methane which has got locked up under pressure during the formation of the coal in breaks in the underground coal and rock structure, and is released when the coal is disturbed. Work has been done by Russian workers with the view of ascertaining how much methane could be stored in the coal substance at the high earth pressures at which coalification processes take place.

Where does the methane come from? The peat-forming stages of decay of vegetable debris involve aerobic disintegration by action of micro-organisms and fungi. The biochemical process may cease with only partial decomposition of the woody substances or may proceed to more complete digestion of the plant material, providing a jellified mass. The process sooner or later smothers itself and becomes anaerobic, and the product becomes consolidated and dehydrated' under its own burden. Gases such as methane and carbon dioxide can still escape; but before long they may become imprisoned by the overlying strata. From this stage down, biochemical reactions diminish; but the product is gradually further dehydrated, devolatilized and compacted, in fact coalified and matured under increasing pressure and temperature. (It is rash to mention a temperature; it is probably generally somewhere between 100° and 150° C. and only in exceptional circumstances rises higher than 200° C.) The degradation of the original plant celluloses and lignins in the production of bituminous coal would involve the removal of nearly twice the mass as gaseous products (methane and carbon dioxide) and water, and some have supposed that a quarter of the mass of the coal would have appeared as methane. The late Prof. Briggs and Prof. Hickling have written most interestingly on the subject. In the production of bituminous coal some suppose that dehydroxylation occurs and carbon dioxide and water are eliminated, but others are puzzled that methane as well as carbon dioxide is found. The anthracitization of bituminous coals, however, certainly seems to require the production of about 10 per cent of the mass of the coal as methane, as the carbon/hydrogen ratio has to increase and there is not enough oxygen to account for removal of hydrogen by water alone. Nevertheless, the amount of methane found associated with coal in mines is on the average only about 1 per cent of the mass of the coal.

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* Based on the first Coal Science Lecture of the British Coal Utilisation Research Association, delivered on May 7 at the Royal Society.

What becomes of the rest of it? Leaving this rather intriguing question, to consider the occurrence of methane in the coal measures again. The pressure of the methane in the pores of the coal, supposing it were the only gas formed in the later stages of coalification at high pressure, would be at the pressure corresponding to the depth of the seam. There is, in fact, a tendency for higher gas emission in seams of high-rank coals and at greater depths. Dr. Ivon Graham's experiments showed, however, that the pressure of the methane in the coal is very much lower than corresponds to its depth, and very different in different coals; this is no doubt partly due to difficulties connected with getting true samples of the coal, but it is presumably mainly due to the gradual diffusion and escape of part of the gas. Furthermore, the coal is often removed (by geological displacement) to regions at much lower pressure than the depth at which it was formed. In some places where there are porous deposits above the coal, the gas can gradually diffuse out of the coal and soak away; in other places where this occurs, the gas collects in a porous region which is sealed by impervious rock and, if then a boring is made into this porous region or into faulting, the methane which has collected will be released under its own pressure. There are apparently not many coal areas in Britain where this occurs. The well-known Point of Ayr Colliery in Flintshire yields free gas (250–650 cu. ft./min., 98 per cent methane) at considerable pressure (up to 20 atmospheres); there are other 'blowers' in Staffordshire and elsewhere.

The many disasters from firedamp explosions in mines and the measurements of the limits of inflammability eventually led to legislation to keep ventilation of the mines well below the limiting concentration for danger. (Men are withdrawn if the concentration exceeds 2·5 per cent and electric current is cut off at 1·5 per cent.) On the average, about 6 tons of air is pumped through the galleries for every ton of coal mined and the methane in the out-going air is seldom as high as 1 per cent. If the average were even as low as 0·25 per cent, the recovery of the energy in the methane which is at present wasted would be equivalent to 3 or 4 million tons of coal a year, and it is well worth an effort to save as much of it as possible. There are two main possibilities, either to drain off the methane before it gets into the ventilation air, or to utilize the energy of the methane in the ventilation air, without trying to separate it. The first of these two possibilities has recently come into prominence.

Drainage of Methane at Coal Mines

As this 'drainage method' has been described fully in several recent reports and papers, only brief reference is necessary. In the Ruhr, the Saar and in Belgium, methane is now being drawn off by a system of bore-holes in suitable places. Several systems have been developed, the cross-measure hole method being most in favour. This method is being applied in about twelve British pits. The amount of methane drawn off appears to depend on the movement of the coal caused by the mining operations; disturbance of the coal causes disturbance elsewhere, increased permeability of the coal seam and flow of the methane along bedding planes to regions of lower pressure, and subsequent release into the galleries, unless caught on the way. The percentage of methane which is piped off from the boreholes is generally fairly high, up to 90 per cent of that which would otherwise find its way out. A drop of 50 per cent or better in the methane content of the ventilation air can therefore result. The old-established drainage system at the Point of Ayr Colliery is in a different category, for there the gas is stored at high pressures in faults, and it is essential to give it vent before working the coal. In Belgium, the mines are linked by pipelines, and a supply of 3½ million cu. ft. per day is maintained and is converted by cracking to a sulphur-free towns gas. In Germany, the gas is being compressed and used for motor transport. The object in view is increased safety in the mines, while obtaining a valuable product as a raw material for providing energy (power for the mines, or for heating of coke ovens, or as a raw product for other chemicals, synthesis gas, acetylene, etc.). Whether 'drainage' is worth while is very much a question of economics, setting the outgoings against the incomings, and each scheme has to be considered on its merits and in relation to local circumstances. According to report, it has been found that the value of the gas drained has generally more than paid for the installation and operating costs.

Utilization of the Energy of Firedamp in Ventilation Air

The main subject of this article is concerned with the second of the possibilities, namely, the direct utilization of the energy of the methane in the ventilation air. Dr. Roxbee Cox, chief scientist at the Ministry of Fuel and Power, has described in an admirable Hawksley Lecture to the Institution of Mechanical Engineers last year the projects which are in hand for the development of gas turbines for industrial purposes. One of the projects is one which has been suggested by C. H. Secord, of the Ministry:

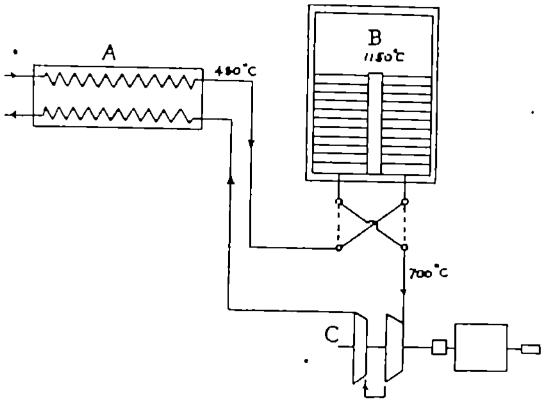

Fig. 1

if the waste methane in the ventilating upcast air from the coal mines could be burnt, the energy released could be converted by a gas turbine into sufficient useful work to provide a large part of the power needed in the collieries. Can such a small proportion of methane (about 0·5 per cent) be burnt ? Knowing that methane can be oxidized well below the limiting mixture strength needed for flame, the suggestion seemed to me worth pursuing, and a few preliminary experiments were made (early in 1949) which showed that fairly rapid combustion could be got in the region of 700–900° C. R. G. Voysey, a member of Dr. Roxbee Cox's staff, thereupon produced a scheme, and Fig. 1 shows the general principle : *A* is a preheater exchanging heat between ingoing and outgoing gases, *B* is a regenerator-exchanger or 'booster', in which the gases are maintained at the temperature necessary for reaction, and *C* is the turbine.

If the temperature rise caused by the combustion of about 1 per cent of methane is 250° C., and 900° C. is the temperature to which it has to be raised for rapid ignition, then, supposing that it enters at 450° C., it will have to pick up 450° C. from the booster, the temperature will rise to 1,150° C. on ignition, and after giving up heat to the other leg of the booster it will drop 450° C. and go to the turbine at 700° C. The valves of the booster are changed over at appropriate intervals to keep the process going. It is very necessary that the combustion should be rapid, otherwise the exchanger booster will be large and costly.

The booster, largely designed by P. D. Edmundson, of the Ministry of Fuel and Power, and constructed by the Incandescent Heat Co., has already undergone successful trials. The engineers, in designing the booster, needed to know how the methane would burn in it. The velocity of the air stream would be about 200 ft./sec. (65 m./sec.), and the residence time in the hot zone might therefore be only a few milliseconds. At what temperature would the combustion start in such circumstances ? Would it be completed quickly when started ? Could it be burnt at a lower temperature by addition of special vapours or by change of surface conditions ? How would the combustion be influenced by other combustibles ? These were some of the questions investigated by A. D. Meads and later by H. Hirsch, under Dr. J. H. Burgoyne's supervision, in the laboratory of the Department of Chemical Engineering and Applied Chemistry of the Imperial College of Science and Technology, London.

Investigation of the Combustion of Weak Mixtures of Methane and Air

It was decided to fix on a rate of flow (0·126 cu. ft./min. at 20° C.) and size of refractory tube ('Mullite' 3/16 in. internal diameter) which would correspond approximately with the expected flow-rates and surface/volume ratio assumed for the preliminary design of the booster matrix. The effect of change of composition and of pressure on the temperature for rapid combustion and on the duration of the reaction was studied. The methane and air could either be preheated separately or after mixing. It was established in the preliminary work that the reaction was taking place homogeneously in the gas phase, starting not at the surface but between the boundary layer and the fast-moving core, and that the mixing of the two separate streams was very rapid and occurred well within 1 cm. of admission (0·4 m.sec.). Most of the work thereafter has been done by heating the methane and air separately, and bringing them directly into the reaction space.

The 'Mullite' tube was about 1 m. long ; the length of the reaction space (less than 10 cm.) could be changed by pushing in the closely fitting exit tube. The furnace was specially contrived to provide even heating, and the temperatures were measured by a suction pyrometer in an identical tube alongside, through which passed the same flow of air without methane. The changes of percentage of methane and of carbon monoxide have been measured by infra-red analysers, which have made it possible to study these fast reactions. The following figures show the temperatures which are needed to cause 95 per cent combustion of a 1 per cent methane/air mixture :

Length of reaction space	Residence time at inlet after mixing	Temperature of gases at inlet
6·5 cm.	3·8 m sec.	1,020° C
4·5	2·4	1,041
1·5	0·3	1,076

All the temperatures referred to are the temperatures of the preheated gases entering the reaction space (and therefore no correction is needed for rise in temperature due to reaction). In 4·5 cm. only 10 per cent is burnt at 1,020° C., so that in the next 2 cm. the combustion, when once started, is all over in about 1 m.sec. There is a delay of nearly 2¼ m.sec. before any appreciable reaction happens. This is fundamentally interesting, in relation to some other experiments on flame propagation. In a flame, gases are heated to the temperature at which they inflame. In these experiments they are preheated until they react rapidly, and that is just what is happening in a flame front.

If gases are passed through a burner in which the gas stream is divided into a number of small channels, in each of which there is stream-line flow on emergence, the streams have a velocity distribution which is the same across the burner. One gets a flat flame[1]. In order to maintain the flame, the gases must be heated up to the temperature of inflammation (that is, the temperature of the lower boundary of the surface of the flame), which for a weak methane/air mixture is about 1,200° C. The distance in which the heating can occur is about 0·03 cm., because at that distance from the flame-front the gases are still too cold to react rapidly. They are moving at about 6 cm./sec. (at 20° C.), so they have less than 2 m.sec. in which to react and reach a temperature of 1,200° C. If when they are already at 1,000° C. according to the 'Mullite' tube experiments, they seem to need 2–3 m.sec. to ignite, it scarcely seems likely that the time available in the flat flame would be sufficient to inflame the gas at the flame boundary. In making that statement, it is assumed that the gases depend for their ignition on heat generated by pre-reactions set up by heat conducted from the flame. It is therefore believed that something else is happening in the gases before they reach the flame front. It is thought these experiments support the view that radicals (probably hydrogen atoms) streaming back from the flame, besides the heat of the flame, are necessary to start the reactions and maintain a flame in existence. Experiments carried out by B. C. Mullins at the laboratories of the National Gas Turbine Establishment on ignition of methane in fast streams of gas indicate even longer ignition-delays at 1,000° C. than those obtained at the Imperial College. I have mentioned this offshoot of the work because it illustrates how study of a technical problem can lead to results of importance in purely academic studies, in this case on the problem: How does a flame maintain itself?

To return to the oxidation of methane, it has been found at the Imperial College that: (1) the effect of pressure up to $2\frac{1}{2}$ atmospheres only slightly decreases the temperature of combustion; but oxygen enrichment decreases it quite considerably; (2) the weaker the mixture (down to 0·5 per cent), the lower the temperature for rapid combustion; methane therefore appears to inhibit its own ignition at these high temperatures; (3) that 0·125 per cent of hydrocarbons and hydrogen lower the ignition temperature quite appreciably but only in proportion to their contribution to the total heat content of the mixture in burning to carbon monoxide.

Does the methane burn at once completely? It was important to know the answer to this question, for, if it is only partly burnt, the full available energy cannot be converted in the turbine. With constant residence time (4–5 m.sec.), the 1 per cent methane burns more and more completely as the temperature rises, until at 1,020° C. it has been completely burnt. Carbon monoxide is formed by the combustion of the methane; its combustion is inhibited by the methane, and it only begins to burn after practically all the methane is burnt. The carbon monoxide, however, does not burn completely in the time available unless the temperature is raised to 1,050° C. These results show that the combustion of methane is not a single but a dual process, being composed of two separate processes of different rate: the combustion to carbon monoxide; and the subsequent combustion of the carbon monoxide, the second being inhibited by the first. Fig. 2 shows how marked is this effect. 1 per cent of carbon monoxide (moist) would burn rapidly at 777° C., but with 1 per cent methane it will not burn until the temperature is raised a further 200°, and then only when the methane has been burnt. It is obvious there is some radical essential to the combustion of carbon monoxide which is destroyed by a hydrocarbon, like methane.

This effect has been noted by others in mixtures of much higher concentration in the region of ignition limits at lower temperatures. During the Second World War, the flaming of exhaust from aircraft at night had to be reduced. It was found that hydrocarbons (lubricating oil, for example) injected into the exhaust helped to prevent the blue glow due to combustion of residual carbon monoxide when the hot exhaust-gas discharges into the air. R. R. Baldwin[2] has shown that the combustion of hydrogen, as well as carbon monoxide (moist), is inhibited by hydrocarbons to an extent dependent on the oxygen concentration. He has suggested that the hydrocarbon removes hydrogen atoms, since these alone react with oxygen in the hydrogen–oxygen reaction. He assumes that these hydrogen atoms react with hydrocarbon and give rise to a hydrocarbon radical, which is afterwards destroyed. This explanation, however, does not seem to fit with the self-inhibition of the oxidation of methane.

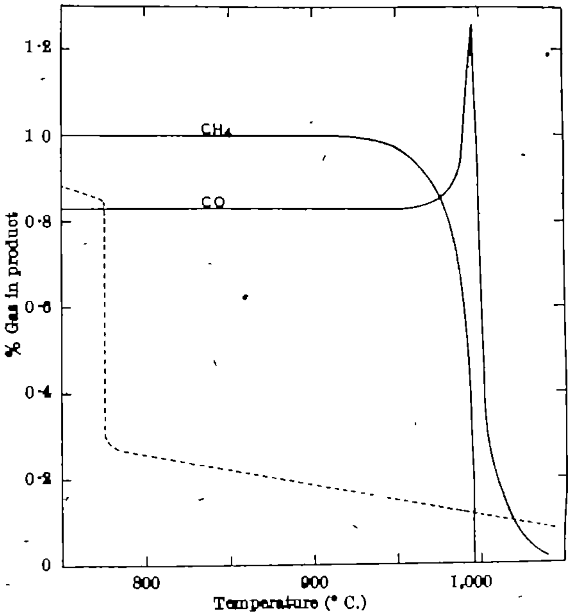

Fig. 2

It is not at all certain yet what is precisely happening in any kinetic gas reaction; even in the case of hydrogen and oxygen, new phenomena turn up which have to be accounted for by new suppositions. D. R. Warren has suggested that ozone is the only likely common constituent of all oxidation reactions, and yet his own discovery of the effect of boric acid on the second ignition limit of hydrogen–oxygen seems to rule out at once any explanation of the hydrogen–oxygen reaction in terms of ozone as a chain carrier. Nevertheless, the dry carbon monoxide reaction seems to demand ozone as a chain carrier, and it is interesting that in these methane weak-mixture reactions ozone is certainly formed at an early stage. These experiments on the oxidation of weak mixtures of methane have yet to yield their full fruit. In this connexion, G. J. Minkoff and A. J. Everett have found that, in spark-ignited mixtures of methane and oxygen cooled in liquid air at low pressures, the flame is remarkably rapid and is attended by a glow lasting several milliseconds, and that considerable amounts of ozone and hydrogen peroxide are chilled out on to the walls of the tube; methyl hydrogen peroxide is also detected, but no formaldehyde. These various lines of work are converging to provide quite considerable information about these rapid chain reactions which control the propagation of flames.

There are now two ways open for the utilization of the mines gas—either by drainage, or by the direct combustion of the methane in the ventilating air. Which is the better way will depend on local circumstances and many other different considerations. They are not mutually incompatible. The drainage method only removes part of the methane that would otherwise find its way into the ventilating air. If, for safety reasons, methane drainage were necessary, it might still be thought worth while, instead of burning the methane under boilers or in diesel engines, to burn it in a combustion chamber along with the ventilating air containing the rest of the methane and gain the power by gas turbine. But having separated methane at high percentage, it seems a pity to burn it; it should be used so as to obtain its value as a high-grade fuel.

Methane as a Fuel for Internal-Combustion Engines

Methane is an excellent fuel for spark-ignition engines. M. Pearce had shown that the same engine on methane with spark ignition at 14 : 1 compression ratio gave 34 per cent more power than when running as a diesel engine on oil. This is because of the high knock-rating (highest useful compression ratio 16 : 1) of methane. N. P. W. Moore and W. T. Lyn have been studying the behaviour of methane in a motor engine at high pressure and have shown that a pale-blue flame precedes at a somewhat lower pressure the white flame of the true ignition. Again, this is perhaps evidence of the dual nature of the combustion.

Attention is directed to the behaviour of methane in engines not only because of its special interest in relation to the problems of combustion, not only to show again how all these different aspects of the combustion of methane interconnect, but also to suggest that its special value as a fuel for internal-combustion engines should not be neglected. Methane obtained by the drainage method in the Ruhr district is being compressed and utilized for motor transport, and this may well be one of the most profitable ways of using it, rather than using it for heating coke ovens or passing it into gas mains after suitable reforming.

Liquid Methane

For many years we have been interested in the possibilities of methane in the liquid state (b.p. − 161° C.). The late Lord Cadman directed my attention to the enormous volumes of methane which went to waste in the Persian oil-fields. I suggested at the time that it might be liquified and shipped as liquid, and transported like liquid oxygen. This half-crazy idea developed into a less crazy scheme to store gas for domestic use as methane; the storage capacity for the liquid for the same thermal energy would be about a thousand times less than that for the gas. Another idea, that it might be used as a liquid for motor transport, was fully investigated in the Imperial College during the Second World War; and it was shown to be a possible substitute for petrol. The carbon content of coal could be more easily converted to methane than to oil, so that possible supplies of a fuel alternative to petrol were great. Omnibuses were run for about 25,000 miles in the public service on liquid methane in special vacuum-jacketed tanks, which were developed for the purpose. When petrol became available again, the interest flagged; but it is possible that it might revive with methane drainage, or possibly when a store of gas is required to meet special loads. The section at the Imperial College for research on low-temperature technology arose out of our interest in these technical problems relating to the use of methane.

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[1] Egerton and Thabet, *Proc. Roy. Soc.*, A, 211, 445 (1952).

[2] Baldwin, R. R., Corney, N. S., and Precious, R. M., *Nature*, 169, 201 (1952); cf. also Naylor and Wheeler, *J. Chem. Soc.*, 2456 (1931).

BIRD CONSERVATION IN EUROPE

THE Fifth Conference of the European Continental Section of the International Committee for Bird Preservation was held in Bologna, Italy, during May 14–16 under the chairmanship of Dr. Boje Benzon (Denmark). The meeting was attended by delegates of the national sections for Austria, Denmark, France, Germany, Great Britain, Italy, the Netherlands and Switzerland, together with representatives of the International Union of Biological Sciences, the International Union for the Protection of Nature and the Conseil International de la Chasse.

One of the most urgent questions discussed was oil pollution of the sea and consequent destruction of sea-birds. A preliminary survey made by the Royal Society for the Protection of Birds in conjunction with the British Section of the International Committee for Bird Preservation during the winter and spring 1951–52 as to the numbers and species destroyed in this way around the coasts of Great Britain showed 70 per cent of the birds found on the beaches were gulls and 16 per cent guillemots and razorbills. A similar survey carried out in Holland produced a different proportion of birds destroyed, 45–50 per cent being guillemots and only a few gulls. The percentages of other species affected also varied in the two countries. On the coasts of Denmark, scoters and eider ducks appear to be the most frequent victims.

A valuable report on the work being done in the analysis of deposits of oil waste to endeavour to trace the type of ship from which oil pollution has emanated was contributed by the British Section. Work carried out so far shows that specimens of oil deposits taken from beaches were wholly of petroleum origin and identifiable as two kinds of oil, waxy sludge or bottoms as deposited in the tanks of tanker vessels carrying crude oil, and heavy fuel oil. The analysis of oil obtained from the feathers of birds, on the other hand, proved to be fuel oil only. The presence of the latter oil in the sea probably follows the pumping by ships of bilges and ballast tanks, and as this oil remains as a viscous film when spread on water it is more likely to cause oiling of birds. The urgent necessity for such research as a means of assisting to solve the problem of prevention of oil pollution of the seas was appreciated by the representatives of all countries present. A resolution was passed directing attention to investigations in progress into the nature and sources of the types of oil pollution and the need for further facts on important parts of the problem, pressing for completion of the investigations, and asking the governments concerned to give these the fullest support with the view of reaching a constructive and acceptable solution to this serious trouble.

The protection of migratory birds is a question of prime importance to the countries of Europe, particularly with regard to those species which are considered as sporting birds and as suitable for food. Reports on migratory birds giving lists of those regarded as sporting birds, the close-times accorded to both sporting and other migratory birds and details of any species which have decreased, with suggestions as to the reasons, were furnished by the national sections of France, Germany, Great Britain, Greece, Italy and the Netherlands. The interpretation of the term 'sporting birds' varies considerably in different parts of the Continent, thrushes being considered fair game in a number of countries, and in some all small passerine birds are regarded as suitable for the pot. In Germany and Italy, a decrease of all waders and water-birds is reported, and a similar situation is apparent in parts of France, whereas in Greece there is a serious decrease in all sporting migratory birds. Whether other migratory birds are decreasing or not is more difficult to observe, and some countries had no information on this point; in Italy, however, a decrease in swallows and swifts is attributed to the ever-increasing use of insecticides. The need for the further protection of migratory birds was evidenced by the passing of resolutions pressing that shooting in spring should be everywhere prohibited, whether on coasts or inland, and that all methods of capturing birds *en masse* (nets, snares, bird-lime, etc.) should be forbidden.

The proposal put forward at the Conference held in Uppsala in 1950 that an endeavour should be made to establish a series of bird reserves on the main migration routes in Europe was also reported upon. The Camargue Nature Reserve, in the Rhône delta, which was created, and is administered by, the Société d'Acclimatation de France and where protection is afforded to many migratory birds on passage to other European countries, was specially discussed. Grave concern was expressed over the possible effects upon bird-life of a further extension of economic exploitation of the area. A resolution was passed in which it was stated that the Conference considered that the unique and irreplaceable scientific significance of the Camargue as a nature reserve of first-rate European importance ought to be officially recognized by agreement between the interested governments, and requested the French Government to accept the principle that large parts of the Camargue should be permanently safeguarded not only for future generations of scientific workers and friends of Nature, but also for the conservation of the stock of migratory birds on their way to other European countries. The Conference also invited the Société d'Acclimatation de France to accept the help of other countries.

Birds which are a menace to other species present a difficult conservation problem, and the situation with regard to the herring gull in the countries bordering the North Sea was the subject of reports from Denmark, Germany and the Netherlands. A survey made of the herring gull colonies in the three countries showed a total of 56 colonies, of which 31 consisted of more than 1,000 pairs, 12 from 100 to 1,000 pairs and 13 less than 100 pairs. Various lines of investigation are being pursued, such as ringing, study of food taken by the birds and the effect they have on other species nesting in the proximity of colonies. Results of measures taken to control the numbers of gulls were also reported upon. In Holland, herring gulls prove a menace to other species and the control of their numbers is considered essential; in Denmark, on the other hand, they are found to cause little damage to other species and are considered a necessary part of the ecology of sea-bird colonies. Ringing results have established that German herring gulls are non-migratory and, though not yet complete, the Dutch results indicate that in the Netherlands the birds do not wander far from their original nesting grounds.

The International Convention for the Protection of Birds which was signed *ad referendum* at a Government Conference in Paris in 1950 has made no further progress, the majority of national sections present reporting that their respective governments were awaiting the passage of national legislation before adhering to the Convention, though some signified that their governments would not long delay.

The investigations into the status of the Anatidæ being carried on in various countries were reported upon, and Dr. Edward Hindle, honorary director, presented a report on the work of the International Wildfowl Research Institute which was set up in London to correlate these investigations and act as a centre of information.

Other subjects dealt with were the conditions of birds transported alive from tropical countries to Europe, the use of birds' feathers in millinery and excessive shooting and netting of birds in parts of France.

CENTENARY OF THE AMERICAN GEOGRAPHICAL SOCIETY

THE American Geographical Society of New York, the oldest society of its kind in the United States, has now reached a ripe age for an American institution —one hundred years. It ushered in its centennial year with a largely attended dinner last autumn, and on May 22, 1952, it celebrated its 'Charter Day' with a convocation at which Mr. John Foster Dulles spoke and an exhibition was formally opened. The approaching centennial was a factor leading to the choice of the United States as the meeting-place for the Seventeenth International Geographical Congress, which is to be held in Washington in August. At special ceremonies the Society will entertain and honour foreign geographers on their arrival in New York *en route* to the Congress.

The Society is twenty-one years younger than the Royal Geographical Society and has had a somewhat comparable career*. Its founders consisted of merchants, ship-owners, and other business and professional men—among them, an influential group of newspaper publishers, editors, historians and writers. Until 1871 the institution was called "The American Geographical and Statistical Society", and about a third of the papers read before it at that time had to do with statistics. From the beginning the Society has kept up a consistent interest in exploration, though to a lesser degree than its sister Society in London. It aided the American Arctic expeditions of Kane, Hayes, Hall, Greely, Schwatka, and De Long, during the 'fifties, 'sixties and 'seventies, and later was closely associated with Peary (who served as president during 1903–6), Stefansson, Rasmussen, Wilkins, Byrd, Louise A. Boyd, Ronne, and many other explorers. Judge Charles P. Daly was president from 1864 until his death in 1899 and did more than anyone else during its first half-century to establish the Society on firm foundations. In 1874 he said that one purpose of geographical societies was "to press the importance of scientific attainment . . . upon all who are ready to encounter the toil, the privation, and the peril that are incident to such noble undertakings [that is, exploring expeditions], that they may bring back what will be honourable to themselves and useful to the world". The Royal Geographical Society and the American Geographical Society have adhered to this principle.

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* For further details on the history of the Society see the following recent publications by Dr. J. K. Wright, director during 1938–49 of the Society: "Geography in the Making. The American Geographical Society, 1851–1951" (New York, published by the Society, 1952), reviewed on p. 89 of this issue of *Nature*; "The American Geographical Society: 1852–1952", *The Scientific Monthly*, 74, No. 3, 121 (March, 1952); "British Geography and the American Geographical Society, 1851–1951", *Geographical Journal*, 118, 153 (1952).

Both Societies have also striven to advance geographical education along modern lines in their own countries. In the mid-'eighties the Royal Geographical Society took the lead in the movement that established geography in British universities and effected its improvement in the schools. Similarly, in the mid-'nineties the American Geographical Society adopted a policy of close collaboration with teachers. It gave moral encouragement and material assistance to the Association of American Geographers during the latter's formative period. The Association, consisting largely of university geographers, was founded by Prof. W. M. Davis in 1904 for the development of geographical research. The American Geographical Society also came to the rescue of the school teachers' *Journal of Geography* when that estimable little magazine was about to expire in 1918. In 1912 the Society conducted an excursion through the United States to the Pacific coast and back. Ninety American and forty-three European geographers participated, the Europeans as guests of the Society through the generosity of Mr. Archer M. Huntington, the Society's outstanding benefactor. This extraordinary trip forged new bonds of friendship, esteem and collaboration across the Atlantic—bonds that held firm despite the First World War and that help to explain a broadening of the Society's world outlook in the years that followed.

Isaiah Bowman (1878–1950) was the first director; he served from 1915 until 1935, when he resigned to assume the presidency of the Johns Hopkins University. Before his appointment, the Society had confined its activities almost entirely to publishing a journal, building up an excellent library, holding semi-popular lectures, and awarding medals and other honours. Dr. Bowman more than quadrupled the membership and raised the scientific standards of the journal, which was renamed *The Geographical Review* in 1916. He inaugurated several series of monographic publications, including the well-known Research Series and the Special Publications, in which some eighty works have appeared to date. Furthermore, during Dr. Bowman's administration, chiefly through his initiative, and with the financial support of Messrs. Huntington, J. B. Ford and others, the Society embarked upon a new type of enterprise: the conduct of large programmes of original investigation both by members of its staff, who were added for the purpose, and by outsiders under the Society's general supervision. These have dealt especially with techniques of exploration and cartography, and with the geography of Latin America, of the polar regions, and of pioneer settlements in different parts of the world. They have yielded fruit in new instruments and techniques of reconnaissance surveying and map-making, in a great "Map of Hispanic America on the Scale of 1 : 1,000,000" (107 sheets), and in many other maps, monographic works, and periodical articles. In these ways the Society extended its influence and gained recognition as a genuine research institution.

The American Geographical Society is now crossing the threshold of its second century under the invigorating leadership of a British geographer. In 1950 Dr. George H. T. Kimble, formerly of the University of Reading, and later professor of geography in McGill University, Montreal, was appointed director. He is putting into effect a reformulation, recently adopted by the Council, of the Society's time-tested policies. Research is to be maintained and accelerated. The Hispanic-American programme will continue, though on a reduced scale. Fresh fields are being energetically opened: the geography of diseases, the study of glaciers in relation to climatic changes, and investigations of the distribution and use of natural resources. The Society is also seeking new ways and means whereby geography may be applied to useful purposes and is striving to "bridge the gap between geographical scholarship and teaching", a gap that yawns altogether too wide for safety, not only in the United States but also in most of the other countries of the world.

OBITUARIES

Prof. H. A. Kramers

An untimely death has removed from the world of physical science one of its most original and inspiring figures. Prof. H. A. Kramers was professor of theoretical physics in the Technical University of Delft.

Prof. Kramers was universally respected as a master in many fields, skilful alike in putting to use the most subtle methods of algebra and in bringing to light the essential physical features of the most varied phenomena. He was universally liked as a man: everyone who came into touch with his warm and fine personality yielded to its charm and mingled respect with affection. His shrewd judgment of human affairs and his interest in people made him eminently suitable for the responsible positions he occupied in international bodies ministering to the common needs of physicists of all nations. Deeply concerned with ethical problems, he regarded the control of nuclear energy as a most compelling task. His work in the Atomic Energy Commission of the United Nations Organization was a sacrifice accepted in all simplicity: he came back with his health irreparably undermined. Although in his last years his curiosity and enthusiasm for the new advances of physics were as youthful as ever, he had not recovered the vigour of his former days. Yet he strained to the last his failing strength in the fulfilment of his unselfish work for science.

To the physicists of my generation, who knew of the heroic days of quantum theory only by the tradition received from our elders, Kramers had about him the glamour and the wisdom of the pioneer. His early association with Bohr, his later collaboration with the young Heisenberg, exerted a marked influence on the shape taken by the development of quantum mechanics. He had been brought up against the background of the Lorentzian tradition, still very much alive even to this day in Holland, and the incisively critical spirit of his teacher Ehrenfest could not have failed to leave its mark on him. Kramers's role in this first period of his scientific life has thus been to carry over, in a highly original form, the great classical traditions of Dutch physics into the growing tide of quantum theory. This he did, above all, by his masterly analysis, in the spirit of Bohr's correspondence argument, of those optical problems which had absorbed Lorentz's attention so fully. His very first attempt, on the intensities in the Stark effect, became at once a model for the methods of quantum theory in its initial stage; so much so that when Schrödinger first wanted to test the powers of his wave-mechanics, he quite naturally took up that very problem for comparison. But a still more decisive advance was Kramers's reformulation of the theory of optical dispersion, which paved the way to Heisenberg's great discovery.

After his return to Holland, the task he accomplished, though of a different character from his work in Bohr's circle, was no less honourable and no less exacting. If the old Dutch tradition of theoretical research in physics has been so brilliantly upheld and continued along the lines of quantum theory, it is due in no small part to the powerful influence of Kramers's personality. By his versatile activity he contributed much himself to the development of the methods of quantum mechanics and to their application to many fundamental problems of atomic physics. But who will tell how much he stimulated his fellow-workers by his example, his experimental colleagues by his advice, his pupils by his guidance, his students by his teaching? Besides all this, there was Kramers the man, to whom nothing human was foreign. His friends would never seek in vain his wise counsel in affairs of public import, or his warm sympathy in their private worries. His help often came unsought, and sometimes a hint, unobtrusively preferred, would make you realize that, unknown to you, he had given long and careful thought to your problems. His name will live in the annals of science; his gentle image in the hearts of his friends. L. ROSENFELD

Prof. Louis Guillaume

THE death, following an accident at Strasbourg on May 29, is reported of Prof. Louis Guillaume, Ingénieur en chef at the Bureau de Recherches Géologiques et Géophysiques in Paris, and well known and respected among British geologists.

Guillaume, who was born in 1894, held academic posts at both Caen and Strasbourg, and in 1941 helped to found the Bureau des Recherches Géologiques et Géophysiques, the object of which was to co-ordinate, facilitate, and if need arose, to initiate, the search for useful economic materials in France. He was the author of numerous scientific articles in the fields of palæontology and stratigraphical geology, and his premature death deprives his colleagues of his collaboration in a number of important works, particularly on hydrogeology, for which he had assembled an extensive and valuable documentation.

Guillaume was a fervent anglophile and had made many friends in Great Britain; they will mourn the passing of a generous and dynamic personality.

A. C. TOWNSEND

NEWS and VIEWS

Medical Protozoology in the University of London: Prof. H. E. Shortt, C.I.E., F.R.S.

PROF. H. E. SHORTT, who has held the chair of medical protozoology in the University of London at the London School of Hygiene and Tropical Medicine since 1947, is to retire in October. Prof. Shortt was formerly in the Indian Medical Service, and has made discoveries of fundamental importance in the field of tropical medicine. During his work in India on the etiology of kala-azar, carried out over a period of twenty-five years, he proved that the transmitting agent was *Phlebotomus* and contributed profoundly to the knowledge of this disease and its causal organism. In recent years he has carried out brilliant researches on the life-cycle of the malaria parasites, in which Dr. P. C. C. Garnham collaborated, and for which they were jointly awarded in 1951 the Darling Medal and Prize given by the World Health Organization.

Dr. P. C. C. Garnham

DR. P. C. C. GARNHAM, who is to succeed Prof. Shortt, was in the Colonial Medical Service during 1925–47 and was director of the Division of Insect-borne Diseases in Kenya during the last four years of his service. He has published numerous original articles, many of which are concerned with malariology, a subject in which he has specialized and achieved distinction. In Kenya he carried out important research not only on malaria but also on relapsing fever, plague, onchocerciasis and jungle yellow fever. The epidemiology of these diseases and the bionomics and control of their insect vectors were his special concern. An outstanding success in this field was his discovery of the use of DDT in destroying the larval stages of *Simulium neavei*, the vector of onchocerciasis in Kenya and other parts of East Africa. This method of control has resulted in the complete eradication of the insects in certain endemic foci. On joining the staff of the London School of Hygiene and Tropical Medicine as reader in medical parasitology in 1947, he participated in the experimental work which led to the first discovery of a pre-erythrocytic stage in the life-cycle of mammalian malaria parasites. His collaboration in this work and in the subsequent researches which established the presence of this long sought-for missing link in the life-cycle of the human malaria parasites, *Plasmodium vivax* and *P. falciparum*, has earned for Dr. Garnham an enduring name in the history of tropical medicine research.

Institution of Mining Engineers: President for 1953–54

MR. J. CECIL MITCHESON has been elected president of the Institution of Mining Engineers for the year 1953–54, and will succeed Mr. R. J. Weeks at the annual general meeting to be held next January. Mr. Mitcheson comes of an old mining family, his great-grandfather having worked with George Stephenson at the Old Killingworth Colliery; both his grandfather and father were also associated with the industry. Mr. J. C. Mitcheson was educated at Bootham School, the Royal Military Academy, Woolwich, and the University of Birmingham, where he graduated B.Sc. in mining. After obtaining his colliery manager's certificate, he was appointed lecturer in coal mining and demonstrator in mine rescue in the University of Birmingham under the late Prof. K. Neville Moss. In 1924 he returned to the mining industry to assist his father in his consulting practice in the Midlands, and was later appointed managing director of the Birch Coppice Collieries of Morris and Shaw, Ltd. During the Second World War he was group production director for the Warwickshire Coalfield. When the mines were nationalized, Mr. Mitcheson served for a time as mining development engineer to the West Midlands Division; later he resigned to take up consulting work and to look after the interests of his former company. He has visited mines in France, Germany, Belgium, Spain and the United States, and has recently reported on the brown-coal deposits of Iceland for the Icelandic Government.

Paris to London Television Relay

DURING the period July 8–14, a new and advanced experiment in the international exchange of television programmes was carried out between Paris and London. By co-operation between Radiodiffusion et Télévision Françaises and the British Broadcasting Corporation, a part of each day's programme in the public television service in Great Britain originated in Paris. Due to the failure to achieve uniformity in the television standards in use in Europe, it was necessary to convert the television signals from the French 819-line system to the British standard of 405 lines. This conversion was carried out at Cassel by equipment developed by the B.B.C. in which the picture with the original number of lines on the screen of a cathode-ray tube is re-scanned by a television camera operating on the number of lines normally used at the receiving end of the circuit. Earlier experimental work had shown that the success of this technique depended on the use in the picture tube of a screen having a phosphor with a decay time comparable with that necessary to scan a single frame of the television image. By this means the camera views an image that is virtually continuous during each frame. The phosphor used in the cathode-ray tube at Cassel is zinc beryllium silicate, which has an exponential decay characteristic such that the brightness of any particular point in the image falls to about 28 per cent of its original value during the time of scanning one frame. A Marconi Image-Orthicon camera was used to re-scan the picture at the 405-line standard. From Cassel the pictures were transmitted to London by a series of radio links. Apart from some intermittent technical faults with both the sound and vision signals, the experimental programmes could be regarded as very successful in indicating the possibilities of exchange of programmes between European capitals and other places separated by a few hundreds of miles. As a combined operation between R.T.F. and B.B.C., this achievement marks a new step forward in the development of outside television broadcasting.

The Chemical Society of the University of Edinburgh

FOR his presidential address to the Royal Society of Edinburgh delivered on July 7, Prof. James Kendall spoke on "The First Chemical Society, the First Chemical Journal, and the Chemical Revolution". He discussed the first volume of the proceedings of the Chemical Society of the University of Edinburgh, which was discovered a few years ago in the library of the Royal Irish Academy and has since been presented to its original owners in the University of Edinburgh (see *Nature*, 159, 867; 1947). The volume is a well-bound folio of 452 pages in copperplate manuscript, containing thirty-two dissertations on topics of chemical interest. Although the communications presented are not of major scientific importance, they do afford a unique record of contemporary chemical thought. In particular, they disclose one fact of significant historical interest, namely, that Joseph Black, commonly regarded as among the last to accept the 'chemical revolution' of Lavoisier, must have been among its earliest advocates, since the majority of his students were already converts to the oxygen theory of combustion in 1785–86. The penultimate paper, by Mr. John Carmichaell, merits special consideration. It consists of a violent attack upon the long-established doctrine of phlogiston, which Lavoisier overthrew, and concludes with a quotation from Virgil applicable thereto: Venit summa dies (Its last hour has arrived). That pronouncement was obviously endorsed by Mr Carmichaell's colleagues, since on the title-page of his medical graduation thesis in 1787, where he continues the attack, he proudly announces himself as "Extraordinary Member and President for the Year of the Chemical Society of Edinburgh". This thesis was almost certainly one of two sent by Black to Lavoisier in 1790 as proof that Edinburgh students, while enjoying "the most perfect liberty of chuseing their philosophical opinions", had in general embraced his system. Incidentally, Mr. Carmichaell was one of the few original members of the Society who was a native Scot.

International Commission on Glass

THE International Commission on Glass held its annual meetings under the presidency of Prof. W. E. S. Turner throughout the week June 30 - July 5. The first two days were spent in London, in part in the rooms of the Institute of Physics, and in part at the Research Laboratories of the General Electric Co., Ltd., Wembley; the meetings on the other four days were held in Sheffield at the Department of Glass Technology in the University. Representatives of Belgium, France, Germany, Great Britain, Holland, Japan, Spain, Sweden, Switzerland and the United States attended. The technical work of the Commission occupied three full days, one of them devoted to an open session; the two other days to committee work on a variety of subjects classified under the group headings of glass literature; chemical properties of glasses; physical properties of glasses; glass furnace problems. Reports were presented on tasks or projects previously undertaken by affiliated organizations; agreements were reached on a number of fundamental issues, and plans were prepared for further collaboration. The International Standards Organization sent, by invitation, two observers to the meetings. Among the events were visits to the Research Laboratories and the glass works of the General Electric Co., Ltd., and to the imposing new works—unique in Europe—at Harworth, near Doncaster, where the glass envelopes for electric lamps and radio valves are manufactured at tremendous speed. Prof. W. E. S. Turner, to whom illuminated addresses were presented from Germany and Japan, will, after being continuously in office for twenty years, retire from the presidency in 1953. He will be succeeded by Dr. B. P. Dudding, honorary secretary of the Institute of Physics and at present secretary of the Commission. M. Henri Vandecapelle, director of the Institut National du Verre, Charleroi, was appointed secretary-elect.

Problems of Land Reform in Under-developed Countries

IN the under-developed regions of the world there are many impediments to the improvement of rural living standards. Among them are the fragmentation of holdings, the concentration of land ownership in a few hands, high rents and insecurity of tenure, low wages, exorbitant taxation and inadequate provision for agricultural credit. In a report, entitled "Land Reform: Defects in Agrarian Structure as Obstacles to Economic Development", published by the United Nations' Department of Economic Affairs (pp. 101. New York: United Nations. 75 cents. London: H.M.S.O., 1951. 5s.), it is emphasized that it is the agrarian structure and, in particular, systems of land tenure which prevent a rise in the standard of living of small farmers and agricultural labourers. Land reform, however, if it is to be effective, must comprise improvement in all the social and economic conditions affecting farm life. Changes in the land tenure systems are more likely to lead to a rise in the standard of living of the rural community when they form part of a general programme than when they are undertaken in isolation. The provision of credit facilities, co-operative marketing, technical advice and health services are among the major services needed. The report points out that if steps are not taken to provide facilities of these kinds to newly established small farmers, many of the benefits which might be expected to result from reform of the land tenure system will be nullified.

Eradication of Bovine Tuberculosis from Cattle in Denmark

DENMARK, with some 1,600,000 dairy cows, has recently completed the eradication of bovine tuberculosis from among her herds, and is the first country in the world to guarantee that all exports of butter and cheese are from the milk of tubercle-free animals only. The occasion was marked by official celebrations in Copenhagen on June 13. The campaign was begun sixty years ago, when Prof. Bernhard Bang, of the Royal Veterinary College, Copenhagen, advocated the tuberculin-testing of all cattle, the isolation of the healthy animals, and the weeding out of reactors; its completion involved the slaughter of 318,000 reactors between 1934 and 1951 ("The Campaign against Bovine Tuberculosis in Denmark and its Eradication." By T. Mathiassen. Aarhus: by the Danish Federation of Dairy Associations. '*Re* Lur' branded butter and cheese: Order of Danish Ministry of Agriculture, March 27, 1952).

Ethics of Management

A STRIKING article in the current issue of the *Journal of the Institute of Personnel Management* (34, No. 319) is one by the Institute's director, Mr. H. E. Roff, on the ethics of management. Accepting the four-fold aim of industry as the provision of goods and services, the earning of profit on capital, the provision of employment and the provision of social and work satisfaction, Roff suggests that management has responsibility to the customer, the shareholder, the employee and the community, the latter including responsibility for preserving the amenities of Britain, making effective use of natural resources, helping to produce democratic citizens and, finally, teaching the new generation of managers. The journal also contains an account of the workshop for elderly men at Rubery Owen and Co., an examination of the scientific study of human relations in industry, the report of a morale survey in a Danish department store, and the part played by trade unions in German industry. There are also some interesting notes on the training of shop stewards and the employment of older workers as well as the usual reviews of books and periodicals.

Imperial College of Science and Technology, London: Report for the Year 1950-51

THE forty-fourth annual report of the Governing Body of the Imperial College of Science and Technology, London (pp. 55; from the College at South Kensington, London, S.W.7; 1951), covering the year ended July 31, 1951, refers to the further special grants of £3,000 made by the University Grants Committee in 1950–51 rising in 1951–52 to £4,000 for the provision of bursaries for postgraduate students in engineering. The first of the projected extensions to the chemical technology building and the new chemistry laboratories were completed during the year, adaptation of the Union building was nearing completion and the erection of laboratories for mineral dressing by adaptation of part of the Bessemer Laboratory is expected to be complete in August 1952. In spite of continuous progress in developments on the technological side, increasing costs have checked the steady advance in the quality and quantity of the work of the College during the first four years of the quinquennium. A deficit of more than £9,000 was incurred in 1949–50, and much larger deficits are anticipated in 1950–52. The finances have accordingly been closely examined to determine the directions in which economies are possible with the minimum reduction of efficiency. Capital grants from the University of London for new construction and equipment totalled £154,290; but room for expansion constitutes a serious problem. The plan for a South Kensington site has come no nearer to fruition; but the acquisition of the sites at 181–5 Queen's Gate and of the underlease of the property at 177 Queen's Gate should provide sufficient room for necessary normal development in the next five or ten years. Appendixes to the report include, besides the statement of accounts, a list of publications during 1950–51, arranged by departments.

Interpretation of Seismograms

PRIOR to the year 1930 seismologists were obliged to acquire information required for the interpretation of seismograms piecemeal from papers and portions of books on seismology, and from a careful study of their own particular instruments. In 1930 they became indebted to Dr. Frank Neumann, mathematician of the United States Coast and Geodetic Survey, for collecting these data and for making them available in mimeographed form. With the advance of the science of seismology it has now been necessary for Dr. Neumann to revise and enlarge his original work on this subject, and seismologists are now indebted to the Coast and Geodetic Survey for printing the work as Special Publication No. 254, "Principles Underlying the Interpretation of Seismograms". This work, which has been brought thoroughly up to date, is written for the Seismograph Station director, for the student who is beginning his career as a seismologist, or for the amateur seismologist. The reader is provided with basic background information pertaining to the origin and transmission of seismic waves and the recording characteristics of the principal types of seismographs now used in the long-range detection of earthquakes, including short-period instruments. The established fundamentals of earth structure, upon which seismic wave propagation is dependent, are set forth, and travel-time tables for the major phases are discussed; graphs of the Gutenberg–Richter tables for four depths of earthquake focus, and published during 1934–39, are given. It is to be noted that an error of one second in determining the arrival time of the primary or *P* phase will result in epicentral distance errors ranging from 8 km. at a distance of 1,000 km. to 22 km. at a distance of 10,000 km. Rather more than ten years ago, Gutenberg and Richter introduced the earthquake magnitude scale, based on measurements of seismograms, to replace the earthquake intensity scales used previously. This logarithmic magnitude scale is described in detail. An increase of one unit in magnitude signifies a 63-fold increase in energy, and on the Gutenberg–Richter scale an earthquake of magnitude 5 would release 10^{21} ergs of energy. Copies of interpreted seismograms are given as illustrations in the publication.

The Blue Sun of September 1950

The results of spectrophotometric observations of the blue sun, made at Edinburgh between 15h. 20m. and 15h. 25m. U.T. on September 26, 1950, have been described by R. Wilson (*Mon. Not. Roy. Astro. Soc.*, 111, 5; 1951). The 36-in. Cassegrain reflector of the Royal Observatory was used with the two-glass prism train of the attached Hilger universal spectrograph, giving the respective dispersions 132, 45 and 28 A./mm. at $H\alpha$, $H\beta$ and $H\gamma$. Very full details of the procedure and the deductions are given in the paper, at the end of which appears a summary of the conclusions. The layer causing the phenomenon was due to extensive forest fires in Alberta on September 23, 1950, the smoke from which was carried by upper winds to Europe, where the effect was quite different from that in America. Over the latter continent at various times and places there was complete darkness, and when the sun was visible it was purple or blue, while the scattered light in the sky produced shades of orange, purple or blue. Over Edinburgh on the afternoon of September 26 the smoke was observed, and the sun, seen quite clearly through the haze, was a deep indigo blue. According to E. M. Elsley (*Weather*, 6, 22; 1951), the scattering particles were globules of oil, caused by the distillation of wood, and the scattering theory predicted various features which were experimentally verified by Wilson's investigations. These particles were dielectric in nature and very homogeneous in size and constitution, and there appears to be the possibility that there was another system of particles in the layer, producing a neutral extinction. Using a relation deduced between the diameter and the refractive index of the scattering particles and assuming the latter to be about 1·5, which is near the value for most organic oils, the diameter of the particles would be of the order of one micron. If there was the other system of particles in the scattering layer, it is suggested that their most likely constitution was carbon, and it is possible that their size could be the same as that of the uniform dielectric particles. Communications in *Nature* of September 29, pp. 545 and 554, and December 22, p. 1086 (1951), also discussed this topic.

Exhibition of Geometry at Chicago

The Illinois Institute of Technology has arranged an exhibition of geometry at the Chicago Museum of Science and Industry, and Prof. Karl Menger has written an attractive 34-page guide-book, with the title "You will like Geometry". The most striking feature of this is the large number of beautiful diagrams. The subjects treated are very varied. There are simple constructions of plane geometry, including some of a puzzle type which do not appear in the usual text-books. There is also a section on the regular solids, including Kepler's star-faced solids and Poinsot's star-cornered solids. Other parts of the guide book deal with more advanced mathematics, such as the theory of groups, which is introduced with reference to operations on triangles and other geometrical figures. An account is given of the 'universal curve', discovered by the author, which has the property that every curve of our space can be deformed into one of its parts. As the preface claims, "Geometry is amazing and ingenious and beautiful and profound; and, most important, it is alive and growing".

Announcements

'Open days' are being held at the Chemical Research Laboratory, Teddington, Middlesex, during September 23–26. Industrial firms wishing to send representatives and who are not already on the mailing list should apply to the Director, before August 31, for invitations for September 23 (afternoon), September 25 or 26 (morning or afternoon).

Pakistan's first seismological research station is now being built in Quetta with the technical assistance of Unesco. The new service would be grateful for reprints of seismological papers published before 1948 and for back numbers of journals, which should be sent to the Pakistan Meteorological Service, Geophysical Division, Kings Road, Quetta, Pakistan.

Messrs. Blundell Rules, Ltd., Chaul End Lane, Luton, Beds, have issued a small handbook of 22 pages (price 6*d*.) describing their range of slide rules, and giving examples of the uses of the various patterns. Thus, in addition to the usual rules in various styles graduated for simple mathematical operations, there are others with log–log scales, commercial calculators, electricians' scales with appropriate quantities, and a timber calculator. Most of these scales are made entirely of a white plastic material, based on vinyl chloride–vinylidene chloride copolymers, with a 'satin' finish. It is claimed to be resistant to water, most chemicals and fungi. It is strong, and the scales are sharp and clear; in some patterns the tension of the slide can be adjusted. Model A.G.1 (£1 13*s*.), a simple general-purpose rule, has the usual *A*, *B*, *C*, *D* scales, and also scales for reciprocals, cubes and mantissæ; additional red lines on the cursor provide for finding areas of circles of given diameter.

Erratum. In the communication entitled "Cellular Permeability of Yeast to Metallic Ions", by E. Quagliozzi and A. Rescigno, published in *Nature* of July 5, p. 35, the first equation should read:

$$\frac{V}{L}\,\frac{\mathrm{d}x}{\mathrm{d}t} = -\,v\,\frac{x}{Lb/V} + v\,\frac{(x_0 - x)\,V/L}{a}\,;$$

and the second should read:

$$\frac{x}{x_0} = \frac{a\,.\exp\left(-\,v\,\dfrac{a+b}{ab}\,t\right) + b}{a+b}\,.$$

The second reference in the footnote should be disregarded.

BIOSYNTHESIS OF CAROTENES IN RIPENING TOMATOES

By DR. T. W. GOODWIN and MALINI JAMIKORN
Department of Biochemistry, University of Liverpool

PORTER and Lincoln[1] have recently put forward a theory of carotenogenesis in tomatoes. This scheme is based mainly on the results of pigment analyses carried out on the ripe fruit of various specially-bred crosses. From these a series of polyenes was obtained, differing from each other by four hydrogen atoms. As the members of the series could always be detected in every cross, it was postulated that the fully unsaturated carotene, lycopene, is formed from more saturated precursors by the stepwise removal of four hydrogen atoms, thus: perhydrophytoene → phytoene → phytofluene → ζ-carotene → neurosporene → lycopene. Lycopene is then assumed to become isomerized, in amounts varying according to variety, to α-, β- and γ-carotenes. The scheme was justified on genetic grounds. Porter and Lincoln emphasize, however, that a different mechanism may operate in other plant tissues such as green leaves.

The pioneer observation of Duggar[2], that ripening of excised tomatoes above 30° results in the inhibition of lycopene synthesis but not that of carotene, has frequently been confirmed[3]. Furthermore, as soon as the ripening temperature is reduced to 30° or below, lycopene synthesis is resumed and proceeds normally.

It was decided to find out what happened to the members of the Porter–Lincoln series other than lycopene when the synthesis of this latter carotene was inhibited by ripening excised tomatoes at high temperature. In particular, the variation in the phytofluene content was followed quantitatively, as this polyene occurs in reasonable amounts in ordinary commercial varieties, whereas most of the other members (for example, ζ-carotene and neurosporene) are only present in traces.

Methods and Results. Tomatoes were removed from the vine while still green as soon as the very first signs of ripening appeared. They were divided into four groups and these ripened at either 0°, 15°, 30° or 37°. Samples were taken for analysis once every three days for twelve days. The pigments were extracted and separated chromatographically according to the procedure recently described in detail by Goodwin[4]. α- and β-carotenes, lycopene and phytofluene were determined quantitatively, and the presence or absence of ζ-carotene and neurosporene was noted. Phytoene was never present in detectable amounts.

The results obtained are recorded in the accompanying table, from which the following conclusions can be drawn.

(1) It is confirmed that lycopene synthesis is inhibited at temperatures above 30°; there is, however, no concomitant accumulation of phytofluene or other members of the Porter–Lincoln series.

(2) The synthesis of the members of this series is equally inhibited under conditions inhibiting lycopene synthesis.

(3) Although all members of the series tend to appear together at the same stage of ripening, the rate of accumulation thereafter is not necessarily the same; for example, at 30°, from the ninth to the twelfth day of ripening, the amount of lycopene increases tenfold, whereas that of phytofluene is only doubled.

(4) The production of both α- and β-carotene is only slightly inhibited by ripening above 30°.

(5) Synthesis of all polyenes is inhibited in tomatoes held at 0°; but, again, that of lycopene most of all.

(6) No member of the Porter–Lincoln series is present in green (unripe) tomatoes.

Discussion. There seems little doubt from this and previous work that the major route of α- and β-carotene synthesis in normal tomatoes is a process entirely separate from the mechanism producing the Porter–Lincoln series. It is probable that α- and β-carotene can also be synthesized by a mechanism very similar to that producing the Porter–Lincoln series, but this can occur only to a very minor extent. The present results suggest that certainly not more than 15 per cent is formed in this way; but further observations are required before an accurate assessment can be made. Additional evidence that carotene can be produced in tomatoes by this second route comes from the results of Kohler, Lincoln, Porter, Zscheile, Caldwell, Harper and Silver[5], who produced a cross in which the carotene content of the ripe fruit was increased from a normal value of about 6 μgm./gm. to 101 μgm./gm.; this increase appeared to be almost entirely due to reduction of lycopene synthesis, for the total amount of carotenes present was not altered. Accepting the biosynthetic mechanism postulated by Porter and Lincoln, breeding in

SYNTHESIS OF POLYENES IN TOMATOES RIPENED AT DIFFERENT TEMPERATURES

	Amount present (μgm./gm. wet wt.)			
	3 days ripened	6 days ripened	9 days ripened	12 days ripened
Ripening temperature, 0°				
Lycopene	0	0·13	0·28	2·19
α-Carotene	0·20	0·25	0·34	0·51
β-Carotene	0·86	1·06	1·08	3·14
Phytofluene	0	?	?	1·14
ζ-Carotene Neurosporene	absent	not detectable	not detectable	present
Ripening temperature, 15°				
Lycopene	0	6·6*	5·74	26·4
α-Carotene	0·11	0·76	0·97	0·93
β-Carotene	0·76	5·34	3·70	6·34
Phytofluene	0	1·16	2·17	2·44
ζ-Carotene Neurosporene	absent	present	present	present
Ripening temperature, 30°				
Lycopene	0·39	—	2·52	25·2
α-Carotene	0·19	—	0·52	0·82
β-Carotene	1·11	—	2·78	6·75
Phytofluene	?	—	1·09	2·18
ζ-Carotene Neurosporene	not detectable	—	present	present
Ripening temperature, 37°				
Lycopene	0	0	0·24	1·59
α-Carotene	0·17	0·32	0·66	0·47
β-Carotene	1·01	2·49	2·02	5·23
Phytofluene	0	0	?	?
ζ-Carotene Neurosporene	absent	absent	not detectable	not detectable

* At 15°, the selection for six days was at a more advanced stage of ripeness than that for nine days.

this case can be assumed to have caused a shift in the equilibrium lycopene ⇌ β-carotene.

The question then arises: What mechanism exists for the production of most of the α- and β-carotene synthesis in tomatoes if the Porter–Lincoln pathway is only of minor importance? The most reasonable assumption at the moment is that the synthesis is due to a 'carry-over' of the mechanism operating in green leaves. This assumption is made highly likely for three reasons: (1) it is known that no member of the Porter–Lincoln series exists in green leaves and, therefore, the biosynthetic mechanism there is probably different; (2) unlike the synthesis of lycopene in tomatoes, that of carotene in tomatoes and in isolated leaves[6] is not significantly inhibited by temperature above 30°; and (3) at 0°, when the complete physiological ripening process in tomatoes is almost entirely inhibited, the synthesis of α- and β-carotene still continues to a significant extent in the green fruit whereas that of lycopene is negligible.

Furthermore, although the carotenoids present in fungi and the non-photosynthetic bacteria include the Porter–Lincoln series as well as β-carotene[7-9], the synthesis of β-carotene in, for example, *Phycomyces blakesleeanus* can be completely uncoupled from that of the Porter–Lincoln series[10]. In green leaves, as just stated, none of the Porter–Lincoln series occurs. This appears also to be true for the photosynthetic bacterium, *Rhodospirillum rubrum*. This organism produces only a single fully unsaturated carotenoid, spirilloxanthin (together with small amounts of *cis*-isomers)[11], and no evidence has yet been obtained of the presence of any member of the Porter–Lincoln series[12].

Although it is reasonable to assume that all the members of the Porter–Lincoln series are synthesized via very similar routes, there is as yet no conclusive biochemical evidence establishing the claim of Porter and Lincoln that the more saturated members are precursors of the more unsaturated ones. It is possible that the reactions proceed in the reverse direction to that envisaged, or that, as suggested by Goodwin[3], the members of the series are formed by a number of parallel syntheses which would not involve the utilization of any member as an intermediate in the formation of another.

Whatever the final outcome of experiments designed to test the stimulating hypothesis of Porter and Lincoln, it is clear that two mechanisms of carotenogenesis exist in ripening tomatoes. In one, the synthesis of most of the α- and β-carotene is achieved by a very similar mechanism to that occurring in green leaves; in the other, the synthesis of the Porter–Lincoln series occurs. The exact mechanism of both these processes is still almost completely unknown.

We wish to thank Messrs. A. H. Kitson and C. Rutherford for a gift of suitable tomatoes, and Prof. R. A. Morton for his continued interest in this work.

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[1] *Arch. Biochem.*, **27**, 390 (1951)

[2] Washington Univ. Stud. Sci. Tech., 1, 22 (1913).

[3] "The Comparative Biochemistry of Carotenoids" (London, Chapman and Hall, 1952).

[4] *Biochem. J.*, **50**, 550 (1952).

[5] *Bot. Gaz.*, 108, 219 (1947).

[6] Bandurski, R. S., *Bot. Gaz.*, 111, 95 (1949).

[7] Bonner, Sandoval, Tang and Zechmeister, *Arch. Biochem.*, 10, 113 (1946).

[8] Haxo, *Arch. Biochem.*, **20**, 400 (1949).

[9] Goodwin, *Biochem. J.* (in the press).

[10] Goodwin, Jamikorn and Willmer (unpublished observations).

[11] Polgar, van Niel and Zechmeister, *Arch. Biochem.*, 5, 243 (1944).

[12] Goodwin and Osman (unpublished observations).

INFLUENCE OF THIOUREA ON REPRODUCTION IN THE MINNOW

By Prof. E. J. W. BARRINGTON and A. J. MATTY

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THERE has been accumulating considerable, if varied, evidence for the existence of some influence of the thyroid gland on the reproductive system of man[1], of other mammals[1-5] and of birds[6-8]. Evidence for such effects in the lower vertebrates, however, is much more limited and fragmentary, although it has been reported that thyroidectomy results in degeneration of the gonads in *Lacerta*[8] and *Triturus*[9]. Investigation of the situation in teleost fish has presented a particular difficulty, for the diffuse nature of the thyroid gland in that group has made surgical removal impracticable; but the discovery of anti-thyroid substances opened up the possibility of carrying out 'chemical thyroidectomy' by immersing fish in solutions of thiourea, and the use of this technique has produced some evidence of a retardation of growth and of the development of the external sexual characters in, for example, hybrids of *Platypoecilus maculatus* and *Xiphophorus hellerii*[10] and in *Lebistes reticulatus*[11].

In the course of an extended study of the thyroid gland of the minnow (*Phoxinus laevis*) we have kept a number of fish immersed in a 0·1 per cent solution of thiourea for several months under constant conditions of illumination and temperature (10° ± 2° C.), a control group being maintained under similar conditions in tap-water. It seemed likely from what was already known of the reproductive cycle of these fish[9] that an effect of the kind envisaged might be most readily demonstrated in the winter and early spring, and an initial experiment was accordingly begun on January 7, 1951. Little change took place in the thyroid gland during the first month of treatment; but by the end of the second month it was possible to demonstrate a substantial and statistically significant increase in the height of the follicle cells and a reduction in the internal diameter of the follicles, indicating that the synthesis of thyroid hormone was being impeded in much the same way as it would be in mammals. At the end of 67 days treatment, all the fish appeared in good condition, as judged by appearance and by the 'condition factor', calculated from the weight/length relationship[12], and a number were therefore killed on March 15 for serial sectioning of the gonads. A comparison of seven control males with seven treated with thiourea, a number known to be adequate for yielding consistent results[9], showed that whereas spermatogenesis was far advanced in the seminiferous tubules, it had largely been arrested at the spermatocyte stage in the latter group, five members of which showed no sperm at all and two showed only traces of them. The situation in the females was less striking; but a comparison of the oocyte diameter, using the same number of animals, showed that those treated with thiourea were, in fact, smaller, the difference between the two groups being statistically significant.

Some animals, although fewer than could have been wished, were kept alive for 154 days, until June 10, by which time all eight members of a group of control animals had developed to varying degrees such external sexual characters as head tubercles and scarlet coloration. In marked contrast to this, a group of nine animals treated with thiourea showed few signs of these; seven, for example, had no tubercles at all, and the other two had minute ones which could only be detected under magnification. The testis of the one male included in this latter group proved to be quite aberrant, lacking both sperm and stages of spermatogenesis, a condition difficult to interpret from a single specimen, but reminiscent of the "devastating" changes reported as occurring in the testes of thyroidectomized newts[13]; the testes of two control males were normal in appearance and full of sperm. The ovaries of four control females from this group, selected at random, were normal, with oocytes of a diameter approximating to those of mature eggs; but those of four females treated with thiourea possessed oocytes no larger than those of the 67-day fish: since, however, there were signs that these animals had not been feeding normally during the last four weeks of the experiment, we do not feel justified at this stage in attaching much weight to this last observation, although it is not necessarily lacking in significance.

While the results reported here seem to indicate a correlation between chemical thyroidectomy and a retardation of sexual activity in the minnow, they do not, of course, necessarily imply that the thyroid hormone normally exerts a direct influence upon the reproductive system of this animal; indeed, one cannot yet be certain that the consequences in fish of treatment with thiourea can legitimately be interpreted as physiological in nature. None the less, it is interesting to find increasing evidence of the existence of cyclical fluctuations in the activity of the thyroid gland of teleosts[14], related sometimes, it has been suggested, to spawning or to migration; and we ourselves, in work to be published elsewhere, have been able to demonstrate a statistically significant trend of increasing cell-height in the gland of the minnow during the winter and early summer. Our present knowledge of the endocrinology of the lower vertebrates is, however, so meagre that the significance of the facts is obscure in the extreme, and a discussion of them must be left for fuller treatment elsewhere.

In the meantime, one further point seems worth making. It has often been suggested that the apparent inhibiting influence of thyroidectomy on the reproductive system of the homothermous vertebrates might be a secondary consequence of reduced metabolic rate; in teleosts, however, such an explanation may prove to be less likely, for the available evidence, contradictory though it is in part, casts doubt on the existence of a marked calorigenic effect of the thyroid in that group. In studying such problems in fish, therefore, one may be analysing a simpler and, in evolutionary terms, more primitive situation than obtains in the higher forms, and it is hoped that work now in progress in this Department will test the correctness of this point of view. [Feb. 23.

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COMPETITIVE SUPPRESSION AND THE DETERMINATION OF LINKAGE IN MICRO-ORGANISMS

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WHILE investigating the standard method of assessing the mutagenic activity of an agent by its enhancement of the back-mutation rate of strains of fungi carrying a biochemical mutation, Grigg[1] has demonstrated a marked suppression of the prototrophs (which arise from, and are used as a measure of, back mutation), by unchanged cells of the mutant strain, with which the experiment was started, and which are themselves incapable of growing on the medium used. Dilution of the spore suspension which was plated out gave an increase in the proportion of prototrophs recovered, presumably through a weakening of the suppression. Similar increases observed after treatment with reputed mutagens, which also kill a percentage of the spores, could therefore be due to a weakening of the suppressive effect and not to any rise in the back-mutation rate.

Kølmark and Westergaard[2] have shown that Grigg's criticisms do not apply to all tests of mutagenic activity made by the observation of back mutation, for on media containing excess nutrients competitive suppression does not occur. Indeed, it might be expected that competition will appear only where some nutrient is present in sufficiently small amounts for even the very limited activity of the non-prototrophs to cause its depletion. Since, however, suppression does occur under these, and possibly under other, so far unanalysed, conditions, it is essential for the correct interpretation of the results that, where such conditions are liable to be achieved experimentally, its effect should be recognized and its intensity evaluated.

Now clearly a similar suppression of prototrophs by spores themselves incapable of growth might occur where the prototrophs have come into being by means other than mutation. Techniques of demonstrating and estimating genetic linkages in micro-organisms are often dependent on the recovery of prototrophs, here arising by recombination of the genes in question, on selective media. In these cases, too, the prototrophs must grow in the presence of high concentrations of spores which, by virtue of their being non-recombinants or non-prototrophic recombinants, are incapable of growth. The recovery of the prototrophs, and hence the assessment of the linkages, might well, therefore, be disturbed by the occurrence of suppression similar to that which Grigg has found. Such a disturbance would be all the greater where, as in *Escherichia coli*, sexual fusion is itself rare, or where, as in the homothallic fungus *Aspergillus nidulans*, many of the fusions occur between nuclei of like genotype. In such species high concentrations of spores must often be plated in order to recover the prototrophs arising from the relatively rare fusion of nuclei of the appropriate types.

The occurrence of a suppression in *E. coli* is suggested by certain observations already in the literature, notably from studies of the effect of irradiation on recombination made by Haas, Wyss and Stone[3]. These authors used a concentrated inoculum, the cells coming from two strains which had complementary biochemical requirements. Only the prototrophs arising by recombination would grow on the medium used. The numbers of prototrophs increased with time of exposure to radiation, up to a maximum of thirty seconds at which a large number of cells were killed.

These results were taken as showing an increase in recombination resulting from some unanalysed effect of the radiation. It would appear, however, to be explicable by the suppression effect as Grigg has described it. We merely have to make the further, and not unreasonable, postulate that suppression of prototrophs can be produced by mixtures of two or more non-prototrophic genotypes, as it can by a uniform sample of one such genotype. The lethal action of the radiation would lead to a reduced concentration of viable cells and hence a reduced suppression of prototrophs just as in Grigg's case.

Any lethal agency should, on this view, lead to a similar rise in the rate of recovery of prototrophs (and hence to a similar rise in apparent frequency of recombination), and indeed these same authors, in collaboration with Bennet-Clark[4], have shown that treatment of the spore suspensions with hydrogen peroxide (except where this is vitiated by pre-treatment with catalase) and sodium azide, both of them killing agents, produced just this result. True, above a certain level the treatments led to a decrease in the absolute number of prototrophs recovered; but this could arise at any point where the killing of the prototrophs themselves was no longer offset by a reduction in the suppression, as would be the case when the suspension had been thinned out below a certain level by the general lethal action of the treatment.

A further observation of these authors[5] also fits into the same picture. They found that after plating irradiated *Staphylococcus aureus* on to media containing streptomycin or penicillin the number of colonies formed increased with dilution of the cell suspension. They were able to offer no explanation of this result, but the interpretation is obvious in terms of suppression. The streptomycin- or penicillin-resistant colonies which develop are the equivalent of prototrophs and they are growing in the presence of large numbers of non-resistant cells which, of course, are inactivated by the antibiotic. Dilution would thus, as before, reduce the suppressive effect which one might suppose to exist.

Evidence of a similar nature is provided by Newcombe[6]. He found that concentrations of non-prototrophs higher than half those normally used in linkage estimations in *E. coli*, that is, 2×10^9, led to an apparent reduction in the rate of mutation of *E. coli* to bacteriophage resistance. This could be due to a suppression of the prototrophs, which are in this case the resistant mutants, by the large excess of non-prototrophs, and not to a reduction in the actual rate of mutation.

Finally, there is the evidence from an investigation by Nelson[7] into the relationship between the concentration of the two parental types mixed together, and the number of prototrophic recombinants produced in *E. coli*. Although in some cases the relationship was linear over the concentrations of parental types investigated, in others there was a marked falling off in the number of prototrophs recovered as the concentration of parental types increased. Extrapolation of one of the curves shows that at the concentration of parental types normally used in linkage estimations, approximately half the expected number of prototrophs would be recovered.

The investigations of Nelson illustrate a further point, namely, that the extent of suppression, if any, is specific for a particular prototroph – non-prototroph – concentration – medium combination. Therefore, if more than one type of prototroph is selected for in the presence of a mixture of non-prototrophs, by a particular medium, there is the possibility of differential suppression of the prototrophs. If this is true, one would expect the different prototrophs, or combinations of genes in an individual, to be recovered with different frequencies according to the particular character used as a basis for selection, as this will alter not only the types of prototrophs but also the types of non-prototrophs and the ratio of prototrophs to non-prototrophs. It is significant in this respect that Newcombe and Nyholm[8] obtained different linkage relations for non-selected characters according to whether they selected the prototrophs for their ability to grow on a minimal medium or for particular streptomycin reactions of the recombinants.

Thus there is a large body of evidence suggesting that the type of suppression reported by Grigg occurs in these micro-organisms whenever prototrophs are selected in the presence of large numbers of non-prototrophs. Furthermore, this suppression appears to occur no matter whether the prototrophs are selected by their ability to grow on a particular minimal medium, or for their resistance to, or requirement of, a particular drug, their ability to tolerate poisons, or their resistance to a bacteriophage.

In fungi, linkage experiments depending on the complete analysis of tetrads, or asci, must be above suspicion of this particular type of disturbance; but mass analysis of sexual spores, such as ascospores, or conidia, by a series of screening media will open the way to upset by competitive suppression. Such disturbance is likely to be all the more serious when the prototrophs are rare, for example, when recombination between tightly linked genes is being investigated, for in these cases heavier inocula of spores are generally plated in order to secure a reasonable number of the rare recombinants.

The operation of competitive suppression of the type discussed above would make true linkage appear tighter than is actually the case, while genes which really recombine freely might appear linked.

The literature on the genetics of *E. coli* abounds with reports of anomalous segregations and apparent non-linear arrangements of genes. Since the linkage estimations are normally made by the recovery of prototrophs from inocula carrying 10^8 or 10^9 of each parental type of cell per ml., it may well be that they merely reflect the widespread occurrence of the Grigg phenomenon. Certainly until this point has been cleared up the observations cannot be taken as incompatible with a chromosome system of the conventional kind (though, of course, the justification for postulating such a system in bacteria is perhaps another matter); and the more complex the screening technique used for the analysis, the more involved the competitive systems and the more confusing the effects of suppression might be.

Should the Grigg phenomenon turn out to be a source of complication in such linkage experiments, it is not easy to see a simple way of avoiding its effects. To keep the spore concentration constant in any set of determinations is an obvious elaboration of the standard technique; but this could not be relied on to do more than stabilize the disturbance so that a correction, which must itself be obtained from other considerations, could be applied. The correction, or the spore concentration, might well, however, have to be varied between the experiments involving different genes, for there is evidence that non-prototrophs of different kinds may not show the same strength of suppression on the various prototrophic recombinants. The only sure way round the difficulty would be the possibly tedious and demanding method of always using concentrations at which suppression does not occur or at least is negligible.

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INTERNATIONAL HEALTH ORGANIZATIONS

By SIR ARTHUR MacNALTY, K.C.B.

PESTILENCE has ever been a stimulus to preventive medicine. The dire visitations of cholera in Great Britain led to Snow and Budd's discoveries that water conveyed the disease and later to Koch's discovery of the *Cholera vibrio*. As international communications increased, so did the risk of transmission of disease from country to country. The principles of collaboration between governments in matters of health, established by the first international conference in 1851, led to further international sanitary conferences, the first general convention on quarantine in 1903, and the founding of the first international health organization, the Office International d'Hygiène Publique, at Paris in 1907. The Office carried on the work of the former Constantinople Superior Board of Health in preventing the spread of cholera by Mahommedan pilgrims to the holy places of Arabia. It also supplied important epidemiological information and data to fifty countries and secured international agreement on many medical and public health problems.

In all this work, Great Britain, the pioneer in public health, often took the initiative and placed her experience and knowledge at the service of other countries. Nor, since the beginning of the century, has the United States been far behind in this respect. The Pan-American Sanitary Bureau was founded by an International American Conference in 1901, and the First Pan-American Sanitary Conference in 1902 organized its work. Under the able directorship (1920–46) of Surgeon-General Hugh S. Cumming, and, afterwards, under that of Dr. Fred L. Soper, the Bureau's activities expanded to cover all aspects of public health of concern to the American republics. From co-operating closely with the Paris office as an information bureau which promptly reported outbreaks of certain epidemic diseases of international importance, it has become a central health agency for all American countries, and, on request, renders such aid as is possible to these countries in the prevention, control and eradication of disease.

The first example of international collective action against epidemic disease was seen after the First World War. There were big epidemics of typhus fever and other diseases in Poland, Russia, Roumania, Greece and other parts of Europe, and the threat of their spread was a serious menace. Through the League of Nations National Council, in May 1920, the Epidemic Commission was set up, and its team of international experts helped the countries concerned to get the epidemics under control.

The Covenant of the League of Nations contained a mandate to the League "to endeavour to take steps in matters of international concern for the prevention and control of disease (Article 23 (f) of the Covenant)". The Health Organization of the League began in 1921, and its constitution was finally adopted by the fourth assembly of the League in 1924. Dr. L. Rajchman (Poland) held the post of medical director from 1921 to January 1939. Its Health Committee was composed of the chief national health administrations, including the United States. Its secretariat comprised a number of medical men of different nationalities, public health officers and assistant staff.

The Health Organization's work met with success. It established close relations beween the health services of different countries, gave information on public health questions and epidemics, promoted technical studies including international standardization, provided expert assistance in field investigations, organized study tours and set up a Far-Eastern Bureau in Singapore. The Organization was greatly helped by Sir George Buchanan, the British delegate to the Paris office and to all the International Sanitary Conferences during 1919–35, who recorded some of its achievements in his Milroy Lectures (1934); by Dr. M. T. Morgan, British delegate from 1936; by Prof. T. Madsen (Denmark), president of the Health Committee, 1921–37; by Prof. J. Parisot, president during 1937–47; and by many others.

During the Second World War co-operation on international health work was perforce restricted, and the Health Organization of the League of Nations was much reduced. When the War ended, in anticipation of threatened famine and severe epidemics, the United Nations Relief and Rehabilitation Administration was already in being. Though its duration was brief—it was dissolved in 1946—its labours controlled European epidemics, averted famine and supplied a temporary pressing need.

Following on the work of a technical preparatory committee which met in Paris during March–April 1946, a World Health Conference was held in New York in July of that year, attended by delegations from the fifty-one members of the United Nations, ten non-members, the Allied Control Commissions for Germany and Japan, and from ten international health organizations. As a result of this Conference, the World Health Organization was constituted and established. It has absorbed or integrated the work of previously existing international health organizations, set up its permanent headquarters at Geneva, and works in accord with the United Nations, the Food and Agriculture Organization, the United Nations Educational, Scientific and Cultural Organization, the International Labour Office and other important bodies. An interim commission made preparations during 1946–48 for the permanent World Health Organization, continued the statutory functions of the previous health organizations and conducted emergency health international work.

The objective of the World Health Organization is defined as "the attainment by all peoples of the highest possible level of health". For the time being, this high aim cannot be realized. Once more, international politics have placed obstacles in the way of world health. The U.S.S.R. and its satellites have withdrawn from the Organization, and the new government of China is not a member. With expenditure on armaments and national health services, there is little money available for helping and subsidizing the public health work of less progressive countries. The main work of the Organization seems, therefore, for the present to lie in epidemic intelligence, the making of international standards and the giving of expert advice, on request, to health administrations on public health matters. If disappointment be felt at this conclusion, when preventive medicine holds so many powerful weapons for the eradication of disease and suffering, it should be remembered that the work of the past hundred years has laid the foundations of international health, that much has been achieved, and that work of this character marks progress on the way to the time when all the nations of the world will unite for the good of mankind.

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BRITISH WELDING RESEARCH ASSOCIATION

NEW FATIGUE TESTING LABORATORY AT ABINGTON, CAMBRIDGE

MUCH is already known of the fatigue properties of structural steel and other industrial metals, when tested as simple laboratory specimens. Even so, it is essential to take into account the geometrical and metallurgical notches introduced into structures by welding or other methods of fabrication if fatigue failures are to be avoided. Because of this, the fatigue testing of welded structural components forms an important part of the work of the British Welding Research Association at its Engineering Research Station at Abington, near Cambridge. This work has received new impetus with the completion of a new Fatigue Testing Laboratory, officially opened by Lord Woolton, Lord President of the Council, on June 23. The new laboratory, which has a floor area of 5,000 sq. ft., is of technical interest in itself, since it is the first building to be erected for which the plastic design method, originated by Prof. J. F. Baker, professor of mechanical sciences in the University of Cambridge, has been applied. Appreciable economies in steel have been effected thereby, and the architect and consulting engineers have been enabled to produce an æsthetically pleasing building in which the steelwork is particularly unobtrusive.

The structural components which are tested come from the oil and power, aeronautical, shipbuilding, automobile and general engineering fields, and it is not surprising, therefore, that three broadly different methods of load application are used. Of these, the method of resonance vibration has been used for some years. The basis of this is the Lanchester oscillator, in which a pair of eccentrically mounted masses are rotated in opposite directions by means of a variable-speed motor, to produce an oscillating force in a given plane relative to the specimen, which is freely suspended at its nodes. When the speed is adjusted to a point near resonance, considerable stresses are set up in the specimen. In one case, fatigue bending tests have been carried out on light box members simulating chassis members in a motor-car, while, at the other extreme, tension/compression loads of ± 30 tons have been excited in Bailey bridge members, by the addition of masses at either end to establish the correct mode of vibration. Precise control of the induced stresses is important, and is achieved by speed control, using either amplitude of vibration or strain, through a wire-resistance strain-gauge, as the variable governing the servomechanism.

The resonance method is flexible in its application to varieties of structure, but has the disadvantages of producing only equal tension and compression load-cycles, and a severe size limitation caused by the rate of wear of large oscillators. The Association has therefore acquired two non-resonating machines of 100 tons capacity for installation in the new laboratory. The Losenhausen machine, with mechanical and hydraulic actuation, works at speeds of 100–600 cycles per min. (compared with more than 3,000 cycles per min. for a resonance machine). An interesting feature is its mounting on twenty-four struts, the Euler crippling load of which has just been exceeded, so that they behave as soft springs, ensuring that no vibrations from the 20 tons mass of the machine are communicated to the foundation. This method of mounting was developed by T. S. Robertson, of the Naval Construction Research Establishment, Rosyth. The other machine was designed by Prof. W. M. Wilson, of the University of Illinois, and is operated by means of an eccentric and a load-multiplying lever. Two specimens may be tested independently and simultaneously in this machine, but only at 100 cycles per minute. Parts for this machine have been made in Great Britain and given to the Association by a number of manufacturers interested in furthering the work of fatigue testing. Both the Illinois and Losenhausen machines make provision for statically preloading the specimen during test, so that load-cycles to the extremes of zero to maximum tension or compression may be applied.

The remaining fatigue-testing machine operated by the Association is concerned with pressure vessels and pipeline components subjected to internal pressure. This consists of a large-capacity hydraulic pump, together with automatic valve gear designed to apply pressure pulsations from atmospheric to 6,000 lb./sq. in. at up to 100 cycles per min.

The method of fatigue testing is attractive, even for structural members which may not be subject to severe pulsating loads during service, because of the searching comparison which may be made between types of weld and methods of design. Proneness to failure through the effect of stress concentration is exposed where static loads would be sustained with full ductility.

In parallel with the full programme of fatigue testing at present being carried out by the staff of the laboratory, studies are being made of the mechanics of crack propagation, the phenomenon which is fundamental to brittle and fatigue structural failures.

A. A. WELLS

THE BEHAVIOUR OF BOWER-BIRDS

A COMMUNICATION by Prof. Evelyn Hutchinson, of Yale University, in a recent issue of the *American Scientist* (40, No. 1) throws considerable light upon the behaviour of bower-birds. The bower-birds are a group of Australian and New Guinea birds, generally classified along with the rifle-birds, Australian catbirds, and birds of paradise as the family Paradiseidæ, or pair of families, the Paradiseidæ and Ptilinorhynchidæ, which most ornithologists have regarded as closely allied to the crows. Though they lack the resplendent plumes of their allies, the birds of paradise, some of the bower-birds exhibit behaviour of a kind which in its complexity and refinement is unique in the non-human part of the animal kingdom.

The unique feature of the majority of bower-birds is that, during the breeding season, the males build tiny ceremonial houses, set neatly in clearings and furnished with a variety of objects which are used in display and which, when not in use, are piled up carefully on the cleared area in front of the bower. These bowers have nothing whatever to do with the nests of the species, which are constructed by the female alone at some little distance from the male's display area.

Hitherto this extraordinary type of behaviour has been interpreted anthropomorphically; but some recent papers permit the behaviour to be interpreted primarily in avian terms. The studies related mainly to two species, the tooth-billed bower-bird, *Scenopoeetes dentirostris* and the satin bower-bird, *Ptilinorhynchus violaceus*. The former makes no true bower, though its behaviour is remarkable enough, while the latter not only builds a bower but also paints the inside of it, and so is perhaps one of the most advanced and complicated of all bower-birds in its habits.

Scenopoeetes is found only in a restricted area of north-eastern Queensland, living in tropical rain-forest. It is a dull-coloured bird about 27 cm. long and exhibits no external sexual dimorphism. The most remarkable morphological feature of *Scenopoeetes* is a triple saw-toothed apex to the maxilla, which fits into depressions at the apex of the mandible.

Like so many other male birds, the male *Scenopoeetes* occupies a definite territory during the breeding season, and from that territory he calls or sings. The central part of the territory, under the singing perch, is defined as a clearing, all the litter of the tropical forest floor being carefully taken away. On this clearing or stage, every morning the male *Scenopoeetes* arranges a number of leaves sawn off from neighbouring bushes and trees and placed with the pale conspicuous lower surfaces uppermost. Before this is done, the withered leaves of the previous day are carefully removed to a refuse pile outside the stage. The leaves are gathered by sawing through the petiole with the toothed tip of the beak. Not all species of bush or tree produce leaves which suit the tastes of *Scenopoeetes*, and individual males appear to have individual tastes in this matter. The leaves of *Alpinia* and *Darlingia*, which are often used, may be twice as long as the bird which collects and arranges them. The stage, which may be up to 2 m. × 3 m. in dimensions, can have more than forty leaves laid out on it. Although the toothed apex of the bill is not known to have any function other than that of sawing through leaf petioles, many of the leaves used can be easily detached by a sharp pull that would seem to be well within the physical capabilities of the bird. If *Scenopoeetes* had discovered this, its whole life might have been easier, though its evolution would probably have run a different course.

In *Ptilinorhynchus violaceus* there is a more elaborate type of behaviour. The bird is about the same size as *Scenopoeetes* and of normal form, but is strongly sexually dimorphic; both sexes have intensely blue eyes. The males do not acquire their adult plumage until they are at least five years old. This is a remarkable age for maturity in a passerine bird, for most species have a mean expectation of life at fledging of a little over a year, and show little change in survivorship from year to year, even when the potential physiological longevity may be ten or a dozen years.

The bower of *Ptilinorhynchus* is described as made of two parallel rows of sticks, each row being about 30 cm. high and 35 cm. long. The two rows lean towards each other, so producing an incomplete roof space. The long axis of this structure is normally set north and south, and in front of the north end a display area is cleared.

On the display area, a number of coloured objects are systematically arranged. The objects collected by *Ptilinorhynchus* are usually blue, less often lemon-yellow or greyish-brown. Throughout the entire breeding season, the male is likely to pick up one of these objects, moving in and out of the bower and displaying in front of the object by erecting the feathers and making characteristic movements. A female may be lurking behind the bower while this is happening; but the male appears to pay more attention to the blue flowers, berries, pieces of broken glass, or in some cases even street-car tickets, than to the blue eyes of the female.

The bower, therefore, cannot be involved in sexual selection as such, though, since the building habits develop each year in association with increasing testicular activity, the bowers and adjacent display areas with the associated coloured objects presumably have a sexual significance. It is probable that the blue and to a less extent the other coloured objects provide a greatly enhanced visual stimulation of the kind otherwise received from the blue eyes and possible other epigamic colouring of the female.

After mating, the female leaves the area of the bower and builds a nest by herself. Throughout the period of nest building and incubation the male continues displaying at the bower. During this period spermatogenesis continues actively, though in most single-brooded monogamous birds sperm production stops after mating and nidification. When the young are fledged, they are brought by the female to the bower and for a week or two the family engage in communal display activities. Then the bower is abandoned and all birds join the autumnal feeding flocks.

Some males of *Ptilinorhynchus* have the extraordinary habit of making a paint out of charcoal, or fruit pulp, mixed with a secretion produced from the mouth, and of applying this paint to the inside of the bower by means of a wad of fibre from some soft kind of bark. The habit is exhibited only at the height of the breeding season, when spermatogenesis is most active and mating and ovulation are occurring. The significance of this behaviour is entirely unknown.

The available information suggests that the extraordinarily specialized behaviour of the bower-birds is an immensely complicated development of avian territorialism. The chronology of the events in relation to spermatogenesis, no less than the detailed sequence of the behaviour itself, is in accord with this idea. The need for such behaviour arises from the fact that it is advantageous for any male to secure his territory and mate as early as possible, for competition is often severe, while it may be highly disadvantageous for reproduction to begin until much later in the year when adequate food for the young is available.

In addition to an elaboration of this kind, there is the extraordinary substitution of inanimate objects for the primary sexual stimulus, a process which would be termed fetishism in human psychopathology. This curious development directs attention to the way in which individual culturally determined acts in man so frequently have parallels in the specifically characteristic behaviour of birds.

HEALTH OF THE SCHOOL CHILD

IN "The Health of the School Child", the report for 1948–49 of the Chief Medical Officer to the Ministry of Education (London : H.M.S.O., 1952. Pp. 92. 3s. net), it is stated that the children in Great Britain are healthier than ever before in our history.

The numbers of under-nourished school children are now so small that school medical officers do not consider that the subject calls for special mention. Some of them, however, give data on heights and weights. Between 1939 and 1949, London school children gained an average of ¾ in. in height and 1¾ lb. in weight. A striking feature was that the changes in height and weight were proportionate ; while the greatest improvement had been in districts above average in 1938, there had also been a definite improvement in the worst areas. Children were not merely taller and heavier than their parents but were members of a generation altogether of greater physique. Figures relating to 5-year-old children in Wolverhampton showed that girls gained an average of over 6¼ in. in height and more than 8 lb. in weight between 1909 and 1949 ; boys gained an average of nearly 4¼ in. and 6¼ lb. during the same period. Weighing machines in senior schools in this area were no longer adequate for pupils in their last year.

During the period 1939–49, the school meals service multiplied roughly seventeen times and had changed out of all recognition. With restrictions on the building of new canteens, the report suggests concentration on stabilizing and improving the existing service. The development of training courses for staffs at all levels is proposed. The lack of courses for women who serve the meals is unfortunate, particularly since reports on food poisoning frequently attributed the trouble to lack of knowledge in the canteens.

Figures for October 1949 showed that 53·2 per cent of the children present (2,851,000) took school dinners, and there were 23,000 canteens serving 27,000 schools. 1,950 schools were then without school meals facilities. In addition, 86·9 per cent (4¾ millions) of the children present took milk in school. More than 98 per cent of the milk was either tuberculin-tested or pasteurized.

During 1948, 96,262 school children had tonsil operations. The following year the figure fell to 69,449. The large number of operations in 1948—the figure was only exceeded in 1929–30–31—was mainly due to the widespread poliomyelitis epidemic in 1947. This caused the postponement of operations which would have been carried out in that year. The report stresses that tonsillectomy is scarcely ever an urgent operation and that only cases in need of urgent treatment should be referred to hospital for operative treatment. It is becoming increasingly realized that tonsillectomy is not a trivial operation and should not be treated lightly. Cases that are not urgent should be kept under observation for at least three months before being referred to a surgeon. All cases put on hospital lists should be examined periodically, since experience has shown that many who had been on a waiting list for a long time no longer required treatment. It is more important to deal safely and efficiently with a few children than to operate on large numbers, many of whom are in no need of urgent treatment.

The serious effect of the National Health Service on the school dental service is discussed. Because of the higher incomes obtainable under the new general dental service, many school dentists resigned to enter private practice. By the end of 1949, the number of school dental officers was 884 (equal to 732 full-time officers), compared with 1,063 (921 full-time) in 1947. In eighteen months, the service had lost one-fifth of its strength and was back to its war-time position.

There are signs in some areas that the improvement in the teeth of school children during and just after the War is on the wane. One report suggested that sticky buns given by mothers to restive young children was the possible cause of "the deplorable teeth so often seen in children between 5 7 years".

Nearly 450,000 school children (8 per cent of those on the registers) were found to be in a verminous condition in 1949. This was "profoundly disappointing" and showed no improvement on post-war years. In 1948, more than 4½ million school children—probably more than half of those on the registers—were medically examined or re-examined, other than for dental disease or verminous condition. The incidence figures for the various defects showed no major changes from those of 1947, though increases in the number of cases of defects of vision and speech needing treatment were recorded.

The new outlook on physical education is commented upon, and the growth of interest and skill in athletics noted. In Wales, athletics had made considerable headway where hitherto progress had been slow. The Midland and South-Western Divisions also reported an increase in the popularity of athletics ; in the North-Western Division it was "probably the one aspect of physical education in which improvement was most obvious".

The report contains a special chapter on the problems of diabetic children. England is believed to be the only country in the world providing hostels for these children ; but the report stresses that while such accommodation is indispensable for a minority of diabetic children, the great majority should remain at home since there was no substitute for a good home. The report also contains chapters on the co-ordination of the school health service with the National Health Service, the treatment of defective vision, and the prevention of tuberculosis in school children.

The cost of the school health service and special schools, which was £10,194,000 in 1947–48, fell to £9,234,000 in 1948–49.

INCENTIVES AND SIZE OF INDUSTRIAL PLANT IN GREAT BRITAIN

THE information about the "Proportion of Time-workers and Pieceworkers" which is published by the Ministry of Labour[1] may be expected to direct inquiries on industrial structure into new channels. A remarkable connexion between the distribution of pieceworkers and the variation of the size of plants emerges from this information, a connexion which in the past seems to have been overlooked by both theoretical and empirical studies in this field.

The first detailed survey of methods of wage payments in separate industries appeared in 1947; it was followed by two similar but more elaborate surveys, for October 1949 and October 1951. A new feature of these two is the classification of the data according to the size of industrial plants. Four size-classes are distinguished: establishments with less than 25, 25–99, 100–499, and with 500 or more wage-earners. Pieceworkers are defined as workers paid under any system of "payment by results", and data are supplied for 131 separate (mostly manufacturing) industries. The 1951 survey covers some 6¼ million workers, which amounts to more than two-thirds of the total number employed in the 131 industries.

To appreciate this material it should be recalled that the Census of Production gives data on size of plants and wages but not on wage methods. Although it might seem plausible that incentive schemes are more suitable for larger than for smaller plants, there has been no evidence of this. Indeed, it is known that they are widely used in such industries as cotton, potteries, dressmaking, etc., where relatively small and medium, rather than large, plants prevail. Thus, a close relationship between an industry's size-structure and particular payment methods could scarcely be expected. That it does exist, nevertheless, can now be seen from the Ministry of Labour surveys. We must exclude, of course, those industries where the proportion of pieceworkers as a whole is too small (say, less than 10 per cent) to be significant for the present purpose or where the information for separate size-classes is incomplete. There remain seventy-five industries, and forty-seven of these show a consistent relation between size-structure and incentives: the proportion of pieceworkers increases step by step with increasing size of plant. In iron and steel melting and rolling, for example, the percentage of pieceworkers rises from class I (less than 25 workers) to class IV (500 and more), in 1949, as follows: 25, 37, 51 and 65 per cent; and similarly in 1951: 24, 41, 54 and 66 per cent. Other important industries with the same pattern are motor-vehicles, rayon and nylon weaving, building, boots and shoes, rubber, furniture and iron foundries. The industries which do not show a connexion between size of plant and methods of payment include woollen and worsted, cotton weaving, tailoring and agricultural machinery.

While a full explanation must wait for further data, two conclusions may already be suggested. The specific advantages of larger organizations are not only a matter of technical conditions, but involve also the opportunity of controlling a relatively larger number of workers through wage incentives; and the possibility of increasing the use of incentives, on the other hand, depends at least partly on the scope for expansion. There can be no doubt that the Ministry of Labour surveys are extremely useful for the advancement of research into these problems. It would be desirable, however, if in future actual figures of wage-earners, not merely percentages, could be supplied, and if the largest size-class could be split up into 500–999 and 1,000 and more workers. It would then be possible to link up the information with the Census of Production. W. BALDAMUS

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[1] *Min. Lab Gazette*, October 1947, October 1950 and April 1952.

EAST AFRICAN INDUSTRIAL RESEARCH BOARD

REPORT FOR 1951

THE ninth annual report of the East African Industrial Research Board* covers activities for the year ending December 31, 1951. Laboratory trials described in the last annual report have been followed by an experimental run at a factory producing sodium phosphate commercially, which has demonstrated that a satisfactory product can be obtained in a continuous chamber kiln fired by wood producer-gas, with proper control of firing. Storage trials over a period of three months have demonstrated that there is no deterioration of this type of product, provided there is no marked leaching.

The characteristics of cement clinker obtained by burning varying proportions of a product containing less than 0·5 per cent of phosphorus pentoxide, from limestone containing 2 per cent of phosphorus pentoxide, with raw limestone and clay are being investigated, and also the effect on refractory quality of bonding different grain-sizes of kyanite with various materials. Two new clay deposits have been found which proved satisfactory bond clays for refractories, and certain lavas have been found which can form the basis of a glaze for drain-pipes and which can be fired at a lower temperature than that required for salt glazing. The distillation of surplus wood from the wattle industry to give charcoal and wood tar is being investigated, and metallurgical charcoal obtained from wattle may be of use for smelting and other purposes in the Tororo area. Simple pulverization reduced the bulk density of the husk from dried coffee cherry sufficiently to permit its transportation for use as a substitute for bran in stock feeds. Mixed fatty acids obtained from the seeds of *Moringa oleifera* are highly suitable for froth flotation in the production of kyanite, and a drying oil which is satisfactory for paint manufacture has been obtained in 17 per cent yield from the whole nuts of *Aleurites triloba*, grown in Uganda, and in 55 per cent yield from the kernels.

Hecogenin, a steroid, which can be used as a raw material for the synthesis of cortisone, can be conveniently obtained from the juice of the sisal leaf, and a pilot plant has been built at the laboratory to provide the Medical Research Council with a supply of hecogenin for the synthesis of cortisone. A note appended to the report outlines the process and indicates the work which an officer of the National Institute for Medical Research is carrying out on the occurrence of hecogenin in sisal leaves. A note on the drying of sisal fibre and a list of publications on industrial research are also appended.

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* East African Industrial Research Board. Ninth Annual Report, 1951. Pp 10. (Nairobi Government Printer, 1952.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Evidence for the Polarization of the Protons produced in the D—D Reaction

SEVERAL authors[1,2] have measured the angular distribution of the particles produced in the D—D reaction as a function of bombarding energy in the range 100–400 keV. A theoretical fit to the observations demonstrates the possibility of a strong spin-orbit coupling in the interaction[3]. This coupling may produce polarization of the outgoing protons[4]. The polarization can be detected by observing the azimuthal angular distribution of D—D particles scattered by nuclei in a process involving spin-orbit coupling. An azimuthal anisotropy would be proof of the polarization. Such an anisotropy has been demonstrated in a double-scattering experiment for protons of 3-meV. energy scattered by helium[5]. This provides a valuable analyser for the polarized proton. It was therefore decided to use this method in the search for a polarization of the protons produced in the D—D reaction. A previous attempt to detect polarization of the neutrons by scattering on carbon was vitiated by the background of neutrons produced by scattered deuterons in the accelerator tube.

A beam of 300-kV. deuterons was collimated by two diaphragms of 5-mm. diameter on to a heavy-ice target, thus producing 10^8 protons per second. Protons escaping at an angle of 120° to the deuteron beam were allowed to go through an aluminium window 6·5 mgm./cm.^{2}, and to pass through a scattering chamber (1·2 cm. diameter) containing helium at atmospheric pressure. The scattered protons were detected with a proportional counter (diameter 2 cm., length 7 cm.), filled to a pressure of one atmosphere with argon, at a distance of 2 cm. from the axis of the scattering volume, separated by an aluminium window (2·8 mgm./cm.^{2}). Protons that had passed through an average of 4·0 cm. of helium and which were scattered through an angular range (75°–120° centre of mass) could enter the counter. At the moment of being scattered they had an energy of (2 ± 0·2) MeV. Their energy on entering the counter was 600 keV., which is more than twice the maximum energy of argon recoils from the 2·5-MeV. neutrons. The walls of the counter were lined with lead in order to avoid a background of protons due to an (n,p) reaction which a brass wall counter was found to give.

The whole arrangement of scattering volume and counter could be rotated around the axis of the scattering chamber.

The centre of the scattering volume was 7·5 cm. from the target, which was aligned at 60° to the deuteron beam. The copper target was cooled with liquid air, and heavy ice was formed on it continuously. The size of the copper target was such that displacements of the incident deuteron beam could not cause serious asymmetries in the intensity of the proton beam in the scattering chamber. The measurements were monitored with a neutron recoil counter (filled with methane at 20 atmospheres pressure). The ratio of the intensity of scattered protons to neutron monitor counts was found to be constant within the statistical accuracy of 5 per cent, for any one orientation of the scattering chamber. The proton counting-rate was measured forward and backward in the plane of incident deuteron and emitted proton beams, and in the two positions normal to this plane. The rates observed were

Forward	1·80 ± 0·07
Backward	2·97 ± 0·11
Normal positions	2·30 ± 0·08, 2·3 ± 0·09

The azimuthal distribution is of the form $\sigma(\theta,\varphi) = \sigma[1 + PA \cos\varphi)$, where φ is the angle between the normals to the scattering planes. The magnitude of A is estimated from the geometry of this experiment and an average value for the analyser efficiency[5] of 87 per cent obtained. The product PA is evaluated from the above data and equation, correcting for the range of φ accepted by the counter. The value of PA is 0·25 ± 0·05. The analyser efficiency A is 0·87 for our geometry, with an uncertainty due to the experimental errors on the data obtained for p—He scattering. Thus the polarization of the D—D protons is (30 ± 6) per cent.

The symmetry of the D—D reaction for proton and neutron emission leads one to expect a similar degree of neutron polarization. Longley, Little and Slye[6] have reported a polarization of (40 ± 20) per cent for D—D neutrons. We cannot make a comparison with our result since they do not indicate the energy of their deuteron beam.

The interest of the availability of a source of polarized neutrons and protons for the investigation of spin-orbit coupling in nuclear scattering and of the interaction of polarized particles with polarized nuclei is obvious.

We are much obliged to Dr. R. J. Blin-Stoyle for suggesting this experiment to us, and for many stimulating discussions. We thank Lord Cherwell for his continued interest. One of us is indebted to Imperial Chemical Industries, Ltd., for a research fellowship, and another to the Department of Scientific and Industrial Research for a maintenance grant.

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G. PRESTON H. H. HALBAN
Clarendon Laboratory,
Oxford. June 23.

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Weak Echoes from the Ionosphere with Radio Waves of Frequency 1·42 Mc./s.

IT is well known that medium-frequency radio waves (0·5–1·5 Mc./s.) are often very highly absorbed in their passage through the lower ionosphere, so that the amplitude of the echo may fall below the limit of detectability of the usual ionospheric recording equipment. The occasions of greatest absorption occur in the day-time in summer, on certain days of abnormally great absorption in winter and for short intervals during radio fade-outs.

By the use of a new method, we have been able to improve the sensitivity very considerably and have been able to make measurements throughout days of high absorption in winter on a frequency of 1·42 Mc./s. It is the purpose of this communication to outline the results obtained. The apparatus will be described in detail elsewhere. It is sufficient to state here that it uses a frequency-modulation method, which is a development of the original Appleton and Barrett frequency-change technique, and that special arrangements are made to integrate the output over a period of the order of 1 sec.

As in all 'radar' systems, the ultimate sensitivity depends on the mean power of the sender, provided the receiver is designed for optimum signal-to-noise ratio. With a pulse system the optimum signal-to-noise ratio could only be achieved by the use of pre-detector integration; it is not achieved with the ordinary type of pulse receiver. A comparison of our new system and the ordinary kind of pulse system may be made by stating that our mean power is 500 watts and our effective receiver band-width 1 c./s., whereas a typical high-power pulse apparatus uses a mean power of 100 watts (peak power 10 kw., pulse-width 200 sec., repetition frequency 50 c./s.) with a band-width of 20 kc./s.

It is easily possible with our apparatus in its present form to detect echoes corresponding to reflexion coefficients of 3 × 10^{-5} (attenuation 10 nepers).

Experiments on a frequency of 1·42 Mc./s. have been in progress since the beginning of the year. On several days of high absorption in January and February, when our colleagues, working with a pulse sender of frequency 2 Mc./s. and a peak power output 1 kw., were unable to detect any echo, waves of frequency 1·42 Mc./s. were observed to be reflected from heights between 75 km. and 80 km., and the effective reflexion coefficient was found by measurement to be less than 3 × 10^{-4}. On other days when the absorption was less, there were discrete reflexion heights near 90, 96 and 112 km., the latter height corresponding to the ordinary *E* region observed by our colleagues on a frequency of 2 Mc./s. These reflexion levels (75–80 km., 90–95 km. and 112 km.) appear to be the same as those observed by Naismith and Bramley[1] in measurements with waves of frequency 2 Mc./s. at oblique incidence. Since mid-March, the reflexion height has been consistently in the range 102–105 km., corresponding closely to the ordinary *E*-region reflexion. This height is still observed if the sender frequency is reduced to 1·025 Mc./s., so that there cannot be, at this time of year, any lower layer with electron density greater than about 1·3 × 10^{4} cm.$^{-3}$.

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Cambridge. May 30.

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Fine Structure of Chloroplasts in Two Flagellates

THE structure of chloroplasts has been described in several recent reviews[1]. Previous information based on the use of the polarizing[2], ultra-violet[3] and electron microscopes[4] has provided some evidence that the chloroplasts have a lamellar structure. The electron microscope studies have been made exclusively on isolated plastids in which artefacts may be easily produced by disintegration and injury during the preparation of the specimens. The electron micrographs obtained have shown that the chloroplasts and even the grana consist of disks; but they have not yielded information about the orientation of these disks to one another. Progress in embedding and thin-sectioning techniques now permits us to examine in the electron microscope the structure of intact chloroplasts *in situ*. The present communication summarizes observations made by such methods on the chloroplasts of two algal flagellates, *Euglena gracilis bacillaris* and *Poteriochromonas stipitata* (a phagotrophic chrysomonad).

These flagellates were grown in chemically defined media[5] in light and in darkness. In light, they were deeply pigmented; in darkness they became completely colourless; this process was reversible. In the present study, in which they were grown under continuous light for four to seven days, both species contained elongated chloroplasts (1–2 μ in diameter and 5–10 μ in length for *Euglena*, smaller ones for the chrysomonad) which appeared faintly laminated in the phase-contrast microscope. For electron microscopy the flagellates were fixed in 1 per cent osmium tetroxide in 0·028 *M* acetate-veronal buffer, or in 0·21 *M* sucrose, embedded in *n*-butyl methacrylate, and sectioned at 0·05 μ (see ref. 6 for detailed techniques).

The electron micrographs of the sections of *Euglena* (Fig. 1) show that each chloroplast is approximately 1 μ in thickness, is limited by a membrane, and consists of a number (approximately twenty) of regularly oriented lamellæ. In cross-sections (Figs. 2 and 3) the lamellæ can be seen as dense bands, nearly uniform in thickness, and appearing to be continuous and homogeneous at the resolutions used. Measurements on fifty of these bands gave an average thickness of 250 A. (variations from 180 A. to 320 A.). The interlamellar spaces vary in thickness from 300 A. to 500 A. and contain a less-dense material that appears homogeneous except for occasional dense granules of 300–800 A. in diameter. Since there was no control on the angle of cutting, chloroplasts were frequently sectioned on the bias. Consequently, in such sections both the lamellæ and the interlamellar spaces show increased thickness. For this reason it is believed that the smallest values found for the thickness of the lamellæ are the more reliable. Additional factors appear to play a part in the variability of the spacing of the lamellæ; in poorly fixed material, they are frequently pulled apart and sometimes fractured. The most regular layering was found in material fixed by 1 per cent osmic acid in 0·21 *M* sucrose. A certain variability in the spacing of the lamellæ may indeed be present *in vivo* and explain the faint lamination seen in the phase-contrast microscope; obviously the lamellæ them-

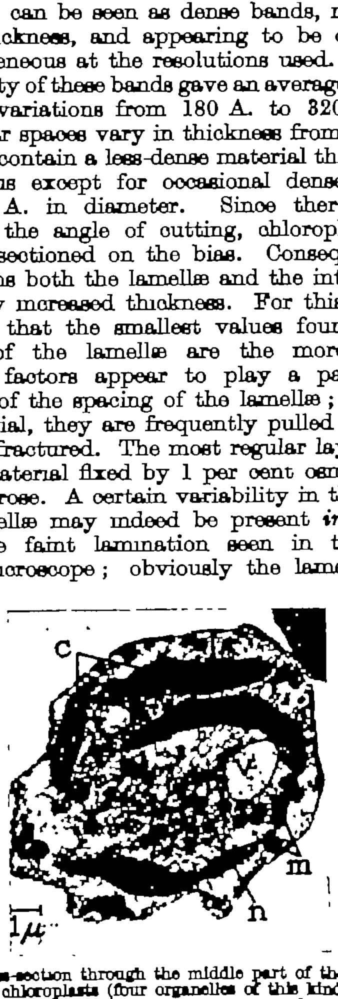

Fig. 1. Cross-section through the middle part of the body of a *Euglena*. *c*, chloroplasts (four organelles of this kind are visible in the section); *m*, mitochondria; *v*, vacuole; *n*, nucleus. The cuticle of the flagellate shows characteristic ridges. × 3,000

2

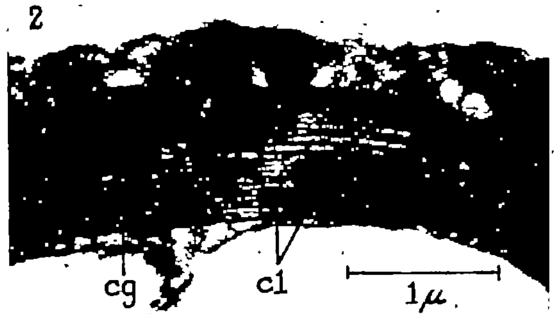

Fig. 2. Section through a chloroplast showing lamellæ (cl), interlamellar spaces and some chloroplast granules (cg). × 20,000
Fig. 3. Section through a chloroplast showing the pyrenoid (py). × 15,000

selves are below the limit of resolution of this instrument. Since the size of the chlorophyll molecule is below the limit of resolution of the electron microscope, nothing can be said at present about the location of chlorophyll in respect to the lamellæ.

A dense body found in the centre of the chloroplasts in some of our electron micrographs is interpreted as the pyrenoid; it appears as a condensation of interlamellar material, with which it is frequently continuous. The lamellæ can be followed, in some cases, through the pyrenoid and appear to be tightly held together in this region (Fig. 3). In other instances, namely, in very dense pyrenoids, the lamellar structure seems to disappear at this level. A large cytoplasmic vacuole is frequently present outside the chloroplast in contact with the pyrenoid.

Chloroplasts with structure and organization similar to those of *Euglena* were found in *P. stipitata.* Further studies on the light versus dark reaction in the formation and structure of the chloroplasts are in progress; a full account of this work will be reported and published elsewhere[7].

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Screw Dislocations in Quartz

In a recent letter in *Nature*, Amelinckx[1] has given evidence for the existence of screw dislocations in mica. He observed a step, 140 A. high, which terminated on the surface: the point of termination of the step defined the point of emergence of a screw dislocation of Burgers's vector 140 A.

I have obtained similar evidence for the existence of screw dislocations in quartz. Fig. 1 is a photograph of the major rhombohedral face $(10\bar{1}1)$ of a natural quartz crystal, showing the edges of growth sheets which have spread in two separate directions, denoted α and β in the figure. The α growth fronts are continuous, and parallel to the geographical contours of the face; but the β growth fronts are discontinuous along the diagonal black line. This line is terminated on the surface at both ends, and is parallel to the line of intersection of the face with an adjacent major rhombohedral plane. Fig. 2 is the corresponding two-beam interference picture (λ = 5460 A.) of the area shown in Fig. 1, and shows that the diagonal line represents a step the height of which varies between 0 and 950 A.

It is well known[2] that the $\{10\bar{1}1\}$ major rhombohedral planes of quartz are planes of 'partial cleavage'. We can conclude that the diagonal line in Fig. 1 is a slip line, partial slip having taken place parallel to the major rhombohedral plane. The points of termination of the slip line, and the points along its length where a change of height occurs, mark the points of emergence of screw dislocations.

The slip line in Fig. 1 is much more visible than the growth fronts, although the latter are approximately 3000 A. high—that is, several times higher than the maximum height of the slip step. The reason for this reduced visibility of the growth fronts is that the risers of the growth fronts make a small angle (approximately 1°) with the plane surface of the growth sheets, whereas the slip line represents a sharp, vertical step.

I have observed a growth spiral on quartz, indicating that growth had taken place from a screw dislocation of Burgers's vector 220 A. This is therefore additional evidence for the existence of dislocations in the quartz lattice. It is hoped to publish a fuller account of a study of the topography of quartz surfaces elsewhere.

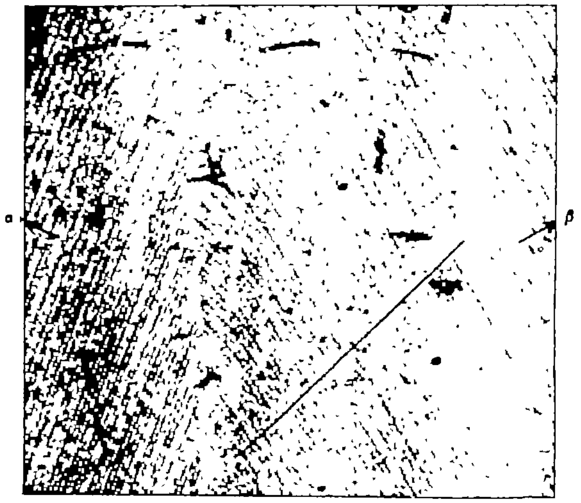

Fig. 1. (× 7)

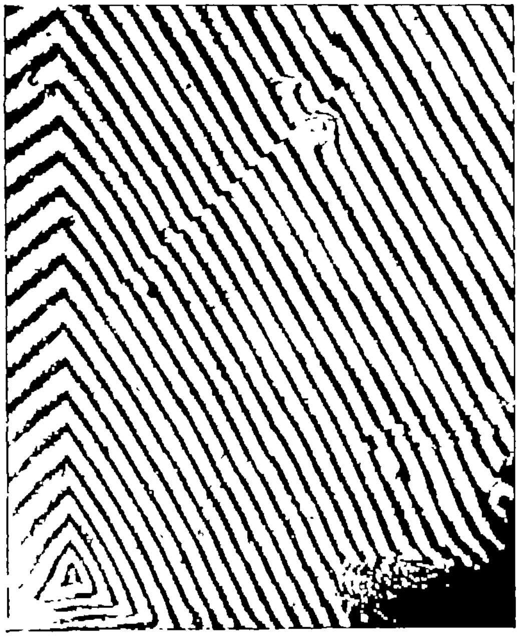

Fig. 2. (× 7)

I wish to thank Prof. S. Tolansky for his continual interest in this work; the Director, Signals Research and Development Establishment, Christchurch, for the loan of the crystal; and the Chief Scientist, Ministry of Supply, for permission to publish this account.

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The Energy Momentum Tensor in Dirac's New Electromagnetic Theory

DIRAC has recently[1] proposed a generalization of his new theory of electromagnetism so as to permit vortical streams of the electrical charge. The vortical motion has been introduced by redefining the potentials in a more general manner. Dirac has then framed two stationary principles, both of which lead back to the Lorentz equation of motion for an electric charge, with, however, the ratio, $m/e = k$, only occurring in it. The first of these stationary principles has for its action density

$$L = -\tfrac{1}{4}F_{\mu\nu}F_{\mu\nu} + \tfrac{1}{2}\lambda\,(v_\nu v_\nu - 1), \tag{1}$$

where the potentials are assumed to be of the form

$$A_\mu = kv_\mu + \xi\frac{\partial\eta}{\partial x_\mu}. \tag{2}$$

In these equations v_μ is the velocity vector, $v_\mu v_\mu = 1$, and ξ and η are two independent functions of the x_ν. λ is an arbitrary function of the x_ν. Varying the integral Lagrangian (1), one gets the equations,

$$v_\nu v_\nu = 1, \tag{3}$$

$$k\,\frac{\partial F_{\mu\nu}}{\partial x_\nu} = \lambda v_\mu \tag{4}$$

and

$$\frac{\partial F_{\mu\nu}}{\partial x_\nu}\,\frac{\partial\xi}{\partial x_\mu} = \frac{\partial F_{\mu\nu}}{\partial x_\nu}\,\frac{\partial\eta}{\partial x_\mu} = 0, \tag{5}$$

so that

$$v_\mu\,\frac{\partial\xi}{\partial x_\mu} = v_\mu\,\frac{\partial\eta}{\partial x_\mu} = 0. \tag{6}$$

(4) is the Maxwell equation, and (5) after reduction becomes the Lorentz equation

$$k\,\frac{dv_\mu}{ds} = v_\nu F_{\nu\mu}. \tag{7}$$

In making the variation, the A_μ, ξ, η and λ were treated as the independent field functions.

The canonical energy momentum tensor $T_{\rho\sigma}$ derived in the standard way from the Lagrangian (1) is

$$T_{\rho\sigma} = \frac{\partial kv_\lambda}{\partial x_\sigma}F_{\rho\lambda} + \frac{\partial\xi}{\partial x_\sigma}F_{\rho\nu}\frac{\partial\eta}{\partial x_\nu} + \frac{\partial\eta}{\partial x_\sigma}F_{\mu\rho}\frac{\partial\xi}{\partial x_\mu} + \delta_{\rho\sigma}L. \tag{8}$$

This tensor is not symmetrical and so with it angular momentum would not be conserved. To make it symmetrical we may proceed in the usual way (see, for example, Wentzel, "Quantum Theory of Fields", Appendix by Jauch) and add,

$$T'_{\rho\sigma} = -\frac{\partial}{\partial x_\lambda}\,(kv_\sigma F_{\rho\lambda}) = -\frac{\partial}{\partial x_\lambda}\,G_{\rho\lambda\sigma}$$
$$= \frac{\partial}{\partial x_\lambda}\,G_{\lambda\rho\sigma}. \tag{9}$$

$T'_{\rho\sigma}$ has the necessary properties of vanishing divergence and vanishing integrals of the energy and momentum components, for

$$\frac{\partial T'_{\rho\sigma}}{\partial x_\rho} = -\frac{\partial}{\partial x_\rho}\,\frac{\partial}{x_\lambda}\,G_{\rho\lambda\sigma} = 0,$$

$$\int T'_{4\sigma}\,dx_1dx_2dx_3 = -\int\frac{\partial}{\partial x_\lambda}\,G_{4\lambda\sigma}\,dx_1dx_2dx_3$$

$$= -\int\frac{\partial}{\partial x_k}\,G_{4k\sigma}\,dx_1dx_2dx_3 = 0.$$

Now by (4),

$$T'_{\rho\sigma} = -\frac{\partial kv_\sigma}{\partial x_\lambda}F_{\rho\lambda} - kv_\sigma\frac{\partial F_{\rho\lambda}}{\partial x_\lambda} = \frac{\partial kv_\sigma}{\partial x_\lambda}F_{\rho\lambda} - v_\sigma\lambda v_\rho. \tag{10}$$

So the symmetrical tensor, $\theta_{\rho\sigma} = \theta_{\sigma\rho}$, is

$$\theta_{\rho\sigma} = T_{\rho\sigma} + T'_{\rho\sigma} = F_{\sigma\lambda}F_{\rho\lambda} - v_\sigma\lambda v_\rho + \delta_{\rho\sigma}L. \tag{11}$$

The ξ and η variables do not appear explicitly in this formula, and the tensor is, apart from notation, of the same form as the tensor of the irrotational theory, the θ_{44} and θ_{4k} components of which have been given by Le Couteur[2].

I thank Prof. P. A. M. Dirac for suggesting this problem to me.

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Calculation of the Internal Surface of a Lung

The following investigation arose out of work carried on in the Pathology Department of King's College, University of Durham, by Prof. J. B. Duguid and his colleagues, for which an estimate was needed of the respiratory surface area within a given volume of lung.

Tomkeieff[1] showed that, in a convex three-dimensional figure, the average linear intercept is equal to four times the volume divided by the surface area; that is,

$$\bar{l} = 4 \times \frac{\text{Volume}}{\text{Surface area}}.$$

If a number of similar such bodies, each of volume v and surface area A, are enclosed at random in a unit volume (V) and this volume is traversed by a number of lines of total length T, if also L is the total length of these lines which is interior to the convex bodies, and N is the number of intercepts, then

$$\frac{L}{T} \rightarrow \frac{\text{Volume of convex bodies}}{\text{Unit volume}} = \frac{L}{4NV} \times \Sigma(A),$$

and in the limit

$$\frac{\Sigma(A)}{V} = 4\,\frac{N}{T}.$$

Therefore, in the limit, the surface area per unit volume is equal to four times the number of intercepts divided by the total length of traverse.

It can further be shown that there is no necessity for imposing the restriction that the bodies should be similar to one another, or that they should be entirely enclosed in the unit volume. It is necessary, however, to postulate that the bodies should be randomly disposed towards the lines of traverse.

In the case of the internal surface area of a sample of a lung, the lung can be embedded in gelatine without shrinkage or distortion and cut in thin sections. These sections can then be scanned under a microscope, and all that is necessary to obtain the internal surface area is to count the number of intersections with cell walls that are made by the line of scanning and divide this number by two to give the number of intercepts. This scanning and counting can, in fact, be done electronically.

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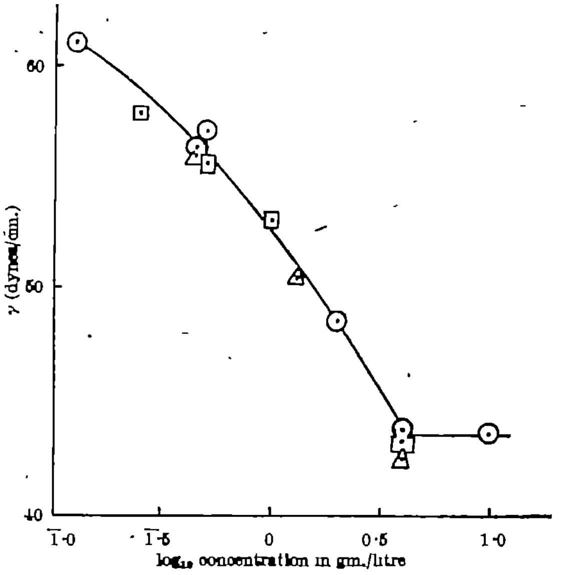
Hæmolytic and Surface Activity of Sodium Taurocholate

It is generally accepted that sodium taurocholate is a good lytic agent for erythrocytes, and a great number of reports on hæmolysis by this substance have been published[1]. Abnormal sigmoid time-dilution curves are sometimes reported for taurocholate lysis, and frequent reference is made to the instability of the taurocholate solutions used by these authors. One report[2] states qualitatively that a synthetic specimen of taurocholate was "moderately lytic", whereas a specimen prepared from natural sources was "strongly lytic". Two other reports[3] also give a much lower hæmolytic activity for taurocholate than that generally accepted.



γ – log *c* relation of sodium taurocholate in isotonic sodium chloride + boric acid buffer (0·02 *M*).
Line drawn as for *p*H 7, 20° C. ○, *p*H 7·0, 20° C.; ⊡, *p*H 7·0, 37° C.; △, *p*H 9·5, 37° C.

Through the generosity of Dr. Stenhagen, we have recently obtained a very pure specimen of sodium taurocholate, which has been examined for its hæmolytic and surface activity. Hæmolysis tests were made at 20° C. with a 5 per cent suspension of thrice-washed human erythrocytes (*AB*,*Rh*+) in 0·85 per cent sodium chloride buffered with 0·02 *M* boric acid, with borax added to *p*H 7·0. No lysis at all was observed overnight in concentrations of taurocholate up to 2·0 gm./lit. A solution of 11·0 gm./lit. effected complete lysis in approximately 30 hr., and one of 19·8 gm./lit. in 90 min. The lytic threshold for pure sodium taurocholate is therefore about 20 gm./lit. at 20° C. The values for human cells given in the papers already quoted are in the range of 0·10–0·15 gm./lit. for the lytic threshold. It is concluded that the previously accepted high lytic activity of sodium taurocholate is to be ascribed to the presence of impurities, perhaps long-chain fatty acids. The low activity of pure taurocholate has been confirmed by further experiments showing that a sample of natural taurocholate purified chromatographically and generously supplied by Dr. Pever has no lytic activity up to 3 gm./lit.

Determinations of surface tension were made at *p*H 7·0 and *p*H 9·5, and at 20° C. and 37° C. on solutions of Dr. Stenhagen's sample in the isotonic saline boric acid buffers described above. The Harkins drop-volume method was used in these determinations, with a glass-tipped tuberculin syringe operated by a micrometer screw. No decomposition of the test solutions was observed at room temperature, and in agreement with the opinion of Hutchinson[4], no surface tension ageing of the bile salt solutions was observed with this pure specimen. The results are given on a logarithmic concentration scale in the accompanying graph. The micelle point of the sodium taurocholate is 4·1 gm./lit. (7·4 × 10^{-3} *M*) in this medium and the maximum micellar surface pressure is 29·3 dynes. A full report will be published elsewhere to show that solutions of surface-active substances interacting weakly or not at all with cholesterol monolayers will lyse red cells strongly if their pressures are greater than 34 dynes. The strong hæmolytic activity previously reported for sodium taurocholate can now be ascribed to the lowering of the surface tension of solutions of the substance by surface-active impurities. The sigmoid time-dilution curves occasionally reported are interpreted as being caused by the zone of minimum surface tension produced by such impurities in solutions of micelle-forming surface-active substances[5].

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Flattening of Meniscus between Water and Organic Solvents

WE have recently been carrying out experiments on the diffusion of solutes across the interface between water and organic solvents, using an optical method. In a cylindrical glass cell (2·4 cm. diameter) the meniscus is about 0·7 cm. deep, convex towards the water. This curvature would complicate the interpretation of diffusion measurements and would give a region on the organic solvent side where beams of light could not pass through undisturbed. If the tube is greasy, the meniscus is inverted.

It has been found possible to flatten this interface by a preliminary exposure of the inside of the tube to the vapours of 'Teddol', a preparation of the type Me_3SiF, which is strongly adsorbed on to the glass. A complete film would render the surface hydrophobic and give an inverted meniscus; but a suitably limited application gives a contact angle of 90°. In practice, it has been found more convenient to give a thorough treatment with 'Teddol' and then partially remove the film with a household metal polish on a test-tube brush. At intervals during the polishing the type of meniscus can be observed, until it is practically plane. When the interface is then formed, a very slight pressure on the liquid on one side or the other allows the final fine adjustment to a plane. With this technique it has been possible to cut down the gap in the light transmitted across the cell to less than 0·1 mm.

The surface formed is reasonably permanent, for the tube only needs re-treating at intervals of several months. It was shown that the optical properties of the tube were unaffected.

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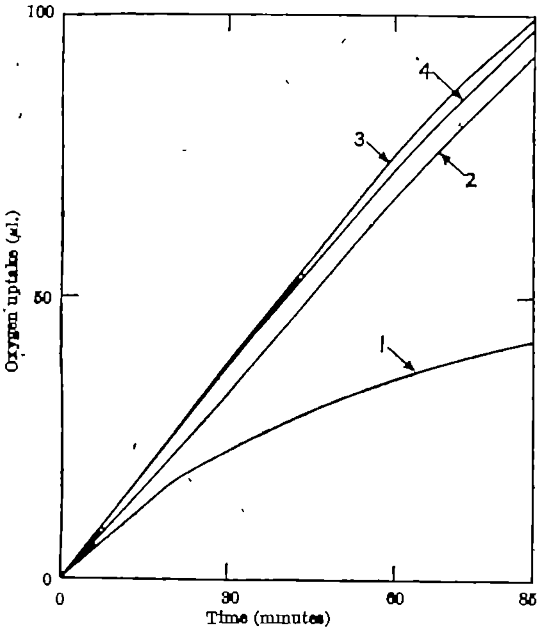
Stabilization of Oxidative Phosphorylation in Heart-Muscle Sarcosomes

FRESHLY prepared suspensions of the granular components of heart-muscle (sarcosomes[1], interstitial granules[2] or mitochondria[3]) are able to oxidize a number of intermediary metabolites, and to couple this oxidation with the synthesis of adenosine triphosphate from adenosine diphosphate and inorganic phosphate (oxidative phosphorylation)[4,5]. In agreement with the experience of other workers using preparations from different tissues, it has been found that the heart-muscle sarcosomes rapidly lose their ability to carry out oxidative phosphorylation, especially at temperatures above 0° C. Such aged preparations oxidize succinate at practically unimpaired rate, but the accompanying phosphorylation is lost. The ability to oxidize α-ketoglutarate is lost to about the same extent as the phosphorylation associated with this oxidation, so that the P : O ratio (the number of atoms of inorganic phosphate esterified per atom of oxygen consumed) is not greatly affected. The lability of rat heart sarcosomes is indicated by the following percentages of inactivation of the α-ketoglutaric oxidase system (the enzyme complex required for the aerobic oxidation of α-ketoglutarate to succinate): 10 min. standing at 15·5° C., 52 per cent inactivation; 15 min. at 25° C., 94 per cent inactivation. Cat preparations are somewhat more stable (15 min. standing at 25° C., 71 per cent inactivation).

These measurements were carried out with granules washed with isotonic phosphate-saline (0·135 *M* potassium chloride, 0·02 *M* phosphate, *p*H 7·4) and suspended in the same medium without further addition. The α-ketoglutaric oxidase system is much more stable in the presence of the reaction mixture used in oxidative phosphorylation experiments, the composition of which is given in the description to the accompanying graph. With cat heart sarcosomes, oxygen uptake and phosphorylation are maintained, under these conditions, at a uniform rate for 30 min. at 25° C.[5]. With rat heart preparations, on the other hand, the rate of oxygen uptake markedly declined after 15–20 min (see curve 1 of accompanying graph).

Since calcium is known to have a destructive effect on the morphology of sea urchin granules[6] and has also been shown to inhibit oxidative phosphorylation[7], the effect of the calcium-chelating agent, ethylenediaminetetracetate[8] (versene), was tried. Versene was found to protect, to a marked degree, the sarcosomal preparations from the morphological changes which occurred on standing. The accompanying graph (curves 2–4) shows that, in concentrations between 10^{-4} *M* and 2×10^{-3} *M*, it completely prevented the loss of activity of the α-ketoglutaric oxidase system which occurred with rat heart preparations even in the presence of the reaction mixture.

Versene, in higher concentrations, has an even more striking effect if it is added to the sarcosomal suspension during a preliminary incubation period before the preparation is added to the reaction mixture. For example, rat sarcosomes incubated for 15 min. at 25° C. in the absence of versene oxidized α-ketoglutarate at only 6 per cent of the rate of a control not given any preliminary incubation; both preparations were added to a reaction mixture containing 0·002 *M* versene. After incubation under the same conditions in the presence of 0·01 *M* versene, the preparation oxidized α-ketoglutarate at a rate



Effect of added versene on the oxidation of α-ketoglutarate by rat heart sarcosomes. Oxygen uptake measured manometrically in micro-flasks. All flasks contained, in a total volume of 1 ml., phosphate buffer, 0·036 *M*; potassium chloride, 0·026 *M*; sodium fluoride, 0·04 *M*; sodium malonate, 0·0089 *M*; glucose, 0·0167 *M*; adenosine monophosphate, 6×10^{-4} *M*; adenosine diphosphate, $6·7 \times 10^{-4}$ *M*; cytochrome *c*, $3·7 \times 10^{-6}$ *M*; magnesium, 0·005 *M*; α-ketoglutarate, 0·0074 *M*; sarcosomal preparation (1·4 mgm. protein) and hexokinase. *p*H 7·4, temperature, 25° C. Curve 1, no versene; curve 2, 10^{-4} *M* versene; curve 3, 10^{-3} *M* versene; curve 4, 2×10^{-3} *M* versene. The sarcosomal preparation was added at zero time without previous incubation

equal to 109 per cent of the control. In a similar experiment using sarcosomes isolated from cat heart and a 30-min. incubation period, 91 per cent inactivation was found after incubation in the absence of versene and 8 per cent activation when 0·01 *M* versene was added prior to incubation. The activity of the α-ketoglutaric oxidase system of cat heart sarcosomes, isolated with and suspended in isotonic phosphate-chloride containing 0·01 *M* versene, was unchanged after one day at 0° C., whereas that of a similar preparation isolated without versene was lowered by 84 per cent. At the end of this period, nearly all the sarcosomes in the latter preparation showed morphological changes, while no change had occurred in the preparation made with versene. Oxidative phosphorylation associated with the oxidation of α-ketoglutarate and succinate were also protected by 0·01 *M* versene; 0·001 *M* versene also gave considerable, although incomplete, protection.

EFFECT OF CALCIUM CHLORIDE ON THE INACTIVATION OF α-KETOGLUTARIC OXIDASE SYSTEM BY INCUBATION

Exp.	Preparation	Incubation		Conc. of calcium chloride added (*M*)	Inactivation (per cent)
		Time (min.)	Temperature (° C.)		
1	Washed versene	15	25	0	18
				0·000033	4
				0·000067	38
				0·0002	53
				0·00067	58
				0·0067	79
2	Washed versene	15	25	0	27
				0·001	72
				0·01	84
		5	17	0	11
				0·01	56
3	Normal	5	15	0	18
				0·001	37
				0·01	44

Since the reaction mixture contained 0·001–0·002 *M* versene in all cases (see graph), it is clear that although versene protects the enzyme systems from the inactivation caused by the incubation, it does not reverse such inactivation.

When the sarcosomes were isolated with an isotonic solution containing 0·01 *M* versene and the versene afterwards removed by sedimentation of the granules in the centrifuge and washing twice with 100 volumes of versene-free phosphate-chloride, the preparation ('washed versene' preparation of the accompanying table) was still relatively stable. Thus, such a preparation from rat heart was only 18–27 per cent inactivated by incubation for 15 min. at 25° C. As is shown in the table, the addition of calcium chloride increased the rate of inactivation. It also increased the rate of inactivation of a normal preparation in the absence of versene. It seems likely that versene stabilizes the preparations by virtue of its ability to remove calcium associated with the sarcosomes. The mechanism of the inactivation by calcium is not known.

Full details will be published elsewhere.

We wish to thank Prof. D. Keilin for his interest and advice. This work was carried out during the tenure of a grant from the Agricultural Research Council to one of us (E. C. S.), and of a Nuffield Dominion Fellowship to one of us (K. W. C.) during leave from the Department of Histology and Embryology, University of Sydney.

Note added in proof. The component of the reaction mixture chiefly responsible for the limited protection of the α-ketoglutaric oxidase system in the absence of versene is adenosine diphosphate. This is in agreement with recent work of Kielley and Kielley[9]. Magnesium, fluoride and phosphate together, but not singly or in pairs, also give considerable protection.

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Glucose-6-Phosphate Dehydrogenase Activity of Rat Liver

A METHOD of assay of glucose-6-phosphate dehydrogenase in liver has been devised employing spectrophotometric measurement of the rate of reduction of triphosphopyridine nucleotide in suitably prepared liver homogenate supernatants. This is preferable to the determination of dehydrogenase activity in extracts of acetone-dried tissues[1], or to the use of unphysiological carriers such as brilliant cresyl blue, 2-6-dichlorophenolindophenol or phenazine methosulphate[2].

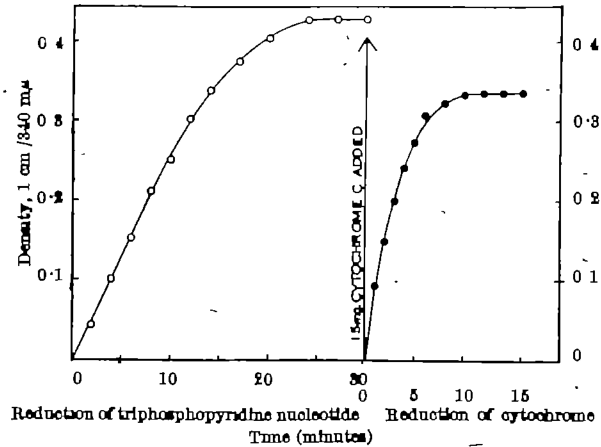

Fig 1. The reduction of triphosphopyridine nucleotide by glucose-6-phosphate dehydrogenase coupled with the enzymic reduction of cytochrome *c*.

The initial reaction mixture (total volume 2·5 ml.) included 0 1 ml. rat liver supernatant and 0 5 ml. veronal-acetate buffer *p*H 7 4, ± 0 2 mgm. 70 per cent triphosphopyridine nucleotide. The reaction was started by the addition of 0·1 ml. of 0·05 *M* glucose-6-phosphate to both cells. When the reduction was complete, excess (1 5 mgm.) cytochrome *c* was added to both cells Temperature 20° C.

Rat livers, chilled immediately after removal, were disintegrated in a Potter glass homogenizer in 4 volumes of ice-cold isotonic potassium chloride containing potassium bicarbonate to maintain the *p*H at 7·0, centrifuged for 60 min. at 4,000 *g* in an International refrigerated centrifuge and the supernatant dialysed overnight in the same cold extracting medium. This dialysed supernatant, which was free from triphosphopyridine nucleotidase and glucose-6-phosphatase, contained glucose-6-phosphate and 6-phosphogluconate-dehydrogenases and sufficient triphosphopyridine nucleotide–cytochrome *c* reductase[3] to be able to couple the reduction of triphosphopyridine nucleotide with that of cytochrome *c*. Results of a typical experiment with glucose-6-phosphate as substrate are given in Fig. 1. When the reduction of triphosphopyridine nucleotide was complete, excess cytochrome *c* was added and its reduction followed spectrophotometrically at 550 mμ. The rapid reduction of cytochrome *c* indicates that there are sufficient microsomes in suspension in the liver supernatant to provide triphosphopyridine nucleotide–cytochrome *c* reductase[4]. The reduction of triphosphopyridine nucleotide by the glucose-6-phosphate dehydrogenase system can also be coupled with the reduction of glutathione, as is indicated in Fig. 2 by the decrease in absorption at 340 mμ on addition of glutathione. This reaction is catalysed by glutathione reductase, which is associated with the combined soluble and microsome fractions of liver homogenates[5].

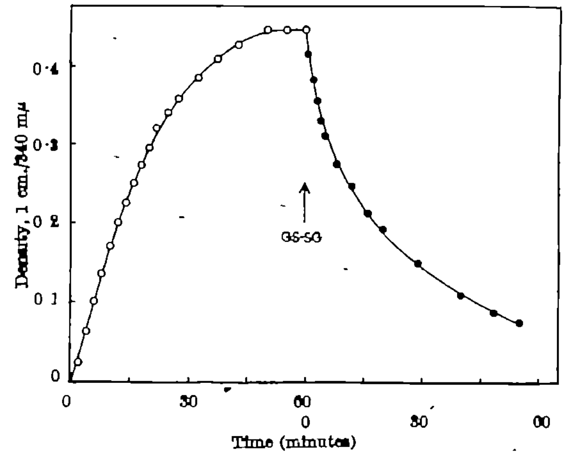

Fig. 2. The oxidation of reduced triphosphopyridine nucleotide by coupling glutathione reductase with glucose-6-phosphate dehydrogenase

The initial reaction mixture (total volume 2 5 ml) included 0 1 ml. rat liver supernatant and 0 5 ml. veronal-acetate buffer *p*H 7 4, ± 0 2 mgm. 70 per cent triphosphopyridine nucleotide. The reaction was started by the addition of a limiting concentration of glucose-6-phosphate (0 1 ml. of 0 005 *M*). When the reaction was complete, 0·2 ml. of 0 025 *M* glutathione was added to both cells. Temperature 20° C.

The reduction of triphosphopyridine nucleotide at 20° by the glucose-6-phosphate dehydrogenase system in these liver supernatants is linear for approximately 15 min. and proportional to enzyme concentration over a sufficiently wide range to make this method applicable to the quantitative estimation of glucose-6-phosphate dehydrogenase in liver.

The $Q^{20^\circ}_{O_2}$ per mgm. nitrogen for the glucose-6-phosphate dehydrogenase activity of seven pooled rat livers was 23·3, and the mean value and standard error on four individual rat livers was 21·15 ± 0·82. The mean (calculated) $Q^{37^\circ}_{O_2}$ for the latter group is 72 and was increased to 106 on spinning for a further 15 min. at 20,000 *g*.

These values indicate that the level of glucose-6-phosphate dehydrogenase in liver is sufficient for this system to be of physiological significance, and indeed for there to be active competition between the glycolytic and direct oxidative pathways for glucose-6-phosphate, their common substrate. It is also of interest that the enzymes of both the glycolytic[6] and direct oxidative pathways appear to be present exclusively in the soluble fraction of liver homogenates.

This work will be reported in detail elsewhere.

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Polynucleotides from Deoxyribonucleic Acids

Dinucleotides are found among the products of deoxyribonuclease digestion of deoxyribonucleic acids. By fractionation of the digest on ion-exchange resins, Sinsheimer and Koerner[1] isolated a dinucleotide containing deoxyadenylic and deoxycytidylic acids and one containing deoxycytidylic acid only. Smith and Markham[2] treated the deoxyribonuclease digest with phosphomonoesterase, thus removing the terminal phosphoryl groups of the polynucleotides, and fractionated the resulting products by paper chromatography in 70 per cent *iso*propanol–water (v/v) in an ammonia atmosphere (solvent 1) into seven bands (numbered 1–7 in order of increasing R_F values). From these, by paper electrophoresis in ammonium formate buffer *p*H 3·5, they isolated six dinucleoside

PROPERTIES OF SOME DINUCLEOSIDE MONOPHOSPHATE DIESTERS AND RELATED SUBSTANCES FROM DEOXYRIBONUCLEIC ACID

Substance	Adenine	Guanine	Cytosine	5-Methyl cytosine	Thymine	Position on chromatogram	Electrophoretic mobility at pH 3·5 (cm./2 hr. at 20 V./cm.)	Source of deoxyribonucleic acid
A—p—A	—	—	—	—	—	Band 5	4·2	Wheat embryo
A—p—G	1·05	0·95	—	—	—	„ 4	6·0	„
G—p—C *G—p—MC* }	—	0·94	0·22	0·78	—	„ 4	3·0	„
A—p—C—p—T	0·97	—	1·03	—	1·00	„ 4	6·2	Herring sperm
A—p—C—p—T *A—p—MC—p—T* }	1·05	—	0·92	0·10	0·93	„ 4	6·2	Wheat embryo

monophosphate diesters, *A–p–C*, *A–p–T*, *G–p–T*, *C–p–T*, *C–p–C* and *T–p–T* (where *A* = deoxyadenosine, *G* = deoxyguanosine, *C* = deoxycytidine, *T* = thymidine and *p* indicates a phosphoric acid residue giving two nucleosides). These originated from the corresponding dinucleotides in the deoxyribonuclease digest.

We have now isolated these and several other substances from similar digests of wheat embryo deoxyribonucleic acid. This acid was chosen because of its singularly high content of 5-methyl cytosine[3] and was prepared via the deoxyribonucleoproteins by the method of Mirsky and Pollister[4]. The digestion of the deoxyribonucleic acid with deoxyribonuclease and phosphomonoesterase and the isolation of substances from the digest by paper chromatography and electrophoresis have been described fully elsewhere[2]. Identification of the substances rests on (1) quantitative analysis for purines, pyrimidines[3] and phosphorus[5], which gives the molecular size directly, as after the removal of the terminal phosphoryl groups the compounds contain (n) nucleoside residues and ($n - 1$) phosphorus atoms; (2) rate of migration on paper electrophoresis at pH 3·5 [6]. The hitherto undescribed dinucleoside monophosphate diesters found are *A–p–A*, *A–p–G*, *G–p–C* and *G–p–MC* (*MC* = deoxy 5-methyl cytidine). *G–p–C* and *G–p–MC* could not be separated from each other by paper chromatography in neutral, acid or alkaline *iso*propanol–water mixtures and, of course, migrate together on electrophoresis. They occurred together in band 4 of that chromatogram in solvent 1, which on paper electrophoresis in 0·05 *M* ammonium formate buffer pH 3·5 gave several bands of substances including one with a movement of 4·2 cm. (2 hr. at 20 V./cm.). This on analysis contained 0·94 mole guanine/0·22 mole cytosine/0·78 mole 5-methyl cytosine/1 mole phosphorus. The molar ratio of total bases to phosphorus is 1·94/1 (theoretical ratio for a mixture of dinucleoside monophosphate diesters, 2/1), and the molar ratio of guanine to (cytosine + 5-methyl cytosine) is 0·94/1 (theoretical ratio for a mixture of *G–p–C* and *G–p–MC*, 1/1). Some properties of these substances are given in the accompanying table.

In similar digests from herring sperm deoxyribonucleic acid we have also found a substance containing equimolar proportions of adenine, cytosine and thymine which we consider to be *A–p–C–p–T*, *C–p–A–p–T*, *A–p–T–p–C* or a mixture of these isomers. In digests of wheat embryo deoxyribonucleic acid this substance occurs together with small quantities of *A–p–MC–p–T*, from which it has not been separated. It is a nucleoside ester of a dinucleotide derived from a trinucleotide.

Similar methods have been used for the isolation of several dinucleotides and one trinucleotide from deoxyribonuclease digests (*without* phosphomonoesterase treatment). On paper chromatography in solvent 1, the components of the digest are fractionated into three bands. From these by paper electrophoresis we have isolated the dinucleotides *AC*, *AT*, *CT*, *GT*, *CC* and *TT*, and a trinucleotide containing *A*, *C* and *T*. Treatment of these with phosphomonoesterase converts them to the corresponding substances of the type described above.

With purified diesterase from Russell viper venom[7], the dinucleotide *AC* gives a mixture of deoxyadenylic and deoxycytidylic acids, both of which are dephosphorylated by a specific 5′ nucleotidase, demonstrating that the terminal phosphoryl group of the dinucleotide is attached to the 5′ position on a deoxyriboside residue. If *A–p–C* (derived from *AC* by phosphomonoesterase action) is treated with the viper venom diesterase, it is slowly hydrolysed, yielding deoxycytidine and deoxyadenylic acid. The latter is entirely converted to deoxyadenosine by the specific 5′ nucleotidase from Russell viper venom and is therefore deoxyadenosine-5′-phosphate. The terminal phosphoryl group of *AC* is thus linked to the deoxycytidine residue, which in turn is joined by a phosphate ester link to the 5′ position on the deoxyadenosine residue. As there is no evidence for internucleotide linkages in deoxyribonucleic acid other than phosphate-sugar ester links, it follows that *AC* is deoxycytidine, 3′(deoxyadenosine-5′-phosphate) ester, 5′ phosphate, and the diesterase splits preferentially the 3′ phosphate ester link.

While our experiments have not yet led to any simple formulation of the action of deoxyribonuclease, they do suggest certain features in the arrangement of nucleotides in the nucleic acid chain, notably with respect to deoxycytidylic and 5-methyl deoxycytidylic acids. In complete deoxyribonuclease digests, the ratio *GMC*/*GC* is much higher than that found for any other pair of dinucleotides differing only in the replacement of cytosine by 5-methyl cytosine. We are inclined not to attribute this to a specificity of deoxyribonuclease, but rather to the position of the 5-methyl deoxycytidylic acid residues in the nucleic acid chain.

We wish to thank the Wellcome Research Laboratories for a generous gift of Russell viper venom.

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Biochemical Differences between Red and White Muscle

MYOGLOBIN, the principal pigment responsible for the red colour of muscle, was estimated by a method previously described by me[1]. The activities of components of the cytochrome system were determined in enzyme preparations[2] made from the muscles. Cytochrome oxidase was measured by determining the rates of oxidation of neutralized ascorbic acid in the presence of known amounts of added cytochrome *c* and extrapolating to infinite cytochrome *c* concentration[3]; succinic oxidase by the rate of oxidation of sodium succinate in the presence of excess cytochrome *c*[4]; and succinic dehydrogenase by the rate of reduction of methylene blue in the presence of excess sodium succinate, using the Thunberg technique[5]. Energy-rich phosphate ($\sim$ P), representing the sum of the labile phosphorus of adenosine triphosphate and of creatine phosphate, was determined as inorganic phosphate by Allen's method[6], after controlled hydrolysis of muscle extracts.

Both in Table 1, which represents data secured by analysis of muscle samples from the adults of various species, and in Table 2, in which are recorded figures for heart muscle from horses of different ages, it is evident that, in general, high myoglobin content in muscle is associated with high enzymic activity, particularly of cytochrome oxidase, in the corresponding enzyme preparations. This suggests that the function of myoglobin, with its power of reversible combination with oxygen and its low loading tension, is to assist in ensuring a constant supply of this element to the muscle oxidase system. The relatively low myoglobin content of horse heart and of pigeon breast muscle, despite high enzymic activity, may perhaps be explained by their possession of an excellent supply of oxygen from the blood, which is continually replenished by their characteristically repetitive contractions, thus partly dispensing with the need for an oxygen store. In contrast, the slow wing movements of the Manx shearwater, as compared with the more rapid ones of the pigeon, are reflected in a higher concentration of myoglobin in its pectoral muscle.

The other striking exception in the table to the general correspondence between myoglobin and the activity of the cytochrome system occurs in the psoas muscle of the blue whale. Its enzymic activity, which is very low in relation to the myoglobin content, helps to explain the diving capabilities of this mammal, for a low rate of oxygen utilization increases the length of time during which its relatively meagre store of myoglobin-bound oxygen could be effective. (When calculation is made to the same original weight of muscle, it is found that the whale psoas has an oxygen store at least twelve times greater, in relation to cytochrome oxidase activity, than that of the horse psoas.)

Table 1. RELATION BETWEEN ENZYMIC ACTIVITY IN MUSCLE PREPARATIONS AND MYOGLOBIN CONTENT IN CORRESPONDING WHOLE MUSCLE. EFFECT OF SPECIES AND TYPE OF MUSCLE

Muscle	Species	Myoglobin (% wet wt.)	Enzymic activity Q_{O_2} (µl. O_2/mgm. dry fat-free wt./hr.)		
			Succinic dehydrogenase	Succinic oxidase	Cytochrome oxidase
Psoas	Horse (mean of 6 animals)	0·71	80	260	1,700
Diaphragm		0·61	60	240	1,700
L. dorsi		0·47	30	140	900
Heart		0·33	210	610	2,800
Psoas	Blue whale	0·84	20	80	600
Psoas	Ox	0·60	40	100	1,200
Psoas	Elephant	0·46	30	140	800
Psoas	Pig	0·43	20	130	1,000
Psoas	Sheep	0·35	30	180	950
Psoas	Hare	0·16	30	110	650
Psoas	Rabbit	0·02	<10	60	250
Pectoral	Manx shearwater	0·69	50	230	1,800
Pectoral	Pigeon	0·22	50	200	2,300

Table 2. EFFECT OF AGE IN HORSE HEART MUSCLE

Age	Myoglobin (% wet wt.)	Enzymic activity Q_{O_2} (µl. O_2/mgm. dry fat-free wt./hr.)		
		Succinic dehydrogenase	Succinic oxidase	Cytochrome oxidase
5 months before birth	0·02	negligible	20	200
6 weeks before birth	0·10	60	160	1,500
18 months after birth	0·27	240	580	2,700
2–12 years after birth (Mean of 6 animals)	0·33	210	610	2,800

It may also be noted from Table 1 that the activities of succinic dehydrogenase and of succinic oxidase in heart muscle apparently represent a greater proportion of the cytochrome oxidase activity than is the case in skeletal muscle. Similarly, in horse heart muscle (Table 2), with increasing age, succinic dehydrogenase and oxidase show a proportionately greater increase than does cytochrome oxidase over the same period. Data (not reported here) for the psoas, longissimus dorsi and diaphragm muscles of the horse also show this effect.

Apart from the above correlation between redness (myoglobin) and the activity of the cytochrome system, other differences have been found between heart, red, and white musculature. In skeletal muscle, the following bear an inverse relation to myoglobin content: (1) the initial resting level of energy-rich phosphate; (2) the ratio of rate of fall of *p*H under aerobic conditions to that under anaerobic conditions, and the ratio of rate of aerobic to anaerobic breakdown of energy-rich phosphate in post-mortem catabolism; (3) the rate of *p*H fall under anaerobic conditions; and (4) the 'maximum'[7] adenosine triphosphatase activity ('resting'[7] adenosine triphosphatase activity is about the same, irrespective of myoglobin content.) In other words, the more myoglobin in skeletal muscle, the greater appears to be its capacity for respiratory metabolism and the less its power for carrying out glycolytic processes; and conversely. Heart muscle appears to be unique in showing a virtual absence of glycolytic mechanisms—there is no detectable fall of *p*H under anaerobic conditions (in fact, a slight rise is often evident) and negligible anaerobic breakdown of energy-rich phosphates in post-mortem catabolism; the resting level of energy-rich phosphate is, moreover, very low. Adenosine triphosphatase activity is also very small and appears to be the same in 'resting' and 'maximum' conditions of activity. Heart muscle thus shows a profound dependence on oxygen for its functioning, with little or no capacity for incurring an 'oxygen debt'.

It is hoped to publish a full account of this work elsewhere.

Thanks are due to Dr. L. Harrison Matthews and Dr. Osman Hill, of the Zoological Society, London; to Mr. R. W. Pomeroy, of the School of Agriculture, Cambridge; and to Dr. J. G. Sharp, Mr. J. R. Bendall and Mr. J. K. Walley, of the Low Temperature Research Station, Cambridge, for making avail-

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Paper Electrophoresis of Serum Proteins

THE separation of the albumin, α_1-, α_2-, β- and γ-globulin fractions of serum protein can be accomplished by electrophoresis on filter paper[1-3]. The protein fractions are delineated as bands by drying the paper, and then staining with bromphenol blue. Cremer and Tiselius[2] estimated the fractions by elution of 5-mm. strips of the filter paper, the concentration of the dye from each strip being determined colorimetrically. A curve is thus obtained, similar to that from the classical Tiselius electrophoresis.

The separation by paper electrophoresis is elegant, and the apparatus simple, but the elution of dye from thirty to forty pieces of filter paper is both tedious and time-consuming, besides having theoretical objections. To simplify the procedure, and make it more adaptable for routine clinical laboratory analysis, we cut out, after staining, whole bands representing protein fractions and estimate the protein by Kjeldahl analysis of the filter paper. If an accurately measured amount of serum protein is used initially, the fractions are thus directly estimated in terms of protein nitrogen. This method gives duplicate results which appear to be as accurate as those obtained by the much longer procedure of elution. A comparison of the results of the analysis of a serum (converted into percentages of total protein) both by this method and that of the classical Tiselius separation is given herewith.

	Albumin	Globulins			
		α_1-	α_2-	β-	γ-
Paper electrophoresis	62 8	3 3	7·2	14·4	12 8
Tiselius electrophoresis (Veronal buffer, pH 8 6)	62·8	3·7	7·1	14 0	12·2

Full details of the method and the results obtained will be published elsewhere.

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Inhibition of Lysine Decarboxylase from *E. coli* by Homologous Rabbit Antibody

IN studies on the production of antibodies to bacterial amino-acid decarboxylases, we have used lysine decarboxylase from a coliform organism as an antigen. This material was partially purified by a modification of the method of Gale and Epps[1] in order to reduce its toxicity for animals. The antigen, containing approximately 1·5 mgm. protein/ml., was injected intravenously into rabbits over a period of a month, at the rate of three injections a week. The dosage was gradually increased from 0·2 ml. to 1 ml. The rabbits were bled ten days after the final injection.

The antiserum was tested for inhibition of the lysine decarboxylase by the manometric method of Miller *et al.*[2]. Double side-arm Warburg flasks were employed, the antiserum being tipped in after the reaction had proceeded for twenty to thirty minutes. With the homologous enzyme, inhibition of decarboxylase activity was about 90 per cent complete. No inhibition of the corresponding glutamic acid decarboxylase preparations was noted, however, when antiserum to lysine decarboxylase was added under the same conditions.

When the antiserum and homologous enzyme were mixed and allowed to stand overnight in the refrigerator, a precipitate formed. The residual activity noted above was found only in the precipitate, showing that the enzyme is both precipitated and largely inhibited by the homologous antiserum. This positive finding is in contrast to the results recently reported by Happold and Ryden[3] for tyrosine decarboxylase from *Str. faecalis*.

A more detailed report of these experiments will be made in a doctoral dissertation to be submitted to Yale University by one of us (A. F. H.).

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Reported Gamma Glutamyl Activation of Peptide-Bond Synthesis

IN a recent paper in *Nature*, Hanes *et al.*[1] postulated a γ-glutamyl transfer mechanism in peptide bond synthesis. It is suggested that the amino-acid forms its first peptide bond with the γ-carboxyl of glutamic acid by displacing the cysteinyl glycine from glutathione. The amino-acid, now peptide bound, could be further transferred to other peptides. The concept is strengthened in view of the universal and yet unexplained presence of glutathione in all living tissues, the great significance of 'transferring' reactions in biochemistry, and the need for some hypothesis to shed light on the mechanism of protein synthesis. Experiments to test this hypothesis are described in this communication.

Labelled γ-glutamyl glycine was synthesized using a micro adaptation of the method of LeQuesne and Young[2]. 40 mgm. of doubly labelled glycine (2·5 μC./mgm.) yielded 25 mgm. of peptide, the purity of which was verified by elementary analysis (theoretical C, 41·2 ; H, 5·9 ; N, 13·7 per cent ; found : radioactive C, 41·38 ; H, 6·01 per cent ; cold C, 41·31 ; H, 5·91 ; N, 13·58 per cent). The uptake of free radioglycine was compared to that of glycine in the presence of glutamic acid, glutamine, glutathione, and cold γ-glutamyl glycine. The systems studied were cytoplasmic particulate matter from rat liver suspended in cell supernatant (*PS* system)[3], whole cells of mouse spleen[4], spleen homogenate, and the Gardner lymphosarcoma of *C3H* mice[4]. The uptake of radiovaline (2-^{14}C-labelled 3·2 µC./mgm.) in the presence of glutamic acid, glutamine and glutathione in the *PS* system[3] and that of radiophenylalanine (2·38 µC./mgm., 2-^{14}C-labelled) in the presence of glutamic acid, glutamine, glutathione, and cold γ-glutamyl glycine in rat kidney homogenate were also studied.

In no case was there any appreciable activation of amino-acid incorporation by γ-glutamyl compounds. The uptake of glycine from the peptide was always appreciably less efficient than that of free glycine. The *PS* system used the peptide glycine three and a half times more efficiently than the spleen whole cell or homogenate.

'Dowex 50' chromatography of the free and peptide glycine showed that, in the liver particulate system, the peptide is 88 per cent hydrolysed in 20 min. and completely hydrolysed in 60 min. In spleen whole cells, the peptide is comparatively stable, 2 per cent being hydrolysed in 20 min. and 5 per cent in 60 min. This demonstrates a dependence of glycine incorporation on hydrolysis of the peptide in these systems.

In incubations with radioglycine at 20 min. and at 60 min., and with radioglycine plus cold γ-glutamyl glycine at 20 min., no radioactive γ-glutamyl glycine was present in the supernatant fluids. The liver particulate and spleen whole cell systems were used.

It is interesting to note that their reported stability to intercellular peptidases[1] was considered as evidence in favour of γ-glutamyl intermediates. The exceedingly rapid hydrolysis of the peptide in liver seems to eliminate this possibility.

These results cannot be interpreted in favour of γ-glutamyl activation as an important mechanism in amino-acid incorporation. Fuller details will appear in a later publication.

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Purification of a Lipid Material ('Cord Factor') obtained from Young Cultures of Tubercle Bacilli

WHEN young cultures of wet tubercle bacilli are mildly extracted with petroleum ether, a small quantity of a lipid material ('cord factor') is obtained[1]. The most characteristic biological property of this material is a delayed type of toxicity. Mice injected at three- to four-day intervals with 0·1 mgm. of the crude extract die after ten to fourteen days, severely emaciated and with hæmorrhages of the lungs. The crude material gives negative reactions for phosphorus[2] (sensitivity < 0·1 per cent phosphorus) and for nitrogen[3] (sensitivity < 0·4 per cent nitrogen).

The characteristic toxicity described was used as a biological test for the identification of the material during its further purification. The crude extract was repeatedly heated in acetone to the boiling point and the clear supernatant decanted immediately. Thus, an acetone-soluble fraction (*A*) is obtained, representing about 99 per cent of the total material. The residue which, under these conditions, remains undissolved (fraction *B*, about 1 per cent) shows the characteristic toxicity, whereas *A* is inactive. Fraction *A* consists chiefly of neutral constituents (mainly phthiocerol), mycolic and other acids, and carbohydrates. A detailed report on these constituents will be published. Fraction *B* is soluble in cold petroleum ether, benzene, chloroform and ether, and insoluble in methanol, ethanol and water. After heating it for about thirty minutes in large volumes of boiling acetone, it can be brought into solution, but it is precipitated again from the cold solvent. It is likewise negative for phosphorus (< 0·05 per cent phosphorus) and nitrogen (< 0·09 per cent nitrogen).

Upon alkaline hydrolysis with methanolic potassium hydroxide in the presence of benzene (80° C., 8 hr.) fraction *B* yields three different fractions : (1) neutral compounds and ether-soluble salts of acids ; (2) ether-insoluble salts of acids ; (3) a water-soluble part, containing the carbohydrates liberated by saponification.

After hydrolysis, fraction (2), which contains the acids, appears as an oily residue. This fraction shows the biological activity of the original material. It is obtained only in minute amounts.

Samples of lipopolysaccharides from tubercle bacilli[4] were kindly supplied to us by Drs. E. Lederer and J. Asselineau. Their material, which is insoluble in hot acetone, did not show the characteristic toxicity of our fraction *B*.

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Toxic Principle of *Lathyrus sativus*

THE toxic substance of *L. sativus* responsible for lathyrism has been identified as selenium. *L. sativus* is much richer in selenium content than other pulses which are harmless (see table). Selenium has been estimated after wet incineration of the dried substance and reduction with ascorbic acid, which is a stronger reducing agent than hydroxylamine used by Klein[1]. Owing to the higher degree of utilization of *L. sativus* (Jiménez Díaz and Romeo[2] observed 86 per cent utilization) the high selenium content is easily transported to the tissues.

Pulse	Selenium content (mgm./100 gm. dry)
P. radiatus	2·5
P. sativum	1·2
C. arietinum	5·0
L. esculenta	2·3
L. sativus	22·9

Selenium has been given intraperitoneally to the monkey beginning with a dose of 500 µgm. and ending with 820 µgm. daily. In a period of eighty-four days, there were thirty-six blank days and forty-eight injections of a total of 31·23 mgm. selenium. After forty-one injections, extensor plantar (upturning of the hallux on stimulation) was first observed. The first sign of abolition of abdominal reflex was observed after forty-three injections. Flaccidity, the sign of ablation of area 4 [3], was also present. The upturned hallux after selenium administration in the monkey is very significant. The sign is produced in man and anthropoids when the pyramidal tract is interrupted; in the monkey, only when the entire cerebral hemisphere is removed[4]. Evidently selenium has not only caused degeneration of the pyramidal tract but has also produced more widespread lesions in the cerebral cortex. After the total dose of 31·23 mgm. of selenium, alkaline serum phosphatase was found to be increased to 90 King and Armstrong units[5], as compared to 14 units in the normal animal. Rudra and Bhattacharya[6] had previously observed that alkaline serum phosphatase is raised in lathyrism.

One of the mechanisms of action of selenium is by interference with methionine metabolism. In lathyrism patients who are still consuming the vetch pea, the methionine excretion falls to a fifth of the normal, the excretion rising to normal as soon as other pulses are substituted for the vetch pea[7]. Very early anorexia and gastrointestinal disorders are probably due to a disturbance in aneurin metabolism. Marked dermatitis may be due to some disorder in biotin utilization, since biotin is interrelated with fatty acid metabolism. We interpret these observations as due to selenium competing with sulphur. There is some indirect evidence that in lathyrism (due to selenium intoxication) the transmethylation process may be interfered with. Gillis and Norris[8] report that vitamin B_{12} helps the trans-methylation process. Rudra *et al.*[9] observed that motor neurone lesions in lathyrism patients are healed (extensor plantar becomes flexor; abdominal reflex) when methionine is given with vitamin B_{12}, while methionine given alone has no effect.

We are of opinion that selenium may interfere with enzyme systems requiring the sulphydryl or sulphamethyl groups for activity. The investigation is being continued.

We are indebted to the British Drug Houses, Ltd., for the gift of sodium selenite.

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Toxicity of Dextran in Rats

The anaphylactoid reaction caused by dextran in rats has recently been studied by several investigators[1-3]. We have found that after intradermal injections of dextran dissolved in physiological saline (in rats), Menkin's intravenous dye test[4] shows a seepage of dye into the wheals when the concentration of commercial dextran (Macrodex, Pharmacia Inc.) is at least 10 µgm./ml. Moreover, it has been found that dextran preparations with highly branched molecular chains are more toxic than those with relatively unbranched chains. Dextran fractions of an average molecular weight of 10,000 cause a positive dye test only in concentrations of about 10 mgm./ml. Sulphuric acid esters of dextran[5] do not cause increased capillary permeability. We have confirmed the previously reported increase in hæmatocrit values after intravenous injection of dextran[3], and found that it is more or less completely prevented by antihistaminics, local anæsthetics and pretreatment with cortisone in high doses. The most potent inhibitor, however, is alloxan intravenously in a subdiabetogenic dose. 2,3-Dimercaptopropanol injected 30 min. before dextran has an inhibitory effect only in some experimental series. The factors causing these variations in the 'antiphlogistic' effect of *BAL* are under study.

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Viability of *Conispiculum guindiensis* in *Calotes versicolor* Preserved in Formalin

Several specimens of *Calotes versicolor* (a garden lizard) were collected from gardens in Guindy near Madras, during March 1949. Blood, exuding from their cut tails, was examined for filarial infection. Six calotes found positive with microfilariæ of *C. guindiensis* were killed by the use of chloroform. Before preservation in formol-saline (one part of commercial formalin to four parts of normal saline) a 2-in. slit was made in the abdominal wall to open it. The specimens were brought to Delhi for demonstrating the adult worms *in situ*. In one specimen, which was dissected fourteen days later, although some degree of putrefaction had taken place, viable filarial worms were seen. Some of the adult female worms contained ova which stretched out to typical microfilarial forms. Similar findings were observed in the remaining calotes dissected at weekly intervals. The last two calotes were dissected in the sixth week of preservation. Temperature during that period ranged from 97·0° F. maximum to 51·0° F. minimum.

Similar results were observed in another batch of four calotes caught from the same area during March 1951. In yet another lot of four calotes, commercial formalin was used as a preservative, but all worms were found dead within a week of preservation. This indicates that formol-saline, though it inhibited bacterial growth, did not kill the worms or the ova in them.

N. G. S. Raghavan

Malaria Institute of India,
Delhi.
Feb. 1.

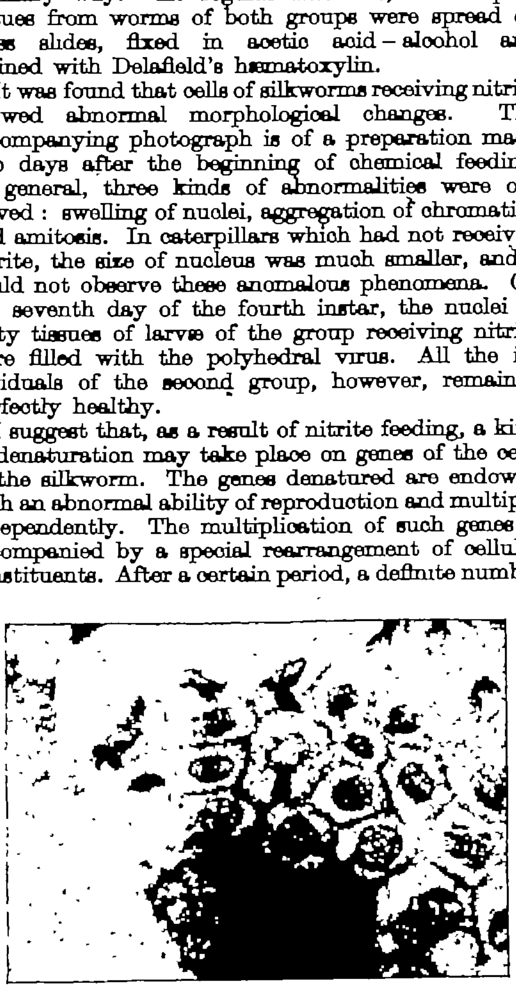
Effect of Nitrite on the Nuclear Structure in the Silkworm

It has already been observed[1] that nitrites caused the production of virus in the body of the silkworm. It is thus to be expected that changes of cellular structure in the worm may be provoked by nitrites. For the purpose of confirming this assumption, I have now conducted several experiments and prepared a large number of specimens.

In one experiment, I bred a virus-free strain in spring. On the first day of the fourth instar, larvæ were divided into two groups. The first group was fed with potassium nitrite once each day. The concentration of nitrite solution given was 2·8 per cent for the first three days, but it was later increased to 4·3 per cent. The second group was reared in an ordinary way. At regular intervals, the adipose tissues from worms of both groups were spread on glass slides, fixed in acetic acid-alcohol and stained with Delafield's hæmatoxylin.

It was found that cells of silkworms receiving nitrite showed abnormal morphological changes. The accompanying photograph is of a preparation made two days after the beginning of chemical feeding. In general, three kinds of abnormalities were observed: swelling of nuclei, aggregation of chromatins and amitosis. In caterpillars which had not received nitrite, the size of nucleus was much smaller, and I could not observe these anomalous phenomena. On the seventh day of the fourth instar, the nuclei in fatty tissues of larvæ of the group receiving nitrite were filled with the polyhedral virus. All the individuals of the second group, however, remained perfectly healthy.

I suggest that, as a result of nitrite feeding, a kind of denaturation may take place on genes of the cells of the silkworm. The genes denatured are endowed with an abnormal ability of reproduction and multiply independently. The multiplication of such genes is accompanied by a special rearrangement of cellular constituents. After a certain period, a definite number of independent genes combine together with re-arranged components, and masses of extraordinary size—virus particles—are thus formed in nuclei. This seems a possible mechanism of chemical virus production.



Adipose tissue of silkworms fed on potassium nitrite. × 460

Kazuo Yamafuji

Agricultural Chemistry Institute,
Kyushu University,
Fukuoka, Japan.
Jan. 4.

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[1] Yamafuji, K., *Nature*, 166, 661 (1950). Yamafuji, K., and Yoshihara, F., *Enzymologia*, 14, 124 (1950). Yamafuji, K., Akita, T., and Inaoka, M., *ibid.*, 14, 164 (1950). Yamafuji, K., and Yoshihara, I., *J. Agric. Chem. Soc. Japan*, 24, 388 (1951).

Some Effects of Ultra-violet Radiation on *Lemna minor*

In view of the fact that treatment with ultra-violet radiation has become a common technique in physiological and genetical work, the following observations we have made on the effect of ultra-violet radiation on *Lemna minor* may be of interest.

We used a 'Vitreosil' mercury vapour discharge lamp $T/M5/369$, which emits radiation mainly in the region of 2500 A. During irradiation the plants were floating on water in small beakers 20 cm. vertically underneath the lamp.

In the early experiments, the plants and the ultra-violet lamp were enclosed in a box during treatments. A strong smell of ozone developed in the box. Treatment for more than 10 sec. produced visible symptoms in the fronds, namely, the exudation of drops of liquid from the upper epidermis. Treatment for more than 30 sec. was lethal: the fronds lost their chlorophyll overnight and died in a few days.

Ultra-violet radiation was accompanied by the production of ozone. Accordingly we investigated the possibility that these symptoms were due to ozone in the atmosphere and not to the ultra-violet radiation *per se*. This possibility does not seem to have received attention in the literature on effects of ultra-violet radiation. Popp and Brown[1] do indeed mention experiments in which plants were exposed to "the ozone only" of the lamp; but they do not say whether there was any effect. To test the effect of ozone alone we left the ultra-violet lamp on for two minutes, with the box closed and empty. The lamp was then switched off, and the plants were put into the box without any ultra-violet radiation and were left in it for varying lengths of time. Under these conditions the same symptoms appeared after the same lengths of treatment as in the earlier experiments, although there was no ultra-violet radiation present.

In a third experiment *Lemna* plants were irradiated as in the first experiment, but two opposite walls of the box were removed and a strong current of air was blown over the surface of the plants to remove the ozone. Under these conditions the amount of irradiation which could be given in a single dose without producing visible symptoms was increased from 10 sec. to about 90 sec. The minimum lethal dose was increased from about 30 sec. to about 600 sec. The symptoms of damage by ultra-violet radiation are somewhat different from those due to ozone alone—for example, ultra-violet radiation without ozone does not cause rapid destruction of chlorophyll. During these final experiments we noticed that plants were affected by the ozone if they happened to be in the same room, even when they were a few yards away from the source of radiation.

We conclude from these observations that if ultra-violet lamps are used in experiments with biological material, care must be taken to distinguish the effects of the radiation *per se* from those of the ozone produced by it.

E. WANGERMANN
H. J. LACEY

Department of Botany,
University College,
Leicester.

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[1] *Bull. Torrey Bot Club*, 60, 161 (1933).

Identification of Tertiary Pollen Grains with those of New Guinea and New Caledonian Beeches

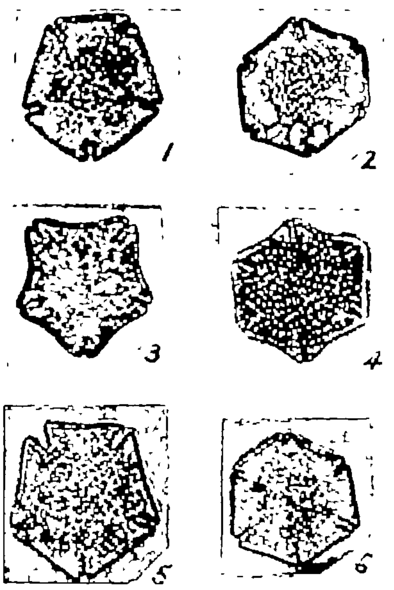
SEVERAL years ago, when certain pollen grains from Tertiary deposits in south-eastern Victoria were referred to the genus *Nothofagus*[1], it was recognized that some of them seemed to be intermediate in form between the two types of pollen grains that normally occur in this genus. At that time these divergent types were believed to be the pollen grains of extinct species of *Nothofagus*, and, as such, it seemed doubtful whether their exact affinity would ever be determined.

Examinations of the pollen grains of one of the New Guinea beeches, first discovered by Pulle in 1912 and independently recognized as *Nothofagus* by Brass and van Steenis in 1939, and of another beech discovered quite recently in New Caledonia by Dr. Baumann-Bodenheim, have shed light on the affinities of the fossil pollen. The pollen grains of both trees fall neither into the *menziesii* pollen group (*N. menziesii*, *N. cunninghami*, *N. moorei* and *N. obliqua*) nor the *fusca* group (*N. fusca*, *N. truncata*, *N. solandri*, *N. cliffortioides*, *N. gunnii* and, according to Cranwell[2], the bulk of the South American species) but are similar to the Tertiary pollen grains referred to by Cookson as *N.* sp. *e*.

This close agreement between the living and fossil pollen grains (Figs. 1–6) implying, as no doubt it does, a close affinity between the parents of each, indicates a long past-history and a far wider geographical distribution than at present. *N.* sp. *e*., which is probably the commonest of the Australian Tertiary pollen types, has been observed, sometimes in large numbers, in deposits that range from southern Queensland to Tasmania and westward into South Australia. Similar, if not identical, 'intermediate' pollen species have been distinguished in Cretaceous and Tertiary beds in New Zealand[3].

Several morphological and anatomical distinctions between the New Guinea beeches and other species of *Nothofagus* have already been observed by Langdon[4], who has remarked that "in certain respects they are sufficiently unlike the more typical members of that genus to justify their reference to a new section of the evergreen beeches". Their pollen morphology, so far as it is known at present, supports this statement.

Male flowers of the New Guinea species mentioned were collected by Mr. A. Schindler at Aiyura in the Eastern Highlands Division of New Guinea, and kindly forwarded to me by Mr. J. S. Womersley, Forest botanist, Department of Forests, New Guinea.



(1) and (2) Acetolysed pollen grains of *Nothofagus* from Aiyura, New Guinea. × 600
(3) and (4) Acetolysed pollen grains of *Nothofagus* from New Caledonia. × 600
(5) and (6) Acetolysed pollen grains of *N.* sp. *e*. from Oligocene clay, Yallourn, Victoria. × 600

Anthers of one of the New Caledonian species were generously supplied by Dr. M. G. Baumann-Bodenheim, of the Botanical Gardens, Zurich.

ISABEL C. COOKSON

Department of Botany,
University of Melbourne.
Jan. 22.

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[1] Cookson, I. C., *Proc. Linn. Soc. N.S.W.*, 71, 49 (1946).
[2] Cranwell, L., *Rec. Auck. Inst. Mus.*, 2, 175 (1939).
[3] Couper, R. A., *N.Z. Sci. Rev.*, 9, 5 (1951).
[4] Langdon, L. M., *Bot. Gaz.*, 108, 350 (1946–47).

Secondary Piliferous Layer in the Lupin

THE communication by J. B. Goodey on a secondary piliferous layer in *Hippeastrum*[1] leads me to record a similar structure in *Lupinus*.

During the examination of seedlings of *Lupinus arboreus* grown in the laboratory, a yellow gelatinous layer was noticed to appear on the roots simultaneously with the emergence of root hairs. This layer was found to consist of the disorganized cells of the epidermis and the two outer layers of cortex. Root hairs had originated in the third layer of cortical cells and penetrated the outer layers of smaller cells either directly or after some distortion. No root hairs were seen arising from epidermal cells.

In culture, seedlings were not infected by nematodes; but plants growing in the wild on the drier parts of sand dunes were highly susceptible to attack. Seedlings in this habitat all had exceptionally heavy developments of root hairs.

P. A. LUSH

Dominion Museum,
Wellington, C.3,
New Zealand.
Dec. 11.

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[1] *Nature*, 167, 822 (1951).

FORTHCOMING EVENTS

Monday, July 21—Thursday, July 24

SOCIETY FOR APPLIED BACTERIOLOGY (at Cambridge).—Summer Meeting and Annual General Meeting.

Thursday, July 24

Symposium on "Aspects of Food Preservation".

Monday, July 21—Friday, July 25

BRITISH ECOLOGICAL SOCIETY (in the Department of Botany, University College, Southampton).—Summer Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

RESEARCH DEMONSTRATOR IN GEOGRAPHY—The Registrar, The University, Sheffield (July 25).

DIRECTOR OF THE RESEARCH ESTABLISHMENT which the Board is setting up at Isleworth, Middlesex (the Establishment will be concerned with all underground activities connected with the mining of coal, and the principal qualifications for the post are proved ability in research in some branch of engineering or physics allied to engineering, and in directing teams of research workers)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/499 (July 26).

TEMPORARY ASSISTANT LECTURER IN MATHEMATICS—The Principal, Royal Holloway College, Englefield Green, Surrey (July 28).

ANALYST IN THE CHEMISTRY OF INSECTICIDES AND FUNGICIDES SECTION—The Secretary, Long Ashton Research Station, Long Ashton, Bristol (July 31).

LECTURER IN CHEMISTRY (with special qualifications in physical chemistry)—The Registrar, University College, Cathays Park, Cardiff (August 2).

TECHNICAL SECRETARY (with a university degree in science or agriculture, or equivalent qualifications, previous administration and secretarial experience would be an additional desirable qualification) in the Division of Biochemistry and General Nutrition, University of Adelaide, Adelaide, to assist the Chief of the Division in matters relating to the administration of the Division, including preparation of reports, handling of technical inquiries, and technical correspondence—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3668 (August 9).

LECTURER (Grade II) IN CIVIL ENGINEERING, and a LECTURER (Grade III) IN THE DEPARTMENT OF PHYSIOLOGY—The Registrar, The University, Birmingham 15 (August 11).

RESEARCH FELLOWSHIPS IN THE DEPARTMENT OF ELECTRON PHYSICS—The Registrar, The University, Birmingham 15 (August 12).

ASSISTANT PROFESSOR OF BIOCHEMISTRY—The Chairman, Department of Biochemistry, Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada (August 15).

LECTURERS IN EXPERIMENTAL AND MATHEMATICAL PHYSICS—The Assistant Secretary of University Court, The University, Glasgow (August 15).

SENIOR LECTURER IN PHYSICS in the University of Natal, Pietermaritzburg, South Africa—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (August 15).

SENIOR LECTURER IN CHARGE OF THE DEPARTMENT OF PHARMACOLOGY, and a LECTURER OR ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSICS, at the University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (August 30).

ASSISTANTSHIP IN PHYSIOLOGY—The Assistant Secretary of University Court, The University, Glasgow (September 1).

PRINCIPAL—The Clerk to the Governors, National Leathersellers College, 15 St. Helen's Place, London, E.C.3 (September 1).

SENIOR LECTURERS (2, qualified architects and Fellows or Associates of the R.I.B.A., with considerable practical and teaching experience) IN ARCHITECTURE, at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 1).

SENIOR LECTURER OR LECTURER IN PHYSIOLOGY at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 20).

READERSHIP IN MEDICAL PARASITOLOGY at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 23).

LECTURER IN PHYSICS (with special qualifications in theoretical physics)—The Secretary, Queen's University, Belfast (November 30).

ASSISTANT AGRICULTURAL ECONOMIST to undertake research and investigational work—The Registrar, Wye College, Wye, Ashford, Kent

ASSISTANT BIOCHEMIST (with a degree or equivalent qualification in chemistry) to undertake clinical biochemistry work—The Secretary, Welsh National School of Medicine, 34 Newport Road, Cardiff.

ASSISTANT (Grade B) to lecture in the DEPARTMENT OF PHARMACY AND BIOLOGY—The Registrar, College of Technology, Suffolk Street, Birmingham 1.

CHEMIST in the Division of Atomic Energy (Production), at Windscale Works, Sellafield, to be responsible for the supervision and operation of small-scale chemical plants processing radioactive materials—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 362.

ELECTRICAL ENGINEER in the Division of Atomic Energy (Production), to be responsible for the efficient upkeep and maintenance of the electrical plant in the production group of a large factory at Capenhurst, Chester—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 360.

EMPIRE RHEUMATISM COUNCIL FELLOWSHIPS (medical or scientific qualifications are needed) to prosecute research in the field of rheumatism—The General Secretary, Empire Rheumatism Council Tavistock House (N), Tavistock Square, London, W.C.1.

HEALTH PHYSICS AND SAFETY GROUP MANAGER (with a knowledge of radioactivity or electronics) in the Division of Atomic Energy (Production), to take charge of a group concerned with the investigation, measurement and control of radiation in a large nuclear chemical factory at Springfields, Salwick—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 357.

HONOURS GRADUATE IN PHYSICS, or related field, to work in Aberdeen on problems of smoking and drying of fish, including investigation of the physical properties of smoke and of the diffusion of water in fish—The Secretary, Herring Industry Board, 1 Glenfinlas Street, Edinburgh 3.

LECTURER IN THE MECHANICAL ENGINEERING DEPARTMENT of the Municipal Technical College—The Chief Education Officer, Guildhall, Kingston-upon-Hull.

LECTURER IN PHYSIOLOGY (honours graduate in physiology of a British university) for the Hygiene and Public Health Department—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

MICROBIOLOGIST at the Colonial Microbiological Research Institute, Trinidad—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref 27069/324

PHYSICIST (with good honours degree) to be concerned initially with the processing of textile fibres, both from a practical and theoretical point of view; an interest in statistical methods is desirable, but not essential—The Secretary, British Jute Trade Research Association, Kinnoull Road, Kingsway West, Dundee.

POST IN THE PHYSICS DEPARTMENT (candidates should have a first or second-class honours degree in physics) to assist in research on the properties of dairy products—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 52/8.

RESEARCH ASSISTANTSHIPS (honours graduates with sound general training in either chemistry or physics) in the recently formed research group of the Department of Applied Science, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

SCIENTIFIC ASSISTANT (with a degree in a biological science related to the work of the Bureau, some ability in and interest in Bureau work, and some knowledge of various languages) for work in connexion with the abstracting, reviewing, and indexing of the literature dealing with veterinary science—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory, Ministry of Agriculture and Fisheries, New Haw, Weybridge, Surrey.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research. Report of the Pest Infestation Research Board with the Report of the Director of Pest Infestation Research for the Year 1950. Pp. iv+38+4 plates. (London: H.M. Stationery Office, 1952.) 1s. 9d. net. [75

Forestry Commission. Britain's Forests—Thetford Chase. Pp. 16. (London: H.M. Stationery Office, 1951.) 1s. net [85

Forestry Commission. Forest Record No. 13: Chemical Control of Weeds in Forest Nursery Seedbeds. By G. D. Holmes and G. W. Ivens. Pp. 32. 2s. net. Forest Record No. 14. General Volume Tables for Japanese Larch in Great Britain. By F. C. Hummel, T. W. Irvine and J. Jeffers. Pp. 14. 9d. net. Forest Record No. 15: General Volume Tables for Douglas Fir in Great Britain. By F. C. Hummel, T. W. Irvine and J. Jeffers. Pp. 28. 1s. 6d. net. (London: H.M. Stationery Office, 1951–1952.) [85

Other Countries

Union Internationale de Chimie Pure et Appliquée. Comptes rendus de la Seizième Conférence, New York City et Washington, D.C., 8–15 Septembre 1951. Pp. ii+160. (Paris: Union Internationale de Chimie Pure et Appliquée, 1952.) [65

Anuario del Observatorio Astronómico de Madrid para 1952. Pp. 397. (Madrid: Instituto Geográfico, 1951.) [65

Geological Survey of Nigeria. Bulletin No. 21. Land Use and Soil Conservation in parts of Onitsha and Owerri Provinces. By A. T. Grove. Pp. viii+79+4 plates. (Lagos: Government Printer; London: Crown Agents for the Colonies, 1951.) 10s. 6d. [65

Companhia de Diamantes de Angola. Publicaçoes Culturais No. 12: Museu do Dundo; subsídios para o estudo da biológia na Lunda—Generalidades acerca da Lunda e da sua exploraçao biológica. Por A. de Barros Machado. Pp. 107. (Lisboa: Companhia de Diamantes de Angola, 1952.) [65

United States Department of Commerce: Coast and Geodetic Survey. Special Publication No. 135. Tidal Datum Planes. By H. A. Marmer. Revised edition. Pp. vii+142. (Washington, D.C.: Government Printing Office, 1951.) 60 cents. [75

National Academy of Sciences: Division of Geology and Geography, National Research Council. Publication 212. Report of the Committee on the Measurement of Geologic Time, 1950–1951. Pp. ii+140. (Washington, D.C.: National Research Council, 1952.) 1 dollar [75

United States Department of Commerce: Weather Bureau. Technical Paper No. 16. Maximum 24-hour Precipitation in the United States. Prepared by Arthur H. Jennings. Pp. iv+284. (Washington, D.C.: Government Printing Office, 1952.) 1.25 dollars. [75

Western Australia: Geological Survey. Bulletin No. 103: Part 1, Geology of portion of the Mt. Margaret Goldfield, by R. A. Hobson and Dr. K. R. Miles; Part 2, Garnetised Gabbros from the Eulaminna District, Mt. Margaret Goldfield, by Dr. K. R. Miles. Pp. 136. (Perth: Government Printer, 1951.) [85

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SCIENTIFIC RESEARCH AND MAN-POWER PROBLEMS

QUITE apart from the fact that it elicited from the Lord President of the Council some indication of the Government's intentions in regard to the Science Centre and the expansion of higher technological education (cf. *Nature*, June 21, p. 1039), the debate in the House of Lords on June 11 and 12 on science and industry is of considerable interest as providing the commentary which the Advisory Council on Scientific Policy might otherwise have been expected to supply in publishing recently the report of its Committee on Scientific Man-power. The debate was initiated by Lord Samuel on a motion asking for a statement on the use made by industry and agriculture of the results of scientific research, and on the Government's policy for promoting the higher education of technologists. Lord Samuel himself commented at some length on the man-power report, stressing particularly the need for a broadly based system of technological education. Lord Woolton, before dealing with this latter question, reviewed briefly the whole Government organization for research, through which some £16,000,000 a year is spent directly on civil scientific research, apart from the £18,000,000 provided by the Treasury for the universities, a considerable part of which is spent in training scientific men. Much of what he said related to the Department of Scientific and Industrial Research, and this part of his speech, as well as further comments in the debate and replies from the Government side, throws some light on the Government's attitude to some disquieting features of that Department's last annual report.

Lord Woolton, after citing examples of substantial returns which had accrued from work under the Department of Scientific and Industrial Research, expressed general satisfaction with the extent of applied research being carried out in Great Britain, though not with the way in which its results are being applied in industry. In asking the Advisory Council on Scientific Policy to review the effectiveness of current arrangements for ensuring that the results of research make their full contribution to the development of the British economy, the Lord President no doubt had in mind some extension of the survey of the organization for research which was carried out by the Select Committee on Estimates in 1947. The Survey Panels which have already been set up to survey the resources and work of particular research associations in relation to the needs of their industries are evidence that the expenditure and efficiency of the Department of Scientific and Industrial Research are being closely examined from within.

A number of comments made during the debate supported this realistic policy, and Lord Falmouth, in particular, pressed for close examination of the vote for research and development under the Ministry of Supply, which now stands at £100,000,000 and has increased by £18,000,000 on last year; this is more than three times the total expenditure on the Department of Scientific and Industrial Research.

In this context the support given in the Lords debate to the plea of the Advisory Council for Scientific and Industrial Research for action to deal with some of the more urgent items in the Department's building programme is the more impressive. Lord Woolton explained that the construction of a modern tank for shipbuilding tests was delayed not on financial grounds but by design difficulties, and assured the House that the project would go ahead as soon as the design is available. Neither he nor Lord Cherwell replied, however, to Lord Crook and Lord Halsbury or other speakers, who strongly supported the Advisory Council's plea for greater flexibility in regard to the Department's expenditure, and particularly that the Department should be permitted to carry over unspent balances and allowed some increase of expenditure of the order of five per cent until its post-war plans are fulfilled.

On the whole, however, the trend of Lord Woolton's and Lord Cherwell's observations warrants some confidence that the support forthcoming for the Advisory Council for Scientific and Industrial Research in this debate will not be without effect. Nor did the Advisory Council's remarks on the man-power situation in the Department pass unnoticed. Many speakers seemed inclined, indeed, to probe that situation more deeply, and especially the observation in the man-power report of the Advisory Council on Scientific Policy that many of the best science graduates appear to be attracted to employment outside the Government scientific service. Lord Pakenham rather discounted the suggestion that inadequate salary-scales are responsible for the difficulty the Department of Scientific and Industrial Research and the Agricultural Research Council are experiencing in obtaining recruits of sufficiently high quality, and urged that it is rather a matter of prestige and of the removal of any barriers which prevent scientific men with administrative gifts from rising to the highest positions.

More may well depend on the conditions of service than Lord Cherwell seems disposed to concede. Conditions are liable to be more restrictive in Government service and, in the main, those conditions, as regards freedom of publication and the like, may not compare unfavourably with those in industry, as Lord Cherwell suggested. Nevertheless, his reference to freedom of movement between men of science in Government service, universities and industry was not too happily phrased and could convey the impression that such movement is regarded with disfavour generally, instead of being restricted or discouraged only in respect of those who have been working on the most secret subjects in Government service.

While Lord Cherwell's attitude here is right and reasonable, it could have been accompanied by some indication that, on the Government side, it is appreciated that any such limitation, however necessary, is a handicap to the advance of science and to industrial development. Misapprehensions are not removed by brusqueness, and, while more attention to general education, as freely emphasized in the debate, may remove a deficiency in the training of scientific men to which the Advisory Council on Scientific Policy directed attention in its fifth report, it will not of itself overcome the reluctance to enter Government service. More attention to the question of status and to like psychological factors appears to be desirable, both from the point of view of recruitment and of ensuring that the best use is made of the services of scientists and technologists and of the results of their work.

Lord Wise referred to the importance of exchange of staff between different institutes and between industry and the colleges of technology, from the point of view of improving standards of training in technology. Government establishments, and notably the research associations of Britain, have their part to play also, and it should be possible for the Lord President of the Council by his policy here to dispel any misgivings that Lord Cherwell's speech may have encouraged. The siting of the proposed new technological university and the choice of the few colleges of technology to be raised to university status should also have regard to the way in which proximity to a university and to centres of industry could foster both exchange of staff and co-operation.

Prof. R. S. Edwards, in a paper in the January issue of *Lloyds Bank Review*, lays much stress on the importance of closer collaboration between universities, research associations and government research establishments, as well as between the universities and industry. He, too, believes that we have still a long way to go before British industry is fully accustomed to the idea of employing university graduates, and that it will be some time before application enjoys the same prestige as pure research. Here, as in his emphasis on the importance of industry being well supplied with men and women capable of understanding the interplay of scientific, technological and market forces, and of framing and executing appropriate policies, he is in agreement with the findings of the man-power committee of the Advisory Council on Scientific Policy, and indeed some of his conclusions and suggestions are more specific.

On this question of co-operation, Prof. Edwards makes three important points. First, referring to the research associations, he stresses the substantial contributions to technological education which such associations could make. Where it is, in fact, being made, he considers it alone justifies support of an association. Financial partnerships between industries and the State on these lines are sound, he urges, provided that there is no pampering, that the negotiation of grants is hard-headed and business-like, that the Government makes sure it gets value for public money, and that it does not keep sickly associations alive too long. It would seem from Lord Woolton's speech that he is already alive to the implications of this view.

Prof. Edwards's second point concerns the universities as well as the research associations. While he considers our research institutions are well adapted to our present needs, he expects the demand for facilities for sponsored research to grow as more scientists and technologists are employed in British industry and technological competition becomes keener. He believes that the research associations should play a part in meeting this need, and that they could, as an extension to the existing advisory services, develop facilities for sponsored projects which do not clash with their co-operative programme without imperilling the co-operative nature of the associations. The universities also should participate in this field, and Prof. Edwards believes that they could do so, with appropriate safeguards and proceeding cautiously, without endangering either academic freedom or distorting their research programme.

One reason given by Prof. Edwards for advocating such a step, which admittedly is not at present favoured in academic circles, is that an increase in the volume of sponsored projects in the universities would raise the prestige of industrial research and application among young scientific workers and would be an additional source of university finance. In the light of the report of the Advisory Council on Scientific Policy, any measure that promises to break down the reluctance of promising students to enter on a scientific and an industrial career should be considered with an open mind, and Prof. Edwards's suggestion should be noted particularly with reference to research in technological institutions, on which stress was laid by Sir John Cockcroft in an article in the May issue of the *Universities Quarterly* as well as in the House of Lords debate. Prof. Edwards's third point is indeed that there should be closer collaboration between universities, research associations and government research establishments in regard to postgraduate studies. He visualizes, for example, research associations collaborating with the universities and the colleges of technology to provide some of the facilities for postgraduate work, on the meagreness of which Sir John Cockcroft pointedly commented.

Such a measure should supplement, rather than be a substitute for, the more generous provision of means for postgraduate research in the technological departments and the colleges of technology themselves. The possibilities in this direction should be carefully examined as part of the policy for the development of higher technological education. This in itself is an urgent reason for placing the responsibility for technological education in the same hands as are responsible for university education. It is to be hoped that at least the House of Lords debate will bring home to the Government the need for definite action in this respect, and for relieving the Minister of Education of this anachronism in her responsibilities.

It is of course, clear from the circumstances of the speeches in the House of Lords that few new points could be contributed to the discussion of the organization of civil research and the recruitment of scientific workers. Its realistic tone was, however, encouraging, and should help to ensure that a close watch is kept to see that the nation gets a full return from its investment in research, and that financial parsimony does not impair efficiency or hold up essential developments.

MORE OLD CAMBRIDGE MEN

Alumni Cantabrigienses

A Biographical List of all known Students, Graduates and Holders of Office at the University of Cambridge, from the Earliest Times to 1900. Compiled by Dr. J. A. Venn. Part 2: From 1752 to 1900, Vol. 4: Kahlenberg–Oyler. Pp. iv+615. (Cambridge: At the University Press, 1951.) 150*s*. net.

ON looking through this volume one is once more struck by the very high proportion of members of the University of Cambridge during the years 1752–1900 who took orders in the Church of England after leaving the University. This is to be explained in part by the fact that the University was for the greater part of the period closely linked with the Church; but that is not the only reason for the change that is to be found in the proportion of clerical graduates to-day. Careers for university graduates were more limited in range in this earlier period; the Church, schoolmastering, an academic career, the professions of medicine and law, the army, diplomacy, the Civil Service, the Indian Civil Service and the Colonial Service, such business careers as banking and publishing—these covered the chief openings for university graduates. Some men joined their fathers' businesses, but posts in industry and business generally were not offered as a rule to university men.

The biographies of individuals in the book are necessarily short; but a number of interesting facts emerge even from a casual study of the volume. Thus we learn that Prof. Herbert Marsh, F.R.S., Lady Margaret professor of divinity, 1807–39 (and simultaneously Bishop first of Llandaff and then of Peterborough), was the first to give his professorial lectures in English, instead of in Latin. Another divine who made a name for himself was the Rev. T. R. Malthus, F.R.S., known not unnaturally as "Old Pop". Of the Rev. Eward Kempe we are told that he left a ton of unpreached sermons behind him. Schoolmasters include the great flogging master, John Keate, of Eton. Naturally a large number followed an academic life—we will only mention here Prof. George Liveing, professor of chemistry for more than forty years, who died at the age of ninety-seven, James Clerk Maxwell, the first Cavendish professor, and Bartholomew Lloyd, who was incorporated D.D. in 1833 from Trinity College, Dublin. He was then Provost of Trinity, having previously been successively professor of mathematics, professor of natural philosophy, regius professor of Greek and lecturer in divinity. The Army provides Teignmouth Melvill, who earned the Victoria Cross at Isandlwanha in the Zulu War. In diplomacy we will mention two exceptional types: Thomas Manning, friend of Lamb, the first Englishman to enter Lhasa, a great Chinese scholar, and Henry Labouchere, who contracted £6,000 of debt in two years in Cambridge, joined a circus troupe, lived for six months in a Red Indian camp, then entered the diplomatic service, was dismissed for impertinence to Lord John Russell, became an M.P., and then a successful journalist with the *Daily News* and *Truth*.

About ninety Fellows of the Royal Society appear in this volume, of whom some half-dozen happily survive to-day; there is a very marked concentration among the names commencing with 'Mac' or 'Mc'. Among the honorary graduates who were also distinguished in science we may mention the names of

Klein, Le Verrier, Lister, Mendeléeff, and (Sir John) Murray. A great many of the graduates were Fellows of the Society of Antiquaries; for example, the Earl of Crawford, F.R.S., the founder of Dunecht Observatory, who went to Mauritius to observe the transit of Venus in 1874. Others who travelled to study happenings far from Cambridge include James Losh, who went to Paris to study the French Revolution and whose life was saved by Marat, formerly a veterinary surgeon in Newcastle; also three war correspondents—Kinglater for the Crimean War, Lockhart for the Franco-Prussian War, and E. F. Knight, a war correspondent in some dozen campaigns.

Various forms of sport and athletics figure among the records: the Hon. Ian Keith-Falconer, the most famous cyclist in the 'eighties, "Black" Morgan, who was the first (with Leslie Stephen) to climb the Jungfraujoch, F. E. Lacey, secretary of the M.C.C., Jack Mytton, the famous horseman, the Hon. George Lambton, trainer of many winners in classic races, John McGregor, of the 'Rob Roy' canoe, John Mackinnon, who played for England against Australia in 1879 and was presented with a bat by his clansmen on his ninety-eighth birthday, and we may add C. F. L'Oste, who went up in an aeroplane on his 103rd birthday, at which age he had never consulted a doctor.

In conclusion, a few names may be mentioned for the human touches in their biographies. W. J. Locke, the novelist, started as a graduate in mathematics, "an utterly futile and inhuman subject". John Mortlock was nine times Mayor of Cambridge. In contrast to J. C. Neild, a miser who left £500,000 to Queen Victoria, was Walter Scott Lockhart, described by his father as a "human financial sieve". Others who earned nicknames were John Lupton, "the pocket Hercules", Richard Martin, "Humanity Martin", H. H. Norris, "the Bishop-maker". Edward Meade-Waldo was one of the very few trained naturalists who claimed to have seen a sea-serpent, Sir William Molesworth, Bart., was sent down for challenging his tutor to a duel, and Edward Maitland claimed to have been previously Marcus Aurelius and St. John the Evangelist, "hence the mention of boiling oil was inexpressibly painful to him".

F. J. M. Stratton

THE RODA NILOMETER

Le Mikyâs ou Nilomètre de l'Ile de Rodah

Par Kamel Osman Ghaleb Pasha. (Mémoires présentés à l'Institut d'Égypte, Tome 54.) Pp. xvi+182+46 plates. (Le Caire: Imprimerie de l'Institut Française, 1951.)

This book gives a detailed description and history of the Roda Nilometer or river gauge, with an account of the extensive repairs and restoration undertaken in 1938.

The author was officially in charge of the gauge for many years as inspector-general of irrigation in Upper Egypt and later as under-secretary of state in the Ministry of Public Works, from which he retired some years ago. It was owing to his efforts that the very thorough restoration of the gauge, estimated to cost about £36,000, was carried out under his supervision.

The Nilometer is situated on the southern edge of Cairo and consists of a large square well walled in stone with a marble column in the centre carrying a scale divided in cubits, and is connected with the river by subterranean passages. It was built about A.D. 861 and succeeded earlier gauges near the same spot, and a still earlier one some miles upstream near Helwan. Records of flood and low-stage levels on these gauges have come down to us beginning in A.D. 622, twenty years before the Arab invasion of Egypt. There have been Nilometers from very early times; but very little information about river-levels can be derived from those, other than that at Roda, which is the most important of all. It was in charge of an official, the Sheikh el Mikyas, whose duty it was to observe the water-level and in flood-time announce to public criers daily the amounts by which the river had risen. If the flood did not reach a certain level much land would go unwatered and there would be famine. At a certain higher level irrigation was assured; and also the taxes to the government. From the building of the present Nilometer until recent times the post of Sheikh el Mikyas has remained in the same family, and the last holder, who died in 1947, inherited the post through his grandmother, who was of the original family—surely a record for length of tenure of an official post in one family.

The book describes very fully the construction of the Nilometer and the changes in it which have taken place, including the recent restoration. In this the marble pillar was removed and the well was cleared of silt right to the bottom. This clearance uncovered work which was previously unknown and revealed the doubtful nature of the foundations. In order to preserve the Nilometer it was necessary to place a solid floor underneath it and surround the well with concrete. The well is now dry and cut off from the river, so the Nilometer should remain as an ancient monument for an indefinite time. The Nilometer has not been in use since 1887, and the river-levels have been observed on a metric gauge near by on the river wall.

Many excellent plates show the details of construction of the Nilometer and the discoveries made during the recent restoration. The author has collected a great mass of references to the Nilometer from the writings of old Arab scholars and of medieval and modern visitors to Egypt. The work of doing this must have been immense. This leads to what is perhaps the most important part of the book, the discussion of the recorded levels. The earliest records of gauge readings are lists compiled in the fifteenth century by three Arab writers; but the sources from which they were derived are unknown. These end with the year A.D. 1470, and after that the sources are a number of writings by Arabs and foreign travellers, and the records are much less complete. In relating these to present-day levels there are many difficulties due to the use by the chroniclers of the Moslem year, which is lunar, and, more important, the various repairs and changes which have been made to the column. In view of the researches of Ghaleb Pasha it will be necessary to revise the list of readings converted to a metric scale, which has been used in all investigations of the past forty years. This will affect the numerical values but not the most important conclusions derived from previous studies of the records. Taking a general view one may say that although the recorded readings contain many sources of error, and naturally have not the precision of modern observations, nevertheless they are probably as reliable as statistics collected to-day about less well-defined phenomena such as health or social conditions. They can be used with suitable precautions for such investigations as the search for periodicities or the probability of occurrence of high or low floods.

Ghaleb Pasha is to be congratulated on having collected and published this great mass of information relating to the Nilometer.

H. E. HURST

UNIVERSITIES OF THE BRITISH COMMONWEALTH

The Yearbook of the Universities of the Commonwealth, 1952

(Published for the Association of Universities of the British Commonwealth.) Twenty-ninth Issue. Pp. xxxii+1661. (London: G. Bell and Sons, Ltd., 1952.) 42s. net.

THE "Yearbook" of the Association of Universities of the British Commonwealth has established itself as a standard work of reference on both general and specific academic matters pertaining to the countries of the British Commonwealth, and such a comprehensive single volume is invaluable not only for universities and colleges but also for government departments, business houses, clubs, schools, libraries and the public generally. It is, in fact, the principal publication of the Association; but it is important to note that it covers Commonwealth university institutions and does not confine itself merely to member institutions of the Association.

This twenty-ninth edition is the largest ever published. The "General Information" sections of most university entries have been expanded, and four new appendixes have been added dealing respectively with United Kingdom degree abbreviations, Commonwealth studies in the United Kingdom, international university organizations, and a select bibliography of books on university topics. A further innovation is an introductory account of more than three pages in the section on the British Colonies, which has been prepared by the secretary of the Inter-University Council for Higher Education in the Colonies. Other changes, recorded for the first time in this edition, are as follows: Rhodes University College and Potchefstroom University College for Christian Higher Education, respectively, become Universities of the same name; entries are recorded for the three Indian Universities of Gujarat, Karnatak and Roorkee, and in Pakistan for the University of Peshawar; and entries are recorded for two additional Colleges recognized by the National Conference of Canadian Universities, namely, Carleton College and the Royal Military College of Canada. Finally, this edition now incorporates a date at the head of each university entry showing the time at which the information relating to the entry was compiled; this is certainly a very welcome piece of information.

The general contents of the book follow much the same lines as the previous edition. After a general introduction, the various universities and university colleges of the Commonwealth are listed, starting with the United Kingdom, then each Dominion in turn, and finally the Colonies. This section covers four-fifths of the book; there are the lists of staff (about 25,000 names), general information on each institution and events during the past year. The remaining part of the book consists of ten appendixes, an index of names and a general index. The appendixes cover respectively the following topics: qualifications for admission to a first-degree course in a British university; postgraduate awards tenable in the United Kingdom; postgraduate awards tenable overseas; students from other countries in British universities; degree abbreviations (United Kingdom only); Commonwealth studies in the United Kingdom; universities of the Republic of Ireland; Anglo-American academic relations; international university organizations; and a short bibliography.

A NATURAL HISTORY OF BACTERIA

Bacteria

By Dr. K. A. Bisset, assisted by F. W. Moore. Pp. viii+123. (Edinburgh and London: E. and S. Livingstone, Ltd., 1952.) 20s. net.

THE ancestral tree of bacteria that Dr. Bisset has drawn is based primarily on morphology; but, as he says in his preface, "it is in reasonable accordance with the parallel conception of evolution by loss of synthetic power". He postulates that the simple cell from which others have evolved is spiral in shape and aquatic in habitat; progress has occurred with an ability to survive in a terrestrial environment, and the development of a reproductive process that relies on airborne spread. Primitive bacteria are Gram-negative; evolution is shown in the development of the Gram-positive state. Starting with the simple spiral-shaped cells, the tree has four main branches. The first includes the Gram-negative rods and specialized aquatic forms; the second the chain-forming Gram-positive spheres and rods; the third those Gram-positive cells with a branching habit; and the fourth the order Flexibacteriales. Between the second and third branches are the packet-forming cocci. In more formal terms the class Bacteria is divided into four orders: Eubacteriales, Actinomycetales, Streptomycetales and Flexibacteriales; of these, Eubacteriales forms the first two branches of the ancestral tree; the second and third orders form the third branch.

Ordinary morphological characters only divide microscopic organisms such as bacteria into a limited number of groups of ordinal or family rank; further subdivisions into genera and species are usually made on physiological differences. Dr. Bisset has applied his work on the cytology of bacteria to the problem and has made use of finer differences in cell structure in his outline classification. This has both advantages and disadvantages: it takes morphology to a lower rank, but it demands unfamiliar, though not difficult, techniques of the systematist. The result is a classification with which few would quarrel except on points of detail.

In a book of this size it is impossible for the author to do justice to his ideas on the classification of so large a group as the bacteria, and many of the chapters are too brief to be highly informative. There is unfortunately only a brief reference to his interesting and controversial finding that strains of *Rhizobium* species from wild legumes produce resistant endospores; in this the strains differ from the better-known species which grow in symbiosis with cultivated crops. The development of his thesis that the

Rhizobia are related to the *Bacillus polymyxa* group would have made most interesting reading. Two often repeated misstatements that seem to owe their survival to plagiarism should be corrected in a later edition; they are the reputed decolorization of *Mycobacterium smegmatis* by alcohol, and that sporing bacilli are among the commonest airborne contaminants, a statement disproved by day-to-day experience in the laboratory and by air sampling.

In this book Dr. Bisset has given us the hors d'œuvres; we now look forward to a more substantial meal in the form of a fully documented manual on the natural history of bacteria.

S. T. COWAN

ENZYME SYSTEMS

Enzymes and Enzyme Systems

Their State in Nature. Edited by John T. Edsall. (Memoirs of the University Laboratory of Physical Chemistry related to Medicine and Public Health, Harvard University, No. 1.) Pp. xiii+146. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1951.) 18*s.* net.

THIS volume is the first of a series of memoirs of the University Laboratory of Physical Chemistry related to Medicine and Public Health, Harvard University, and is a record of a symposium held in July 1949 on the state and nature of proteins and protein enzymes. It is only twenty-five years since J. B. Summer crystallized the first enzyme, urease, and demonstrated its protein nature. Since then a considerable number of enzymes have been crystallized, and, as Prof. J. T. Edsall remarks in the preface, "the generalization—'no enzyme without protein'—appears established as one of the most widely based inductive rules in the field of biochemistry". There is no doubt that very large numbers of protein enzymes occur in Nature and that in numerous cases they can be obtained in a relatively pure and crystalline state in which they can be studied as chemical individuals. Something having been found about the individual enzymes, the question arises: How are they assembled and co-ordinated in the cells so that long series of chemical changes are brought about so smoothly? This volume provides an excellent review of recent progress in this second stage of the study of enzyme function.

The notable progress made in recent years in the study of the enzyme activities of isolated mitochondria is the subject of the first two papers. A. L. Lehninger discusses the respiratory activity of rat-liver mitochondria, and D. E. Green the enzymes which are responsible for the citric acid cycle of reactions. The next group of papers deals with the mechanisms of enzyme reactions. E. L. Smith discusses the specificity of proteolytic enzymes—in particular those peptidases which require metal ions such as manganese or cobalt for their activity—and makes the interesting hypothesis that the metal ion is necessary to complete the bridge between the enzyme and the substrate peptide. A. C. Maehly describes the separation of an enzyme, the peroxidase of horseradish, into its component parts and its resynthesis from these parts. B. Chance discusses the reactions of ferrocytochrome-*c* with peroxidases. In the final paper E. J. Cohn, D. M. Surgenor and M. J. Hunter summarize the results of the very extensive researches on the separation of blood plasma proteins and of liver proteins, which have been carried out during the past ten or twelve years in the Harvard Laboratory. These researches are remarkable for the variety of new technical methods of protein separations which have been devised.

Altogether, this small book provides a very valuable introduction to recent work on complex enzyme systems and, as such, will be widely read.

J. A. V. BUTLER

BIOLOGY OF HOT SPRINGS

Grundriss zu einer Balneobiologie der Thermen

Von Prof. Vale Vouk. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften: Reihe der experimentellen Biologie, Band 5.) Pp. 88. (Basel: Verlag Birkhäuser, 1950.) 11.50 Swiss francs.

THIS is a welcome addition to the well-known series of scientific text-books and monographs issued by Verlag Birkhäuser. The physical and chemical properties of natural waters, particularly thermal springs, and also their clinical effects, have received a considerable amount of attention and have formed, separately and in conjunction, the subjects of systematic reviews. While there are on record numerous observations on different forms of life occurring in hot springs and on the species present in different localities, the present monograph is, as far as the reviewer is aware, the first attempt to bring them all together and deal with the specialized ecology of this environment and the various problems associated with it in a systematic manner. It is therefore of considerable interest and may have importance in the practical field.

Thermal waters have been defined as having a more-or-less constant temperature above the average annual temperature of their surroundings; but, as is pointed out, this is not satisfactory from the biological point of view. In arctic or alpine situations this might easily mean that the temperature would be a normal one in lower latitudes or altitudes. Similarly, the differentiation of thermal waters with reference to the temperature of the human body leaves something to be desired. Prof. Vale Vouk proposes a classification based on the types of living organisms present. His grouping is: chliarotherm, 18°–28° C.; eutherm, 28°–44° C.; akrotherm, 44°–65° C.; and hypotherm 65° C. and above. Thus, for example, the only organisms in the last group are Bacteria and Cyanophyceæ, and it is noteworthy that some members of each of these categories can live at temperatures a little above 85° C.; again, no fish or amphibians are known above the eutherm.

Temperature is not the only ecological factor affecting life in thermal waters, for, *inter alia*, there is the question of the nature and concentration of the chemical substances they contain, and these vary with the provenance of the waters. Thus, while the genus *Mastigopus* is cosmopolitan in distribution, it is as a rule confined to akrotherm waters with a limited concentration of mineral salts. These and other peculiarities affecting living organisms, including the 'Fervor effect' of thermal waters, are adequately discussed. The book is well printed and illustrated, furnished with an index and good bibliography, and provides an adequate summary of the present state of our knowledge of the biology of thermal waters.

LEONARDO DA VINCI, ARTIST AND MAN OF SCIENCE (1452–1519)

By Dr. A. TINDELL HOPWOOD
British Museum (Natural History)

THE Quincentenary Exhibition in the Diploma Gallery of the Royal Academy throughout the summer is designed to illustrate Leonardo's many interests by means of his own works, particularly his drawings and manuscripts. Emphasis on the drawings was inevitable, for the finest collection of them in the world is that in the Royal Library, Windsor, whereas of the eighteen surviving paintings only one, the "Madonna of the Rocks", is in Great Britain. There is no need to describe the genesis of the Exhibition, or to name the owners (Her Majesty the Queen at their head) who have so generously lent their treasures; this is done in the catalogue, another of those masterpieces of concise scholarship one has come to expect as of right whenever the Academy holds a special exhibition.

The name Leonardo da Vinci is familiar to millions who have never seen any of the original drawings and paintings. For most of them he is the painter of "Mona Lisa" and "The Last Supper", or else a scientist and inventor, born before his time, who made his notes in mirror-writing for fear of the Inquisition. This last point is almost certainly a myth arising from religious prejudices. That Leonardo was left-handed his drawings make plain, and the natural tendency of some left-handed subjects to write from right to left, holding the pencil in the left hand as Vasari and others said that Leonardo did, is sufficient explanation. To others, more widely read, Leonardo means many different things, so universal was his genius; yet, were one to be asked what his achievement was, it would be difficult to give a concise answer. Painter, sculptor and architect; anatomist, rhymester and engineer; herbalist, musician and dandy; he was at once all these and more. None the less, little of his work survives outside note-books and drawings; neither do the accounts of those who knew him, nor those of the following generation, suggest that he ever completed so much as his younger contemporaries Michelangelo (b. 1475) and Raphael (b. 1483).

Why this should have been remains uncertain, but the ceaseless questing of his intellect may well have been the cause. Vasari, who wrote nearly thirty years after the death of Leonardo, suggested that little was finished because so much fell short of the master's aim: he also quoted the remark of Leo X, "This man will never do anything, for he begins to think of the end before the beginning". Another pointer in the same direction occurs in a letter dated April 4, 1504, from Fra Pietro da Novelara to Isabella d'Este, reporting that Leonardo's "mathematical experiments have made painting so distasteful to him that he cannot even bear to take up a brush"; and, in another letter only four days later, "Leonardo's life is changeful and uncertain; it is thought that he lives only for the day. . . . He is entirely wrapped up in geometry and has no patience for painting".

Primarily his fame rested and still rests on his drawings and paintings; his notebooks were not deciphered until long after his death. So far as sculpture is concerned, the great clay horse for the Sforza monument was never cast and was destroyed by the French archers when they entered Milan in 1499: this was his most ambitious piece. For the rest, some small works in marble and terra-cotta from the workshop of Verocchio have been attributed to Leonardo in his young days, as well as two small bronze horses, one in Budapest and one in the present exhibition, and three life-sized bronze figures over the door of the Baptistry in Florence. These last, by Rustici, are supposed to owe much to Leonardo's assistance, although, as Vasari recorded, "nothing definite is known".

While he worked at the model for the Sforza monument, Leonardo studied the anatomy of the horse and compiled a note-book of his observations. The book was lost when the French entered Milan; but some drawings made at that time survived and are now at Windsor. At this same period he also dissected a bear, and on various occasions made drawings of dissections of frogs, birds, monkeys, and even lions. His chief interest, however, was in the anatomy of man, "who ranks among animals as first of the beasts" (in this phrase he anticipated Linnæus by two hundred and fifty years), and the fortunate circumstance that by far the greater number of his anatomical studies is now at Windsor has enabled this aspect of his scientific work to be displayed in remarkable detail. Fully to describe the drawings is not possible; they show that he realized that a horse walks on the tips of its toes, that there are similar structures in the legs of frogs and men, and that he not only described the antrum of Highmore, but also the right and left cardiac atria, the cerebral ventricles, of which he prepared casts in wax, and the valves of the heart. The full extent of these studies, at which he worked for a while with Marcantonio della Torre (1482–1512), professor of anatomy at Padua, is indicated by his statement to Cardinal Luigi d'Aragona in October 1517, only eighteen months before he died, that he had dissected more than thirty bodies of all ages, both male and female.

With so much anatomical work to his credit, one might have thought that Leonardo's time was fully occupied, but it was not; of the more than five thousand pages of notes and sketches still in existence, a large number is concerned with engineering projects, machines and scientific instruments. Some of the sketches illustrate his own inventions, others are the earliest known representation of a given object, and yet others are of machines invented before his day for which he had devised improvements. All these aspects are illustrated in this exhibition, and their interest is greatly enhanced by means of a number of models prepared in the workshops of the Science Museum from his notes and drawings.

Among the models are an *N*-girder bridge, a helicopter designed to have a radius of 14 ft., a parachute, a screw-cutting machine of advanced design, and machines for grinding plane and concave mirrors. These are by no means all. One drawing shows the earliest known observation of magnetic dip, another is of articulated driving chains, which he may have invented, and yet another represents the first known use of a pendulum to regulate a clock.

Lastly, there is a contrivance whereby a "weight jerks violently upward the feet of a sleeper, who is thus awakened and goes about his business". Whether this was seriously meant one cannot say; many similar devices are familiar to students of the history of inventions. The particular interest of Leonardo's apparatus is that it is an early example of a relay mechanism.

Concerning the paintings, it would be difficult to add anything to the notes in the catalogue, particularly as they include selected references to the vast literature that has grown up around the subject; but the smile of Mona Lisa, often called mysterious, is a small point of interest unmentioned in the notes. A like smile, so faint as to be barely perceptible, is to be seen in "La Belle Ferronnière" (Louvre), and again, a little stronger, in the "Lady with an Ermine" (Warsaw, Czartoryski Museum). This smirk annoys some, who point out that the women in religious pictures smile in a normal manner (cf. "The Virgin and Child with St. Anne and St. John": No. 109). It should be borne in mind, however, that Leonardo was the greatest painter of his time, and that his sitters, besides being paintable, were wealthy and fashionable. Now the fashionable smile of the ladies of the Renaissance was that painted by Leonardo; in their books of etiquette it was laid down that they should close the mouth at the right corner and open it on the left as though they were smiling secretly. But the fashionable smile of Mona Lisa was not suitable for sacred art; neither, so far as I am aware, did Leonardo ever depict it there. We have Vasari's authority that while Leonardo was painting Mona Lisa, "he engaged people to play and sing and jesters to keep her merry. . . . This figure . . . had such a pleasant smile that it seemed divine rather than human, and was considered marvellous, an exact copy of Nature". The fame of the smile has not diminished after four centuries and a half; but, "an exact copy of Nature"? How that phrase illuminates the gulf extending between the High Renaissance and the present.

THE BRITISH CONTRIBUTION TO TELEVISION

During April 28–May 3, the Institution of Electrical Engineers held a convention on "The British Contribution to Television", which was attended by more than 1,300 registered members, including 137 delegates from twenty-one different countries. The programme comprised ten sessions, at which more than eighty technical papers were presented and discussed, and a number of visits to such places as the B.B.C. television stations and studios, the Post Office Research Station and some dozen firms in the radio industry. A few social gatherings were also arranged, including a Television Ball and Dinner at Grosvenor House, London.

The convention was opened by the Right Hon. Lord Woolton, who surveyed briefly the development of television in Great Britain, starting from the suggestion put forward in 1908 by Mr. A. A. Campbell Swinton to use beams of cathode rays to convert the rapid variations of light and shade into electric impulses at one end, and to reverse the process at the other end of the system. He referred to the facts that the first public television service in the world started in London in 1936; and that the completion of the present plan of installing five high-power and five medium-power stations in Britain will make the television service available to about 88 per cent of the population of the United Kingdom. While we can scarcely expect to emulate the achievements of the United States in their spectacular development of television during the past five years or so, it is gratifying to observe that the radio industry in Britain has taken full advantage of the opportunities provided by the corresponding development here. Many firms must now have, in production, cathode ray tubes and other components assembled in television receivers, on a scale which would have been deemed impracticable a few years ago.

After a brief expression of thanks by Sir John Hacking, president of the Institution, who also welcomed Dr. Donald Sinclair, president of the Institute of Radio Engineers, New York, and other distinguished visitors and guests, an address on "Television Development" was presented by Sir Noel Ashbridge, then the director of technical services of the British Broadcasting Corporation. He traced the growth of the television service in Great Britain from the early experiments of J. L. Baird, with a low-definition system of 30 lines per frame and 12½ frames per sec., to the adoption in 1937 of the system developed by the Marconi-E.M.I. Co., using the technical standards of 405 lines per picture, 25 pictures (50 frames) per sec. with double interlaced scanning and positive modulation. While these standards are practically identical with those in use to-day, there has been much discussion at international committees during the past two years on the relative merits of this and other standards, differing mainly in the use of a greater number of lines per picture. As Sir Noel pointed out, for any improvement to be obtained by the use of more scanning lines, the band-width available at every point in the chain of transmission and reception must be increased correspondingly, with increase in costs all round. If this increased band-width is not available, a worse picture may result than that given by the present system using a smaller number of lines. It is greatly to be regretted that little progress has been made towards internationally agreed standards for television services; and there are, so far, four different specifications for black-and-white television in use, or shortly to be used, for broadcasting.

Looking to the future, Sir Noel said that colour is almost certain to be the most spectacular development in the next few years, and there are two systems sufficiently developed in the United States to merit serious and immediate consideration. No system has, however, been very definitely established on a public-service basis; but it is certain that the costs will be greater than with the black-and-white system in all respects, namely, programme production, technical operation and capital cost. While the use of colour may not be justified in all cases, there is no reason why colour television should not in the end give truer reproduction than colour films have in the past.

Reference was also made to the possibilities of stereoscopic television, with or without colour, and to the other applications of television, such as surgery, whereby a considerable number of people can witness a demonstration under conditions in which limited accommodation would make this impracticable otherwise.

At the second session of the convention, a broad historical review of the development of television was presented by Messrs. C. R. M. Garratt and A. H. Mumford. The history of television may be said to date from the observations, made by Becquerel in 1839, that when two electrodes are immersed in a suitable electrolyte and illuminated by a beam, an electromotive force is generated between the electrodes. The next stage was the discovery by Willoughby Smith in 1873 of the effect of light on the resistance of selenium. This discovery had no immediate sequel, but the era of stimulated progress which followed Bell's invention of the telephone in 1875 provided the background for numerous ideas for 'seeing by electricity'. Many of the resulting inventions were impracticable, chiefly because other discoveries and developments essential to the realization of the main ideas had not been made. From these beginnings, this paper traced the development of television following the suggestion of Campbell Swinton referred to above, and the introduction of the thermionic valve into radio practice. The presentation of the paper was accompanied by a demonstration of the mechanical system of television reception developed by Baird and used in the early experiments of the B.B.C.

The third session was introduced by Mr. D. C. Birkinshaw with a paper entitled "Television Programme Origination: the Engineering Technique". This paper, which was supported by fourteen others, surveyed the development of the engineering techniques associated with the origination of television programmes in Great Britain. Both studio and outside broadcast equipment were dealt with; much detailed design information from experienced authors is contained in these papers.

At the following session, Mr. P. A. T. Bevan reviewed the television transmitting scheme by which the British Broadcasting Corporation hopes to serve the greater part of the population of the United Kingdom. The basic factors underlying the choice of the scheme are discussed in the paper, together with the arrangements for dividing the available frequency-band into five separate channels. The general design of the complete equipment used at the transmitting stations is described with particular reference to the different types of vision and sound transmitters. The four supporting papers describe some of the special equipment features, including the aerial systems, in greater detail.

A survey of British research on wave propagation with particular reference to television was presented at the fifth session by Dr. R. L. Smith-Rose, and his remarks were amplified in four supporting papers. In this review emphasis was placed on the fact that the planning and successful operation of a national television service involves a somewhat detailed understanding of the mode of propagation of the radio waves concerned. For the service to be successful, a satisfactory ratio of the wanted signal to the prevailing noise or other interfering signals must be established within the reception area of each transmitting station. In addition, in view of the necessity of operating two or more stations in the same frequency-channel, a statistical knowledge of the propagation of the waves concerned to considerable distances is necessary in order to avoid mutual interference of the different transmitting stations. Furthermore, the use of radio links at extremely high frequencies for the exchange of programmes between stations involves a knowledge of the vagaries of the propagation of the very short waves concerned under varying atmospheric conditions. The papers presented at this session contain the results of many years work in this field, and form a basis of fundamental knowledge which has enabled the planning and establishment of a television service to be carried out so successfully in Britain.

With two introductory papers and eighteen supporting contributions, the next session dealt with point-to-point transmission. Dr. A. R. A. Rendall and Mr. W. N. Anderson described the arrangements used for temporary linkages for outside broadcasting purposes; while Mr. H. Faulkner spoke on permanent point-to-point links for relaying television programmes between transmitting stations. The object of these links is to provide a reliable system of transmitting vision signals involving a band-width of 3 Mc./s. over which the electrical characteristics are uniform and stable to a high degree. Experience in Great Britain has shown that excellent results can be obtained either by coaxial cable or by radio transmission, so that the choice between the two systems is largely a question of economics. The present advantage appears to be with the cable links on combined television and telephony routes; but, when radio links have been developed for the simultaneous transmission of television and multi-channel telephony, this advantage will be nullified. An item of interest in this connexion is that the travelling-wave tube, produced in Great Britain during the War, has found its first commercial application in the radio link between Manchester and Edinburgh. At the working frequency of 4,000 Mc./s., its high amplification and low noise-factor render an intermediate-frequency amplifier unnecessary and this reduces the overall cost of the link. The supporting papers describe in detail some of these radio and cable links and the associated equipment and testing apparatus.

The seventh session, on "Industrial Television", was outstanding in so far as the presentation was concerned. By the aid of a television link and a projection-type receiver and large screen, the authors introduced their papers from the lecture hall of the Institution of Civil Engineers, while the audience of more than six hundred watched in the adjacent Great Hall. In his survey paper, Dr. R. C. G. Williams pointed out that Great Britain has pioneered in industrial television no less than for broadcasting. Apart from the use of television for education and training and similar 'large-screen' work, an important application is to take advantage of the 'extension eye' principle in such fields as underwater television, the demonstration of surgical operations and the observation of dangerous processes. Among the eight supporting papers was one by Mr. F. Roberts and Prof. J. Z. Young entitled "The Flying-Spot Microscope". In the presentation of this, the authors demonstrated how the apparatus could give an accurate count of the thousands of minute nerve endings in a human nerve trunk, of which they showed a cross-section larger than had ever been seen before as a result of the magnification of more than half a million times with the large-screen equipment.

The next two sessions of the convention dealt in considerable detail with the problems of television reception, and especially with the design and construction of receivers, and the valves and cathode-ray tubes for use therein. In addition to the two survey papers, there were fifteen supporting papers which had been prepared by experts in the various phases of the reception of television broadcasting.

In the tenth and final session, Mr. L. C. Jesty dealt with "Television as a Communications Problem", and laid stress on the need for conserving ether space in the transmission of television signals. This phase of the subject will become of enhanced importance when the possibility of colour television is discussed, and also in connexion with the relaying of programmes over very great distances. Ten supporting papers contribute much detailed information to this question, and two of these deal with some fundamental aspects of colour television of both a subjective and objective nature.

There is no doubt that the holding of this convention brought together a large amount of detailed and expert technical knowledge on the various aspects of television described above; and this knowledge will prove very valuable to those responsible for the future development of television everywhere. The complete proceedings of the convention, containing the addresses, the full text of all the papers and reports of the discussions, will be published in four issues (Nos. 17–20 inclusive) of a special volume of the *Proceedings of the Institution of Electrical Engineers*, Part III A. The first of these special issues is expected to appear shortly. Those requiring copies should apply to the Institution of Electrical Engineers, Savoy Place, London, W.C.2, from whom details of the contents and subscription-rates may be obtained. R. L. Smith-Rose

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PRINCIPLES GOVERNING THE AMOUNT OF EXPERIMENTATION IN DEVELOPMENTAL WORK

By Dr. F. YATES, F.R.S.

Rothamsted Experimental Station

GREAT BRITAIN has lagged badly behind the United States in the practical utilization of scientific discoveries. This is reflected in the demand for men of science in the two countries. The recently published Fifth Annual Report of the Advisory Council on Scientific Policy[1], for example, directs attention to the fact that the United States is turning out nearly three times as many men of science in proportion to the labour force as Great Britain is, and is planning further increases, particularly at the higher level. In part this lag in putting scientific discoveries to practical use is attributable to our neglect of the experiments and tests which are necessary in developmental work. These experiments differ markedly from the laboratory experiments required in pure scientific research, since their main function is to establish empirical rules of operation which are applicable under practical conditions. With the present drive for economy there is serious danger that even such facilities as are available for experimental work of this kind will be curtailed or not used to full advantage. It is therefore important to stress that such curtailment will result in much more substantial and immediate losses through failure to determine the best practices. Developmental work must be expanded, not contracted, if we are to survive.

It is perhaps somewhat remarkable that no very precise consideration appears to have been given to the expenditure that is justifiable in developmental work. Instead, experimenters have tended to rely on their intuitive judgment on the accuracy that should be aimed at, and are frequently influenced in this judgment by the demands, often misplaced, for economy. In its essentials the problem is very similar to that of deciding the accuracy required in a sample survey. For this latter problem I put forward the general principle that the accuracy should be such that the sum of the cost of the survey and the expected losses due to errors in the results should be minimized[2]. The same principle can be applied to experimental work. It is indeed here more widely applicable, since it is usually easier in experimental work to assess the losses due to errors of a given magnitude in the results.

In experimental work, however, we have at the outset to consider the type of results that are likely to emerge and the way in which they will be used. In the case of a treatment of the all-or-nothing type we may simply require a decision on whether or not to apply the treatment uniformly to the whole of the material, or to certain categories, already defined, of the material; or we may hope that the experiments themselves will reveal a way of classifying the material into categories for some of which the treatment will be profitable and for others unprofitable. Similarly, in the case of a quantitative treatment, we may require only to determine what uniform level of treatment gives the greatest economic return, or we may hope to divide the material into categories for which different levels of treatment will be most economic, or find some quantitative characteristic of the material which is correlated with the most economic level.

If the discovery of appropriate categories for non-uniform treatment is the aim, more elaborate experiments will often be required. We may also be prepared to sacrifice some of the smaller gains resulting from pushing the simpler type of investigation to its economic limit in the hope of obtaining the much larger gains which will result from the effective use of differential levels of treatment. For the moment, however, we will leave aside these more difficult problems, and consider the simple case in which the whole of the material is to be treated uniformly.

When a decision whether or not to apply a treatment is required application of the above principle is complicated, and we shall not discuss the matter further here. The problem is probably only soluble in terms of fiducial probability, using the sequential approach, and then with difficulty. It is essentially that propounded by Wald in his "Statistical Decision Functions"[3]. When the most economic level has to be determined, on the other hand, the solution is very simple, and reveals a number of features of general interest.

At the outset it will be well to make clear exactly what is meant by the concept of expected loss due to errors in the results. Consider, for example, the question of the use of fertilizer on an agricultural crop. If the whole of the crop is to be treated alike, the most economic level of dressing, which for convenience we will call the *optimum* level, will be the level at which the cost of a further small increment of dressing exactly equals the value of the resultant average increment in response. In the neighbourhood of the optimum the net loss due to departure from the optimum will in general be proportional to the square of the difference of the actual dressing from the optimum. If, therefore, instead of the optimum dressing $\hat{x}$ we apply a dressing $\hat{x} \pm \delta x$ there will be a net loss of $\lambda(\delta x)^2$ per acre, where λ is some constant.

If $\hat{x}$ is estimated by means of a set of experiments, and the estimate is subject to an error variance $V(\hat{x})$, then the average value of $(\delta x)^2$ over a large number of such sets of experiments will be $V(\hat{x})$. The expected loss due to error in the optimum will therefore be $\lambda V(\hat{x})$. The actual loss may of course be less or greater than the expected loss. An inaccurate set of experiments, for example, may by chance give the correct answer.

If, therefore, the cost C, apart from any 'overhead' or constant component, of an amount q of experimentation is cq, and the error variance of the estimate of the optimum level determined from such experimentation is v/q, the expected loss L will be $\lambda Av/q$, where A is the amount of the material to be treated. We therefore have

$$C + L = cq + \lambda Av/q.$$

This is a minimum when

$$q = \sqrt{(\lambda Av/c)}.$$

In this case

$$C = L = \sqrt{(\lambda Avc)}.$$

In other words, ***the most economic amount of experimentation is that in which the cost of the experimentation apart from overheads is equal to the expectation of loss due to errors.***

If an amount A of material has to be treated each year for an indefinite period, and the experiments take a year to carry out, A must be replaced by A/r, where $100r$ is the interest rate. If constancy of conditions cannot be assumed indefinitely and it is decided to repeat the experiment after t years, then A is replaced by

$$\frac{A}{r}\left\{1 - \frac{1}{(1+r)^t}\right\}.$$

The net loss resulting from undertaking a fraction or multiple f of the most economic amount of experimentation is

$$(f + 1/f - 2)C.$$

If, for example, the cost, apart from overheads, of the most economic amount of experimentation is £4,000, the costs and losses when f has the values of 1, ½ and ¼ will be as follows:

f	Cost of experiments (C)	Expected loss (L)	Cost + loss ($C + L$)
1	£4,000	£4,000	£8,000
½	£2,000	£8,000	£10,000
¼	£1,000	£16,000	£17,000

This table can be looked on as giving the expected additional gains from additional amounts of experimentation in the neighbourhood of the most economic amount. The total gain from the experimentation as a whole cannot, of course, be assessed by this means. In the common case in which the application of the treatment cannot be risked without *some* experimentation, the total gain will be that due to the use of the treatment. This will often be large compared with the marginal gain in the neighbourhood of the most economic amount of experimentation. If, for example, the gain from using the treatment at the correct optimum level is £100,000, and overheads and preliminary fundamental scientific research are costed at £5,000, with other costs as above, the total and net gains will be as follows:

f	Research expenditure (C + £5,000)	Expected total gain (£100,000 − L)	Expected net gain
1	£9,000	£96,000	£87,000
½	£7,000	£92,000	£85,000
¼	£6,000	£84,000	£78,000

In other words, the return on the first £6,000 of research expenditure is £84,000, on the next £1,000 is £8,000, and on the next £2,000 is £4,000.

If, therefore, experimental resources are scarce there may be a case for not carrying out the full amount of experimentation that can be justified on economic grounds, since the returns on the last few incremental steps are relatively small, and it may therefore be possible to use the immediately available experimental resources more effectively on other problems. However, the experimentation which is required to determine an optimum for uniform treatment is often capable also, if properly planned, of providing a basis for differential treatment. If successful in this respect further large gains may accrue. Consequently, since gains must on the average result from increasing the experimentation to the most economic level for uniform treatment, even if no effective basis for differential treatment is found, there is every justification for building up an experimental organization which is capable of dealing with this volume of experimentation.

There is one further point which is often of considerable practical importance. In many types of experimentation it is somewhat difficult to ensure that experimental conditions fully conform to the conditions under which the treatment will be used in practice. If this is not the case a constant component of error, that is, a bias, will be introduced. An error of this kind will not be eliminated by increasing the amount of experimentation, nor will it be revealed by the variability of the experimental results. Although the gains resulting from increased experimentation will *on the average* be the same whether or not a bias exists, the elimination of the bias may result in much larger gains. Additional experimental effort may therefore in such cases be much better directed to the elimination, reduction or correction of the bias, rather than to the reduction of the relatively small random component of error. To effect this a radically different type of experiment may be required.

As an example of the application of the above principles to a practical situation we may consider the experimental work on the effect of fertilizers on sugar beet, a crop introduced into Britain after the First World War. The early recommendations were based on Continental experience, but after various unco-ordinated experiments had been carried out a co-ordinated series of factorial experiments was started in 1933 and continued to 1949 to test the responses to nitrogen, phosphate and potash. The average number of experiments was twenty-two per year, and the total annual cost, exclusive of overheads, was about £700 per annum at pre-war prices.

As an example of the practical value of these experiments it may be mentioned that the results obtained up to 1939 enabled confident recommendations to be made in 1940 on the manuring of sugar beet under war-time conditions[4]. It was recommended, for example, that a dressing of 0·7 cwt. nitrogen per acre would be optimal, in contrast to the dressing of 0·45 cwt. nitrogen which had previously been recommended[5], and which was, in fact, about optimum at the prices ruling prior to the War. The net gain resulting from the change from 0·45 cwt. nitrogen to 0·7 cwt. nitrogen was about 15*s*. per acre at 1940 prices. If this change were made on the whole of the sugar beet acreage the total net gain would be £300,000 per annum. The actual net gain was probably considerably larger, since under-manuring of sugar beet (and other crops) was common before the War.

The determination of the most economic number of experiments in a situation of this type is complicated, owing to the fact that there is an additional random component of variation in response from year to year due to variation in meteorological conditions, and there is also a possibility of long-term changes due to changes in agricultural conditions. Without going into details, which will be dealt with elsewhere, it may be stated that an analysis of the variation in the nitrogen responses indicates that as far as this fertilizer is concerned about sixty experiments per year, possibly falling to forty per year after the first few years, may be regarded as most economic. In view of the fact that many farmers do not as yet follow at all closely the recommendations emerging from such experiments, the programme can be regarded as about adequate for the simple function of determining optimum uniform dressings. Indeed, from this point of view, the most serious defect of the experiments was the fact that the selection of the sites was not fully random, so that appreciable biases may have been introduced into the results.

The experiments were, however, quite correctly undertaken with the additional and more ambitious aim of investigating possible differences in response on different soil types, and establishing relations between responses and chemical analyses of the soils. In the case of nitrogen, for example, it was confirmed that the responses to nitrogen on fen soils (constituting 10 per cent of the sugar beet acreage) were very small, and would not pay for the cost of nitrogenous fertilizer. This fact is still not fully appreciated by the farmers concerned, 85 per cent of whom, according to a 1945 survey of fertilizer practice, applied nitrogen averaging 0·3 cwt. nitrogen per acre. Omission of this nitrogen would save about £25,000 per annum at present prices, that is, about twenty times the annual cost of the experiments. Considerably larger gains may be expected from the better utilization of the differences in response to phosphate and potash on different soil types and their relations with the chemical analyses of soils. That there is room for substantial economies is obvious when it is realized that the total cost of fertilizers applied to sugar beet is of the order of £3 million per year. For these more ambitious objectives a larger number of experiments would certainly have been economic.

But if the experimental work on sugar beet must be judged to have been scarcely adequate for the purposes for which it was undertaken it is, in fact, the high-light of all experimental work on fertilizers in Great Britain. Sugar beet is the only crop on which any co-ordinated series of modern well-designed factorial experiments has been carried out and the only one for which there has been any attempt to secure a selection of fields for the experimental sites which would be reasonably representative of the whole of the land growing sugar beet. For no other crop is there any adequate series of experiments for which chemical analyses of the soils of the experimental sites have been made, or for which there are any adequate descriptions of these soils. On the more difficult questions of fertilizer practice, such as how to use fertilizers on grassland, and the residual values of phosphate and potash, the amount of co-ordinated experimental work is negligible.

If experimental work in agriculture is to be expanded to a more economic level it will, of course, require a complete reconstruction of the existing machinery for experiments. More work is required not only on fertilizers but also on the many other aspects of crop and livestock production that are capable of simple and exact investigation by empirical experiments. If properly organized, such activities need not interfere with more fundamental scientific research, since technicians rather than research workers are the main requirement. The principal functions of the research workers will be to determine what experiments are worth while, to see that they are properly planned, and to examine the results for relationships which are unknown or only suspected when the experiments are begun.

I have chosen an example from agriculture because this is the field with which I am most familiar, and because it can be demonstrated by the principles set out in this article that the amount of empirical experimentation is here entirely inadequate. The general principles enunciated are of wide application in many other fields, and in particular in many branches of industrial research. The technique of empirical experimentation on highly variable material is relatively new, depending in large part on statistical developments made by British workers during the past thirty years. We have yet to learn how to use this technique to the best advantage, but that it justifies wider and more thorough use there is no question.

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[1] Fifth Annual Report of the Advisory Council on Scientific Policy (1951–1952). (H.M.S.O., London, 1952, Cmd. 8561.)

[2] Yates, F., "Sampling Methods for Censuses and Surveys" (London: Griffin, 1949).

[3] Wald, A., "Statistical Decision Functions" (New York: Wiley, 1950).

[4] Crowther, E. M., and Yates, F., "Fertilizer Policy in Wartime: the Fertilizer Requirements of Arable Crops" (*Emp. J. Exp. Agric.*, 9, 77–97, 1941).

[5] Ministry of Agriculture and Fisheries, "Arable Crops on the Farm", Bulletin No. 72, H.M.S.O., London, 1937.

OBITUARIES

Prof. H. A. D. Neville, C.B.E.

AGRICULTURAL education and the University of Reading have both suffered a heavy loss by the death on June 17 of Prof. H. A. D. Neville, emeritus professor of agricultural chemistry in the University of Reading.

Neville was born at Blackburn in 1880 and was educated at Queen Elizabeth's School and the Technical College, Blackburn, obtaining, from the latter institution, the degree of B.Sc. (London) as an external student. After a brief spell as demonstrator under Prof. W. J. Pope, at the Manchester College of Technology, he returned to Blackburn as lecturer and demonstrator under Dr. R. H. Pickard. From there he went, in 1906, to the County Laboratories at Chelmsford, and it was here that he made his first contacts with agricultural chemistry. In 1911 he proceeded to Cambridge to work with Prof. T. B. Wood and Prof. F. Gowland Hopkins; there he was in the midst of agricultural chemical teaching and research. August 1914 found him in the Royal Engineers. He rose to the rank of captain and was mentioned in dispatches. By 1917 he was carrying out research in the Munitions Investigation Department. Neville returned to Cambridge early in 1919, but by September of that year he was appointed to the chair of agricultural chemistry at University College, Reading. Within a year he was elected dean of the Faculty of Agriculture and Horticulture, and continued to hold these positions in the College, and later in the University, until he retired in 1947. In 1948 he was awarded the O.B.E.

In the early days, Neville worked with Pope and Pickard on problems chiefly concerned with the optical activity of a variety of organic compounds. However, his Cambridge days show a complete change of subject, and his researches there dealt with such matters as the fat of yeast and the mucilage of linseed; he was also joint author of a paper on the relative value of white and wholemeal bread. Neville was always described as an excellent analyst and research worker by those who knew him, and in some ways it is to be regretted that the turn of events at Reading led him into administration. Nevertheless, he was the guiding spirit behind the many excellent soil surveys which were carried out by members of his staff between 1925 and 1940.

What was lost to research was gained by the University and the Faculty, for Neville was a first-class administrator. He was one of a small body of men who guided the University College in those important years immediately before the granting of the charter in 1926, and he was the real architect of its Faculty of Agriculture and Horticulture.

The committees connected with university work and particularly with agricultural education on which Neville served are too numerous to mention here; but it was through these that he became known to, and respected by, a large number of people.

H. A. D. Neville was a wise administrator, an excellent teacher and a very good conversationalist; he is gone, but the Faculty of Agriculture and Horticulture of the University of Reading will ever be his monument. CYRIL TYLER

Dr. F. B. Pidduck

FREDERICK BERNARD PIDDUCK, whose body was found on July 1 on a Lakeland mountainside, had lived at Keswick after his retirement in 1950 from a long and distinguished career in scientific research and teaching at Oxford. Born on July 17, 1885, at Southport, he proceeded from Manchester Grammar School to Exeter College, Oxford, where he gained first-class honours both in mathematics and physics, and also the junior and senior mathematical University scholarships. He then studied for a short time at the Technische Hochschule, Charlottenburg. From 1907 he was a Research Fellow of the Queen's College, Oxford, whence in 1921 he became Fellow and Tutor of Corpus Christi College, where the rest of his official life was spent. During 1916–18 he rendered war service as a research officer in ballistics, with rank of captain, at Woolwich Arsenal, where his work gained official commendation. In 1923 he was awarded the D.Sc.(Oxford) for a thesis that included two important contributions to the kinetic theory of gases. In 1927 he became University reader, having previously been lecturer, in applied mathematics; this position he resigned in 1934. Electrical theory was one of his main interests, and he published two text-books on it, in 1916 and 1937, a technical treatise on currents in aerials and high-frequency networks (1946), and, with R. K. Sas, in 1947, an account of the M.K.S. system of electrical units, for which he was an enthusiast.

He was an extremely able mathematician, who preserved his intellectual originality and vigour to the end of his life. He wrote a series of important papers on the magnetron oscillator, and one of his last papers completes a theory of diffraction which he believed would ultimately take a fundamental place in optics. He was also a skilled experimenter, and long acted as senior demonstrator at the Electrical Laboratory, Oxford.

Active and athletic, Pidduck was an all-the-year-round swimmer, and an amateur photographer. He entered little into the life of his Colleges and University, and was apt to dwell on grievances. His reclusive habit unfortunately deprived his fellow workers of valuable contact with his able and wide-ranging mind, and may have contributed to what with some justification he felt to be an undue lack of public recognition of his notable achievements. One of his characteristics that he took trouble to conceal was his private generosity. S. C.

Colonel W. C. Devereux

BY the death on June 21 of Colonel W. C. Devereux, science has suffered a loss which is more serious than would normally be the case in the passing of an important and colourful industrial figure. For 'Dev', as he was universally called by his friends— and these included his work-people—combined success in industry with a real appreciation of the value of scientific and industrial research.

This was based not so much on philanthropy as on a knowledge that scientific research was commercially sound and indeed an essential basis for the new and expanding industry of light metals. After the First World War, during which he was superintendent of the first national aircraft factory, he developed the technique of forging light alloy pistons and was in frequent contact with Dr. W. Rosenhain and his team at the National Physical Laboratory in their work on *Y* alloy. The success of the forged piston in practice led to the formation in 1927 of High Duty Alloys, where the research laboratories, which were constantly expanding, were always an essential and integral part of the organization. Constantly in touch with the foundry and factory, the research laboratories none the less produced results of fundamental importance, as instanced by the work of Dr. L. Frommer on stress analysis by X-ray methods and on spectrographic analysis, and the studies of Dr. R. F. Hanstock and his collaborators on damping capacity.

On resigning from the office of chairman and managing director of High Duty Alloys in 1945, Colonel Devereux formed Almin, Ltd., and took the opportunity of founding the Fulmer Research Institute at Stoke Poges. His contacts with research and development in the United States during the Second World War had convinced him of the need in Great Britain for an organization for carrying out sponsored research to supplement the work of private industrial laboratories and co-operative research associations. The growth of that organization, which has more than doubled its staff (which now includes more than thirty graduates) and trebled its income, is an indication of the soundness of his judgment. Although confident of the continued success of the Institute, we cannot over-estimate the loss we have suffered in the dynamic and zestful personality of our late chairman, who quickly became a personal friend to those of us who had the privilege of working for him. E. A. G. LIDDIARD

NEWS and VIEWS

Chemistry at the Manchester College of Technology: Prof. H. N. Rydon

DR. H. N. RYDON, who has been appointed to the chair of chemistry at the Manchester College of Technology, succeeds Prof. J. Kenner, who has been made emeritus professor. Dr. Rydon was a student at the Imperial College of Science and Technology, London, where as a Royal Scholar he graduated with first-class honours in 1931. After a period of service on the academic staff at the Imperial College and at Birkbeck College, he was elected in 1937 by the Commissioners for the Exhibition of 1851 to a senior studentship, with which he proceeded to Oxford to continue his researches in organic chemistry. In 1939 he was awarded the Meldola Medal, a distinction reserved for younger chemists of exceptional promise; and in 1941 he was chosen as Harrison Memorial prizeman. In the meantime, Dr. Rydon had accepted a post at the Chemical Defence Experimental Station of the Ministry of Supply at Porton, whence in 1944 he was seconded to the Microbiological Research Department. Later, as a member of the scientific staff of the Medical Research Council Unit for Bacterial Chemistry, he worked at the Lister Institute. In 1947, however, he returned to academic work as reader in organic chemistry at Birkbeck College, University of London; in 1949 he became assistant professor and reader in organic chemistry at the Imperial College, where he has been responsible for the organization and general supervision of the advanced practical exercises in organic chemistry forming part of the new undergraduate course of study. In his earlier contributions to organic chemistry, Dr. Rydon participated in studies on olefinic acids which had been undertaken at the Imperial College by Prof. R. P. Linstead; later, he was associated with Sir Robert Robinson in investigations on the sterols; other researches have been concerned *inter alia* with the chemistry of the 2-chloroalkylamines, with the mechanism of the Michael reaction, with the constitution and synthesis of various organic compounds of natural origin, and especially with the biochemical aspects of bacterial growth and inhibition. Dr. Rydon's major interests at present are the chemical basis of chemotherapy, including the chemistry of peptides, and the organic chemistry of phosphorus.

Thermodynamics in Birmingham: Prof. F. K. Bannister

PROF. F. K. BANNISTER has been appointed to a newly created chair of thermodynamics in the Department of Mechanical Engineering in the University of Birmingham. The chair has been created in connexion with the organization of the new graduate school in thermodynamics, and Prof. Bannister will be in charge of this school under Prof. G. F. Mucklow, head of the Department of Mechanical Engineering. Prof. Bannister studied electrical engineering at the Burnley Municipal College and took his first degree in physics in the University of Leeds in 1930. He also holds a London external degree in mechanical engineering. He was a lecturer in mechanical engineering at Burnley Municipal College during 1937–40. In 1941 he was appointed lecturer in mechanical engineering in the University of Birmingham, and was granted the degree of Ph.D. in 1946 and became senior lecturer in the Department in the following year. He was appointed reader in thermodynamics in 1951. Prof. Bannister is well known for his work in thermodynamics, and in particular for his studies in the field of the transmission of pressure waves in gases within containing vessels and the application of these theoretical and experimental studies in such problems as arise in internal combustion engines. He was the joint author with Prof. G. F. Mucklow in 1948 of a paper entitled "Wave Action following Sudden Release of Compressed Gas from a Cylinder", which was awarded the Ackroyd Stuart Prize of the Institution of Mechanical Engineers. He has been closely associated with the Air Squadron at the University of Birmingham since its formation in 1941.

Zoology at Birkbeck College, London: Dr. W. S. Bullough

DR. W. S. BULLOUGH, Cancer Research Fellow and honorary lecturer in zoology in the University of Sheffield, has been appointed to the chair of zoology at Birkbeck College, University of London, as from October 1. Dr. Bullough graduated at the University of Leeds in 1935 and after a period of research joined the staff of that University, becoming lecturer in zoology in 1943. During 1944–46 he was lecturer in zoology at McGill University, Montreal. He then returned to Britain as Sorby Fellow of the Royal Society, a post held with that of honorary lecturer in zoology at the University of Sheffield. He was awarded a Senior Cancer Research Fellowship in 1951. Dr. Bullough has a very large body of published research work to his credit. This has included, in a logical sequence, investigations into the reproductive cycles of fish and the seasonal and hormonal factors influencing them; the reproductive and migratory behaviour in the starling and their possible relation to the incidence of foot and mouth disease; and the mammalian œstrous cycle. From a consideration of the mitotic effects of œstrogenic hormones produced by follicular fluid in the mammalian ovary, Dr. Bullough has more lately directed his attention to energy relations of mitosis. Energy must be stored in sufficient available amount before a cell can divide, and once a division begins it will proceed to the end as an 'all or none' reaction. The hormonal control of these rates of energy production, either by stimulation or inhibition, is now the focus of his attention and may well lead to light being thrown on the evolution of hormonal mechanisms in vertebrates as a whole. Dr. Bullough takes to his new duties a rich experience in three universities both in teaching and research, and Birkbeck College may confidently look to him for a continuation of that activity so well cultivated by Prof. A. Graham, whom he succeeds (see *Nature*, July 5, p. 16).

Heriot-Watt College, Edinburgh: Honorary Fellowships

THE Governors of the Heriot-Watt College have conferred the honorary fellowship of the College upon the following, among others: R. Crichton, managing director of Scottish Oils, Ltd., and a governor of the College during 1937–45; G. Mackay, divisional safety engineer, Scottish Division, National Coal Board, and member of the College Mining Consultative Committee; Dr. J. E. Mackenzie, assistant professor of chemistry in the College during 1894–97 and a governor during 1939–51; R. S. Smillie, assistant professor of mechanical engineering in the College during 1919–52; Sir William Wallace, chairman and managing director of Messrs. Brown Brothers and Co., Ltd., Edinburgh, a former governor of the College and a member of its Advisory Committee on Engineering Studies.

University of Leeds

The following gifts, among others, have been announced by the University of Leeds: *Department of Colour Chemistry and Dyeing:* The directors of Johnson Bros. (Dyers), Ltd., of Bootle, a dyeing and cleaning company controlling nine works (among them Pullars of Perth, Eastmans of London and Crockatts of Leeds) are providing an endowment fund of £2,000 to provide two studentships each of £50 a year in the Colour Chemistry and Dyeing Department of the University. This gift is intended to commemorate primarily the services rendered by the late Mr. Oswald Gunnell, recently chairman and managing director of the Company, and also in acknowledgment of help received from the University, at which no less than ten of its chemists and managers have been students in the Dyeing Department. *Department of Botany:* £870 over a period of two years from the Rockefeller Foundation towards the cost of a photographic assistant in plant biophysics. *Department of Leather Industries:* Additional equipment to the value of more than £3,000 from the Turner Tanning Machinery Co., Ltd.; equipment to the value of £500 from Messrs. Barrow, Hepburn and Gale; machine valued at £380 from Messrs. Baker Perkins, Ltd., Peterborough.

Prof. D. Thoday, emeritus professor in the University of Wales, has been appointed visiting professor in the Department of Botany during the session 1952–53; the title and status of reader in biomolecular structure has been conferred upon Dr. K. M. Rudall and Dr. J. MacArthur, Research Fellows in the Department of Biomolecular Structure.

A Recent Sunspot

The largest sunspot for several months came over the sun's east limb on July 9, and for a few days its area exceeded one-thousandth of the sun's hemisphere. This area is not unusual for a spot (spots up to four and even five times this size were observed in 1946, 1947 and 1951), but with the present approach to the minimum of the 11-year sunspot cycle, the appearance of any big spot is noteworthy in itself. A second point of interest was the position of the spot nearly on the sun's equator—1° to 2° south. The circumstances recall the notable equatorial spot of May 1921 which had a mean area for its disk passage of 1,324 millionths of the sun's hemisphere; parts of the spot structure crossed the sun's equator, the mean position being $\frac{1}{2}$° north. This spot was associated with marked disturbance in the earth's geomagnetic field, culminating in a great disturbance lasting from May 13 until May 17—one of the greatest geomagnetic storms ever recorded. However, the recent spot has shown no such parallel of associated geomagnetic or ionospheric disturbance. Only a few minor flares have occurred in Greenwich daylight hours, one of these on July 16 being associated with transient fading on long-distance short-wave radio communication. The joint absence to date (July 19) of intense flares near this sunspot and ionospheric disturbances, both of the solar ultra-violet radiation type and that denoting the effect of solar particles, is significant. By the time this sunspot had reached the central meridian on July 15·1, the area had decreased to about half that when first seen.

Publications in Astronomy from the University of Manchester

The recent growth of activities in astronomy at the University of Manchester has made it desirable to unify the University publications in this field under the general title of "Astronomical Contributions from the University of Manchester", and three series, numbered as follows, will be published. (1) *Annals.* This series is intended to include publications of observational data or other investigations which, on account of their extent, may be unsuitable for printing in current periodicals. The continuous operation of equipment at the Jodrell Bank Experimental Station for measuring meteor, solar and galactic noise has, in particular, yielded a great amount of observational material, and this will be published at irregular intervals as the occasion warrants. In addition, contributions to theoretical astronomy from the University and its Mathematical Laboratory, which because of their size may not be suitable for publication through other channels, will be incorporated from time to time. The first number, dated April 1952, has recently appeared. (2) *Jodrell Bank Reprints.* Papers on radio astronomy which are communicated to, and published by, the learned societies and other scientific journals in the usual way will be reprinted in this series. At present it includes sixty-eight contributions. Some of the back-numbers are available. (3) *Contributions to Theoretical Astrophysics.* This series, which will likewise consist mainly of reprints from scientific periodicals, was initiated recently and so far consists of three numbers (Nos. 1 and 2 being, however, rather scarce). All three series of publications will be distributed to a wide range of observatories, astronomical institutions and individual scientific workers. Requests for additional copies, or suggestions of additional addresses to which the publications should be sent, will be welcome and will be met as long as the supply lasts. Recipients are asked to reciprocate, on an exchange basis, with publications of their own, two copies being required, one to Prof. A. C. B. Lovell, Jodrell Bank Experimental Station, Holmes Chapel, Crewe, Cheshire, and the other to Prof. Zdeněk Kopal, Physical Laboratories, University, Manchester 13.

Protection of Plants in Europe

Both the working parties appointed by the executive committee of the European Plant Protection Organization have now issued their reports (from the Organization at 14 rue Cardinal Mercier, Paris). One party was set up to review the question of the danger to Europe of the introduction of hitherto unreported pests and diseases and to recommend appropriate precautionary measures. The other was asked to examine the quarantine restrictions imposed by governments with regard to certain pests and diseases affecting international trade, and to advise on the general principles on which such restrictions should in future be based. In the first report, twelve pests and diseases are listed affecting, among other crops, fruit trees, roses and potatoes, which would cause serious loss if they became established in Europe. A number of preventive measures such as field inspection, fumigation, post-entry quarantine, seed disinfection and the prohibition of certain packing materials are in general considered adequate to obviate the dangers; but in certain cases an embargo on import might be necessary. Stress is laid on the desirability of limiting permanent governmental restrictions on imports to a minimum, and of utilizing the European Plant Protection Organization as a reporting centre in the event of suspected trouble arising.

The quarantine working party was concerned with four specific plant troubles—Colorado beetle, San José scale, potato root eelworm and potato wart disease. A short account is given of each pest or disease, and the manner by which it spreads. Its control is then discussed in the light of present scientific knowledge so that any legislation imposed may be adequate but not unnecessarily restrictive. For example, distinction is made between the quarantine requirements needed during the active and the hibernating periods of the Colorado beetle. Where fumigation has to be enforced, as in the case of nursery stocks likely to be infected with San José scale, it is suggested that some body such as the European Plant Protection Organization might act as adjudicator on the adequacy of the fumigation arrangements of the exporting country, thereby saving the importer a further fumigation. Other practical recommendations are the discouragement of growing potatoes in nurseries and a plea for the adoption by all countries of a uniform system of soil sampling for eelworm detection. Details of a suitable technique for the latter are given in an appendix. The reports are published in both French and English.

Organization of Nationalized Industries

Nationalized industry forms the theme of a series of research papers published by the Acton Society Trust, and in a recent addition to this series, entitled "Patterns of Organisation" (Nationalized Industry Series No. 9; pp. 32; Claygate: Acton Society Trust, 1951; 2s.), is found a description of the structure of the various nationalized boards together with a critical appraisal of the assumptions underlying their structure. The idea that large organizations are more efficient than small took firm root in the thinking of the inter-war years. Technicians and engineers were absorbed by the idea of being able to plan for bigger units; the trade-union movement was dominated by the idea of relying upon national agreements to prevent inequitable treatment in any single area; and when the Second World War came, administrators learned successfully how to operate nation-wide controls. The present patterns of organization have been determined by the coincidence in time of these trends; and the Acton Society Trust pamphlet points out that it has been too readily assumed that the limiting factor is the capacity of management to manage, to the neglect of much evidence that the limiting factor resides in the capacity and needs of the workman. The human factors—desire for status, resistance to change, fear of the future—impede the introduction of changes which the new regime was intended to bring about. Basic units in each industry should be small enough to preserve loyalties and personal contacts between managements and employees and between the industry and the public. It is also argued that the co-ordination of these units can be achieved by some much looser system of organization than that at present operating.

Shirley Institute: Report for 1950

The "Shirley Institute Year Book, 1951" (pp. 125; Manchester: British Cotton Industry Research Association, 1951) includes, besides the annual report for 1950, concise accounts of its present organization and services to members with plans of the proposed extensions and the existing offices, laboratories and workrooms, and a chronology of the Institute's historical background and growth. The annual report includes an account of the ceremony on June 14, 1950, of the laying of a foundation stone for the new building scheme, with reports of the speeches made then and at the annual general meeting of the Association on November 9, 1950. Tributes are paid in the report to the services of Dr. J. C. Withers, who retired at the end of September 1950 after thirty years of service as head of the Information Bureau, chief librarian and editor of the "Summary of Current Literature", and to L. H. C. Tippett, head of the Mechanical Processing Division, who was awarded the Warner Medal of the Textile Institute on June 8. The major change in internal administration during the year was the appointment of J. H. Black as head of a new Information Department to co-ordinate all the information services of the Institute, including the library, abstracting, technical inquiries and publications, and the illustration office. Among research results stress is laid on the successful industrial application of the Shirley accelerated drying device and the introduction of the Shirley automatic size box, a revolutionary method of regulating the percentage of size added to the warp before weaving. The Shirley electrostatic eliminator, designed for the rapid removal of static electricity in high-speed processes, seems likely to be of value in other industries. Besides a list of members on January 1, 1951, appendixes to the report give details of the Council, committees of Council, publications of the Institute in 1950, and periodicals taken by and books added to the Library.

Italian Society of Geophysics and Meteorology

The Italian Meteorological Society, founded in 1881, unfortunately had to discontinue its activities during the Second World War. Prof. M. Bossolasco, Geophysical Institute, University of Genoa, who has been very active of recent years in the organization of international geophysical symposia in Italy, now writes, as secretary, to announce the foundation during May of the Italian Society of Geophysics and Meteorology. The Society's interests are planned to cover a very wide scope: they will include meteorology with climatology and bioclimatology, terrestrial magnetism, atmospheric and telluric electricity and radioactivity, seismology, volcanology, oceanography, hydrology, geodesy and geophysical prospecting and their applications. It is planned to begin publication of a Bulletin in the autumn. Membership, which is stated to be already some 120, is open to foreigners as well as Italians, and applications are invited; the annual subscription, which covers supply of the Society's publications, is only 500 lire. British geophysicists and meteorologists will wish the new Society every success.

Plastics Industry Education Fund

The trustees of the Plastics Industry Education Fund, the chairman of which is Mr. P. C. Allen, have recently announced that the total sum they have made available or authorized for expenditure during 1952 is £4,700. Some of the details of this money are as follows. £1,000 is to be made available during the year for the award of ten training grants for students and £100 for travelling and educational expenses for apprentices attending recognized technical colleges.

It has been decided to revise and re-print four of the series of technical monographs originally published by the Plastics Institute, and £1,000 has been allocated for this purpose. £200 has been allocated for the purchase of text-books for the libraries of the local sections of the Institute, with a further special donation of £200 to establish a library for the newly formed South Wales and Monmouth Section. It has been agreed to allot £1,250 for the purchase of capital equipment for technical colleges during 1952, and the trustees have asked the Plastics Institute to make specific recommendations concerning the equipment to be purchased and the colleges to benefit.

International Congress of Psychology

The International Congress of Psychology will hold its next meeting, in 1954, in Montreal, instead of in New York as previously planned. The American Psychological Association and the Canadian Psychological Association will be joint hosts for the meeting. In making this announcement, the American Psychological Association gives as the main reason "the delays and embarrassments which foreign scientists experience in attempting to obtain even temporary admission to this country". The Internal Security (McCarran) Law is considered to be responsible, and, by its restrictive action, to be damaging the exchange of ideas between the United States and the rest of the world. Some two thousand psychologists are expected to attend the congress in Montreal.

Instruments and Measurements: Conference in Stockholm

The Royal Swedish Academy of Engineering Sciences (I.V.A.) and the Association of Technical Physicists (T.F.F.) are arranging an "Instruments and Measurements Conference 1952" to be held in Stockholm during September 22–25. The Conference will be organized into the following main groups: methods of measurement in physical chemistry; methods of measurement and control in industry; mechanical methods of measurement and metrology; methods of measurement in nuclear physics and radioactivity; and miscellaneous methods of measurement. Symposia will be arranged in the first four groups. The official languages of the Conference will be English, German and French. A preliminary programme, with a list of papers, is now ready. All communications regarding the Conference should be addressed to Yngve Axner, Kungl. Tekniska Högskolan, Stockholm 70. An exhibition of instruments and laboratory equipment will be held in the Exhibition Halls of the St. Eriks Fair during September 23–30, to which members of the Conference will be admitted free of charge. Further information on the exhibition can be obtained from St. Eriks-Mässan, Lidingövägen 10, Stockholm 26.

The Night Sky in August

Full moon occurs on Aug. 5d. 19h. 40m., u.t., and new moon on Aug. 20d. 15h. 20m. The following conjunctions with the moon take place: Aug. 4d. 18h., Mercury 6·4° S.; Aug. 12d. 17h., Jupiter 7° S.; Aug. 19d. 12h., Mercury 4° S.; Aug. 22d. 06h., Venus 4° N.; Aug. 24d. 15h., Saturn 7° N.; Aug. 28d. 05h., Mars 3° N. Mercury is in inferior conjunction on Aug. 12 and cannot be observed during the first part of the month; towards the end of the month it is a morning star, rising at 3h. 30m. on Aug. 31, when its stellar magnitude is 0. Venus, an evening star, rises at 20h. 15m., 19h. 55m., and 19h. 25m. at the beginning, middle and end of the month, respectively, stellar magnitude − 3·3. Mars is an evening star, setting at 22h. 30m., 21h. 55m. and 21h. 15m. on August 1, 15 and 31, respectively, its stellar magnitude varying from 0 to 0·3 during this period. It is close to α Libræ early in the month and moves eastward until it is a little south of β Scorpii at the end of the month. Jupiter rises at 23h., 22h. 10m. and 21h. 10m. on Aug. 1, 15 and 31, respectively, stellar magnitude about − 2. The planet is nearly 3° south of δ Arietis during most of August. Saturn is an evening star, setting at 21h. 50m., 21h., 19h. 55m. at the beginning, middle and end of the month, respectively, stellar magnitude 1·1. It moves from a position close to γ Virginis to north of θ Virginis during August. The Perseid meteors will be active during the month, the maximum of the shower occurring about August 10–12.

There will be a partial eclipse of the moon on Aug. 5, partly visible at Greenwich. The circumstances of the eclipse are as follows:

Moon enters penumbra	Aug.	5d.	17h.	26·6m.
Moon enters umbra		5	18	33·4
Middle of the eclipse		5	19	47·4
Moon leaves umbra		5	21	01·4
Moon leaves penumbra		5	22	08·2

The magnitude of eclipse is 0·538, the moon's diameter being 1·0. An annular eclipse of the sun on August 20 is invisible at Greenwich. It will be visible over portions of South America.

Announcements

The following appointments have been announced by the University of Sheffield: F. T. Williams, lecturer in the Postgraduate School of Mining; B. R. Pursall, lecturer in the Department of Mining; P. H. Price (at present research assistant to the professor of fuel technology) to be lecturer in fuel technology; R. G. Siddall, research assistant to the professor of fuel technology; E. H. Gillespie, honorary lecturer in bacteriology. Dr. B. Donovan, lecturer in physics, has resigned on appointment as senior lecturer in physics at the Northern Polytechnic, London.

The Research Fund of the Chemical Society provides grants for the assistance of research in all branches of chemistry. About £700 per annum is available for this purpose, the income being derived from a donation of the Worshipful Company of Goldsmiths, from the Perkin Memorial Fund, and from other sources. Applications for grants should be submitted to the General Secretary, The Chemical Society, Burlington House, Piccadilly, London, W.1, on the appropriate form not later than November 15, 1952.

The American Embassy and the United States Educational Commission in the United Kingdom announce a programme of grants to assist senior British scholars to lecture or carry out research in the universities of the United States. The grants will be paid in dollars, and they will be tenable for the academic year 1953–54; the monthly stipend will not be more than 270 dollars. Applicants must be citizens of the United Kingdom or Colonies, and should have a plan for research which can be effectively carried out in the time they propose to spend in the United States; they must arrange their own affiliation with a university in the United States. Application forms, to be returned before November 15, can be obtained from the Assistant Cultural Relations Officer, Room 302, 41 Grosvenor Square, London, W.1.

ORIGIN OF THE DEFORMATION TEXTURES OF TITANIUM

By D. N. WILLIAMS and Prof. D. S. EPPELSHEIMER
Missouri School of Mines and Metallurgy, Rolla, Missouri

BY proper choice of assumptions, it has been possible to develop a satisfactory theoretical explanation of the tension, compression, and cold-rolled textures of titanium using the graphical method of texture analysis recently reported by Calnan and Clews[1].

The observed textures of titanium can be summarized briefly as follows: *tension*, strong [10$\bar{1}$0][2]; *compression*, [0001] rotated 30° from the compression axis at low reduction. Angle of rotation decreases with increased reduction. Some evidence indicates that <10$\bar{1}$0> is the preferred axis of rotation[3]; *cold rolled*, (0001) [10$\bar{1}$0] rotated 30° or more toward the transverse direction[4]. It is apparent from these results that some mode of deformation previously unreported in hexagonal metals is occurring in titanium.

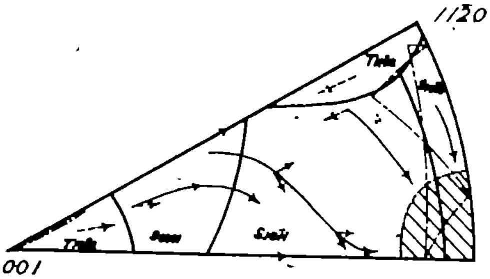

Fig. 1. Theoretical tension texture of titanium

Rosi, Dube and Alexander[5] report that at low reductions titanium exhibits {1010} <11$\bar{2}$0> and {10$\bar{1}$1} <11$\bar{2}$0> slip, and {11$\bar{2}$2}, {11$\bar{2}$1} and {10$\bar{1}$2} twinning. Although they found no evidence of {0001} <11$\bar{2}$0> slip, examination of the deformation textures shows that it must be present, at least at higher reductions.

These modes of deformation were examined separately and then combined to give the observed deformation textures. A satisfactory theoretical texture was developed when the critical shear stresses for slip (C_s) and twinning (C_t) were related as follows: C_s(0001) = 1·1 C_s(10$\bar{1}$1) = 1·02 C_s(10$\bar{1}$0) = C_t(1122) = C_t(10$\bar{1}$2). Since {11$\bar{2}$2} and {11$\bar{2}$1} twinning have the same general effect, only {11$\bar{2}$2} twinning was considered.

The areas within the unit stereographic triangle in which each of the above modes of deformation is favoured are shown in Figs. 1 and 2 for tension and compression respectively. Twinning reorientations are shown by dashed arrows, and slip rotation tendencies by full arrows. The final texture resulting is shown by the shaded areas.

The cold-rolled texture may be approximated by assuming tension in the rolling direction and compression along the rolling plane normal. In Fig. 3 the 0001 pole figure which would result is shown.

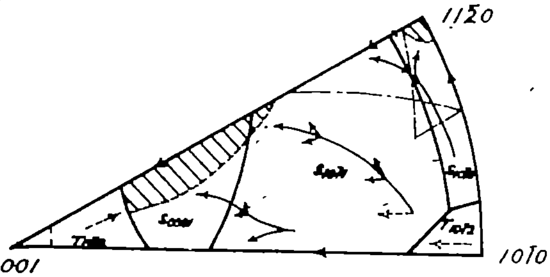

Fig. 2. Theoretical compression texture of titanium

Tension in the rolling direction causes those 0001 poles within 29° of the rolling direction to twin on the {10$\bar{1}$2} planes to a region near the transverse direction. {11$\bar{2}$2} twinning in compression removes 0001 poles within 30° of the rolling plane normal to a new position along the circumference of the pole figure. Twinning reorientations are shown by dashed arrows.

Slip can be assumed to result from combination of compression and tension tendencies. Compression rotates the 0001 poles toward the normal to the rolling plane. Tension rotates the 10$\bar{1}$0 poles into the rolling direction and thus rotates the 0001 poles toward the transverse axis. The tension and compression rotations are shown by arrows marked *T* and *C* in Fig. 3. The resultant rotation is marked *R*.

As the amount of cold-rolled reduction increases, a point is soon reached beyond which the principal movement is slip rotation by compression toward the normal to the rolling plane along the transverse axis, followed by twinning at an angle of 30° from the

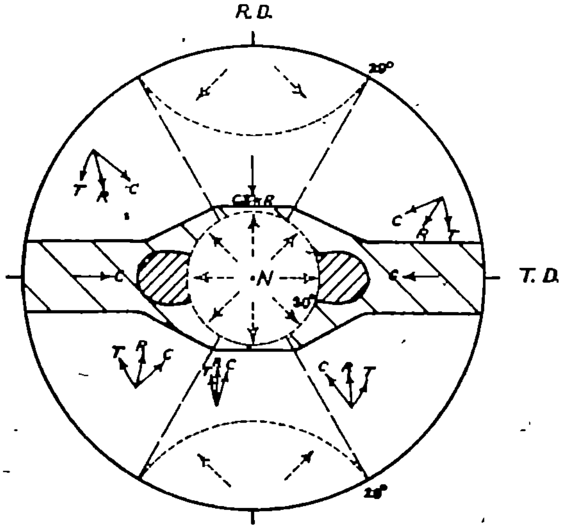

Fig. 3. Theoretical 0001 pole figure of cold-rolled titanium

normal to the rolling plane back toward the transverse direction. The slip rotations and twinning reorientations will occur by rotation about a fixed set of 10$\bar{1}$0 poles in the rolling direction. The resulting 0001 pole figure is shown by shading in Fig. 3.

Complete details of the analysis of the various modes of slip and twinning, along with experimentally determined textures using Geiger-counter techniques, will be published elsewhere.

The work described above was carried out under a research fellowship supported by the Titanium Alloy Manufacturing Division of the National Lead Company.

[March 4.

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A NEW APPROACH TO THE PROBLEMS OF THE SPREAD OF APHIDS AND TO INSECT TRAPPING

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IN recent work with *Aphis fabæ*[1], trapped while flying from infested bean crops, the usual statistical procedures failed to distinguish fluctuations in numbers due to flight behaviour from those due to population changes. This makes it necessary to reconsider current views on the spread of aphids as well as the analysis of trap data in entomological research.

Current Views and Recent Work on Aphid Migration

Resting winged aphids when exposed to winds greater than 1·5–2·0 m.p.h. will not take flight[2-5]. It has therefore been inferred that relatively little migration occurs in windy weather[3,4,6], although shelter may allow some to take place from within crops[6-8]. This idea seemed to be supported by the results of trapping in the field[9,10] and also by the fact that high aerial concentrations are commonly seen only in calm weather and because only then are single plants colonized[11]. Moreover, take-off, colonization and numbers in the air have all been considered in relation to the weather of the occasion, so tacitly over-emphasizing the role of flight behaviour in migration changes. Observations on the actual numbers of aphids in the air over continuous, consecutive, short periods, adequately associated with meteorological data, have hitherto been lacking. Such observations have now been made with suction traps[1,12], and so far from indicating that most migration occurs in calm weather, the opposite appears to be the case.

Correlations between wind-speed and the numbers of *A. fabæ* and other species[1,12] in the air, though sometimes statistically significant, are not strong. Rapid periodic changes in the number of winged aphids on the crop mask the effect of weather-induced changes in the percentage which fly. This factor, hitherto insufficiently appreciated, is partly due to accumulation of alatæ in the interval between moulting and flying, and partly to their depletion on the crop by flight. A 100 per cent take-off from 100 aphids on one day produces a smaller flight than a 50 per cent take-up from 300 on the next; and successive increases in percentage which fly could be accompanied by successively smaller catches as the population diminishes. In fact, it is impracticable to assess degrees of take-off from aerial numbers alone, or vice versa. Even where aerial numbers and wind-speed were negatively correlated, the scatter showed that considerable flights occurred in windy as well as in calm weather. Moreover, mass migration is possible without any local accumulation in the air at low levels; for example, 995 *A. fabæ* were caught in 20,000 cu. ft. at crop-level (a very high density) on July 6, 1949, but the aphids flew upwards from a sheltered situation into a windy one.

Other evidence that has come from our continuous trapping is that only 23 per cent of all the *A. fabæ* trapped over the whole migration period of five to six weeks (and 25 per cent of all other aphid species) were caught during hours when the mean wind-speed was less than 3 m.p.h. Since the trap measures aerial density, catch × wind-speed × hours indicates the number of insects passing a vertical front of constant area at trap-level: by this calculation only 7 per cent of all the *A. fabæ* (and of other aphid species 9 per cent) passed at mean wind-speeds less than 3 m.p.h. Thus nearly all the aphids flying were being dispersed during relatively high wind velocities with little or no voluntary control of direction.

This result is largely due to the few calm hours which occur in south-eastern England during the periods of the day when aphids fly; in July 1949 only 19 per cent had mean wind-speeds less than 3 m.p.h.

Analysis of Trap Data in Entomology

The number of insects in the air is a compound effect of population-level and degree of flight 'activity'. The separation of these two factors in trap data has usually been attempted by statistical procedures, on the assumption that relatively long-term changes are largely due to population fluctuations, short-term ones depending more on activity[13,14]. Thus fluctuations in the running means of catches are assumed to reflect chiefly population change, short-term deviations from the running mean chiefly flight activity. Similarly, differences between the logarithms of catch for successive days or nights have been taken to indicate activity; and differences between two days at wider intervals to reflect population change[14]. This method may work with relatively stable populations when insects return to the locality after flight or, if they migrate, they are replaced by an equivalent number from elsewhere. But the method fails with aphids[1], and no doubt with other insects where rapid, large population changes contribute more to changing numbers than do variations in flight behaviour. It appears, therefore, that this method of analysis cannot be used indiscriminately without regard for the biology of the insects concerned; for deviations from a running mean or differences between the logarithms of successive catches will reflect either population, immigration or other behaviour changes, according to which has the greater effect on aerial numbers. Thus Muller and Unger's results[4,5] for *A. fabæ* obtained by the use of deviation analyses must be treated with reserve, for they may reflect moulting-rate more than flight activity.

I have found that the greatest numbers of aphids migrated in windy weather; therefore, a lack of colonization may be due, not to absence of migration, as previously thought, but to unsuitable conditions for alighting. The significant epidemiological factors may not be take-off changes so much as population-levels, alighting behaviour, and the kinds of crops and situations which affect it.

Alighting requires calmness: therefore, single plants[11] or crops affording little shelter may possibly be colonized only in the relatively infrequent calm periods. This type of aphid distribution might be associated more with short flights favouring the transmission of viruses with a short life in the aphid. On the other hand, crops providing plenty of shelter among stems, or on the lee side, may be colonized continuously by longer-range flights of wind-borne aphids, and this type of dispersal may be associated more with persistent viruses.

Traps are of undoubted value in measuring aerial populations. But it must be emphasized that they are not always suitable instruments, when used by themselves, for the analysis of population and activity factors. [April 18.

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SHELL-FORM IN THE LAMELLIBRANCHIA

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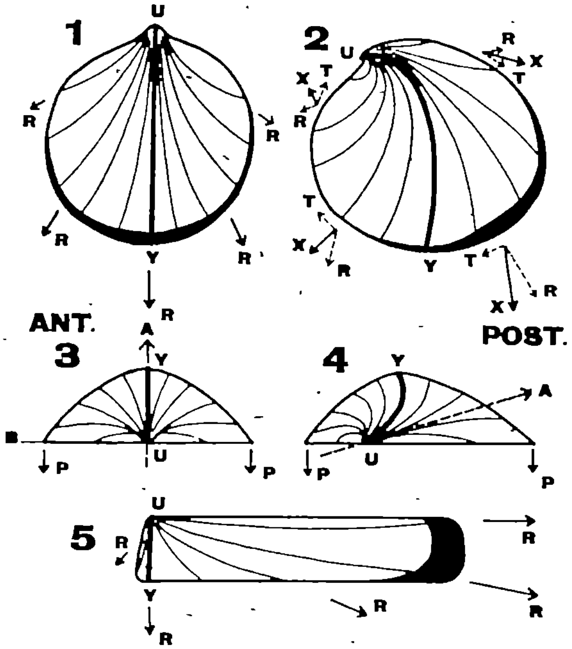
In the Lamellibranchia, marginal increase of the shell valves results from the activity of the mantle edge which is thus responsible for the form of the shell. The direction of growth at any region of the mantle edge may be conveniently resolved into a number of components. In the primitive bivalve, the form of both valves was probably the resultant of: (*a*) a radial component radiating from the cardinal region of the hinge and acting in the plane of the generating curve (represented by the valve margin); (*b*) a transverse component acting at right angles to the plane of the generating curve. Certainly the form of the shell valves in many modern lamellibranchs, for example, *Glycymeris* (Fig. 1) and *Tellina*, is the resultant of radial (*R*) and transverse components (Fig. 3, *P*). In some genera, for example, *Pecten* and *Gryphaea*, growth of only one of the valves is the resultant of these two components; growth of the other, flat valve is the result of the radial component only.

The magnitudes of the radial and transverse components increase from either end of the ligament around the margins of the mantle and shell edge (Fig. 1). Thus, there is a region of the mantle edge ventrally where the effect of the transverse component is greatest (*Y*). In those lamellibranchs in which the generating curve is in one plane (that is, unlike members of the Myidae and Pholadidae), it is proposed to describe this region as the 'normal zone' of the mantle edge. Since the effect of the transverse component is greatest at this region, the normal zone secretes that sector of the shell which exhibits the greatest concavity and in this sense is the *Gewölbescheitelbahn* defined by Haas[1]. It is proposed to designate a line (*UY*) drawn along the centre of this sector of the shell as the 'normal axis' of the lamellibranch mantle and shell. The normal axis can thus be considered with reference to three points: the umbo, the normal zone of the mantle edge and the point at which the greatest transverse diameter of the shell intersects the surface of the valves.



Figs. 1, *Glycymeris*; 2, *Venus* type bivalve; 3 and 4, the right valves of 1 and 2 viewed from the umbonal region, that is, dorsally; 5, *Ensis*.

AU, directive plane; *P*, transverse component; *R*, radial component; *T*, tangential component; *U*, umbo; *UY*, normal axis; *Y*, normal zone; *X*, the direction of growth in Fig. 2. In Figs. 1, 2 and 5 the transverse component acting perpendicular to the plane of the page is not shown. The thickened regions at the valve margins indicate greatest marginal increment

In those bivalves in which the form of the shell valves is the resultant of these radial and transverse components alone, for example, *Glycymeris* (Fig. 1), *Tellina*, *Anodonta* and *Ensis* (Fig. 5), the normal axis (*UY*) is in one plane; that is, it is a plano-spiral. Each of the valves would, if a complete whorl were produced, describe a plano-spiral about the umbo. Enlargement of the generating curve with growth results in the growth curves anterior and posterior to the normal axis being increasingly displaced from the normal plane, so that, unlike the normal axis (*UY*, Figs. 1 and 5), they are turbinate spirals. The form of the shell valves in many lamellibranchs, however, is affected by an additional component acting tangentially to, and in the plane of, the generating curve (Fig. 2, *T*). In genera such as *Cardium*, *Venus* or *Mytilus*, as a result of this tangential component, the normal axis (*UY*) is no longer a plano-spiral but a turbinate spiral. In this case, each valve would, if a complete whorl were produced, describe a turbinate spiral about the umbo.

Growth of the shell valves in *Glycymeris* (Fig. 1) is not affected by a tangential component. The normal zone (*Y*) is mid-ventral and coincides with the region of greatest marginal increment. Moreover, both marginal increase and the effect of the transverse component decrease symmetrically around both sides of the mantle and shell edge. Each valve is therefore symmetrical about the normal axis. The normal zone, however, need not coincide with the region of greatest marginal increase. Thus, in *Gari tellinella*, the generating curve is an ellipse which is roughly symmetrical about the normal axis. There are two regions of maximum marginal increase symmetrically disposed at either end of the ventral margin. The effect of the transverse component remains, however, greatest mid-ventrally. But in genera such as *Anodonta* or *Ensis* (Fig. 5), the generating curve is asymmetrical about the normal axis (*UY*). Maximum marginal increase takes place posteriorly while the normal zone (*Y*) remains ventral to the umbo. The normal axis is in one plane and, as in the symmetrical shells of *Glycymeris* and *Gari*, each valve would, if a complete whorl were produced, describe a plano-spiral about the umbo.

The form of the shell should, therefore, be considered with reference to: (*a*) the form of the spiral (namely, plano- or turbinate) of the normal axis; (*b*) the spiral angle of the normal axis (giving a measure of the concavity of each valve); (*c*) the outline of the generating curve.

Lison[2] claims that the form of the lamellibranch shell is dependent on: (*a*) the angle of the directive spiral; (*b*) the angle of incidence, that is, the angle between the directive plane and the plane of the generating curve; (*c*) the outline of the generating curve. Much depends on Lison's concept of the 'directive plane' of the lamellibranch shell. This is defined by him as follows: "Chez les lamellibranchs existe toujours un plan et un seul, dans lequel s'inscrivent sur toute leur longueur une ou des côtes représentant des courbes planes. Ce plan, qui passe nécessairement par l'umbo, sera appelé le plan directeur de la coquille". According to Lison, this directive plane may be perpendicular to the plane of the generating curve (for example, *Pecten*), or it may be, as in the majority of lamellibranchs, more or less inclined to the plane of the generating curve.

In those genera (*Glycymeris*, *Gari*, *Anodonta* and *Ensis*) in which the 'angle of incidence' is 90° (Fig. 3, *AUB*), the plane of what is here described as the normal axis (*UY*) is identical with this directive plane (*AU*). These, however, are all lamellibranchs in which there is ***no tangential component*** affecting the form of the shell. In *Corbis fimbriata*, quoted by Lison as possessing the directive plane inclined to the plane of the generating curve, there is a small tangential component (Fig. 2, *T*). As shown in Fig. 4, the normal axis (*UY*) is no longer in one plane, and the turbinate spiral ribs posterior to the normal axis are 'deflected' anteriorly as a result of the tangential component. It follows that one of these ribs will come to lie effectively in one plane (Fig. 4, *AU*). As shown in the diagrams, change in the position of the directive plane is a result of the tangential component and will be related to the magnitude of this component. Moreover, in members of the Chamidæ and Glossidæ (that is, *Isocardia*) the magnitude of the tangential component is such that *all* growth curves of the mantle and shell are turbinate spirals; there cannot, therefore, be any directive plane as defined by Lison.

It is hoped to discuss elsewhere the effect of the tangential component on the ligament and hinge teeth. It should be noted, however, that in the majority of lamellibranchs in which the form of the mantle and shell is affected by a tangential component the anterior region of the ligament is progressively split as growth proceeds. [April 21.

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MOLYBDENUM IN RELATION TO CROPPING AND LIVESTOCK PROBLEMS UNDER IRISH CONDITIONS

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IT has been shown[1-3] that molybdenum, although an essential element in plant nutrition, can, when present even in moderate excess in herbage, cause nutritional disorders in livestock. Investigations which we have on hand on the importance of this element under Irish conditions have indicated that it may be of considerable importance from both the deficiency and toxic aspects. Some of the more important findings of this research are recorded here.

Deficiency aspects. When a sandy loam soil of pH 5·3 and low calcium status was used in a pot experiment with *Trifolium subterraneum* as an indicator crop, a striking response was obtained from the application of a small quantity of molybdenum, this response being specially evident in the presence of mono-calcic phosphate. A field experiment with swedes on a soil of similar type also showed a response to applications of molybdenum. This soil also gave a highly significant response to the application of lime, and results now available from the analysis of soil and herbage point to this response as being due in part at least to an increase in the availability of molybdenum in the soil following liming.

When investigating a case of infertility in an organic soil (loss on ignition 95 per cent, pH 5·5, available calcium 2,500 p.p.m. and moderately well supplied with major elements), it was found in pot experiments using *S*.100 white clover as an indicator crop that, while the application of a full supplement of nitrogen, phosphate and potassium caused little if any improvement in growth, a striking response was obtained when molybdenum was added to this dressing. A similar response was obtained from the full supplement plus chalk while, on the other hand, the addition of copper sulphate to the full supplement caused a definite depression in growth. Analysis of the herbage showed that the plants receiving the nitrogen–phosphate–potassium supplement contained 2·5 p.p.m. of molybdenum. Those receiving chalk in addition contained a similar level, whereas those receiving copper sulphate contained less than 0·5 p.p.m. of molybdenum. Plants receiving nitrogen–phosphate–potassium plus molybdenum (5 p.p.m. of soil) contained 24 p.p.m., rising to 38 p.p.m. where 20 p.p.m. of molybdenum was applied to the soil. This instance of molybdenum deficiency in organic soil appears to be unusual, as hitherto such conditions have been usually associated with toxicity of this element[1].

Excess. Instances of a syndrome occurring in cattle associated with unthriftiness, stunted growth in young animals and rough, staring, depigmented coats have been investigated in a number of areas. The coats of red-coloured animals sometimes assume a faded yellow appearance, while although scouring is not a constant feature it has been observed in a few cases. Symptoms are generally similar to those described by other workers[2,4] as being due to a conditioned copper deficiency. Copper dosage is specific as a control. While analysis of herbage samples where affected cattle are depastured have shown normal copper values, that is, greater than 7 p.p.m. (dry matter), the molybdenum content ranged from 5 to 20 p.p.m. On the basis of data quoted elsewhere[3] in connexion with a similar condition in livestock, the above figures are well within the range which represents a moderate excess, the accepted normal for herbage being in the range 1–3 p.p.m. We have also verified the latter figures for normal pasture. It seems reasonable to conclude that the level of molybdenum reported is at least partly responsible for the occurrence of this condition in livestock. While in some of the animals examined the blood copper values tended to be low, that is, of the order of 0·3 mgm./litre, this was by no means a constant finding. Hæmoglobin-levels were normal, and hæmatological studies presented no evidence of anæmia. In view of other findings[5] where an association has been established between defects in bone building in cattle showing symptoms of copper-deficiency and the effects of molybdenum on the utilization of copper and indirectly of phosphorus, it is of considerable interest that we have found the condition reported to be invariably associated with herbage of high calcium content and often of wide calcium to phosphorus ratios, while in several instances blood determinations have shown that deficiencies of both copper and phosphorus co-existed in the same animal.

While this condition occurs frequently on organic soils very similar to those described[3] as being associated with 'peat scours' and other nutritional troubles in livestock, in our investigations it has in addition been found to occur on what are otherwise fertile loams of limestone derivation and typical of important and widely distributed soil series. It may be of further interest that, where the worst excesses have been reported on these mineral soils, the phosphate-level of the latter has been satisfactory. This corresponds with the experience elsewhere[6], as phosphate has been shown to increase molybdenum uptake and also agrees with our pot-culture findings reported above. In two instances also, basic slag used as a fertilizer accentuated the trouble, this being attributable not only to the phosphorus effect but also to the fact that basic slag contains appreciable quantities of molybdenum.

The total molybdenum content of the soils examined, with one exception so far, and representing both the deficiency and excess conditions, was normal, with a range of 0·42–3·50 p.p.m. In one soil a level of 20 p.p.m. has been found. It was found that where response to molybdenum was obtained, the values were less than 0·12 p.p.m. available molybdenum, the latter being determined by the oxalate method, whereas in the soils where the herbage contained excess quantities the soil values were very considerably higher, varying from 0·30 to 0·57 p.p.m. of available molybdenum. Where deficiencies have been identified, the *p*H of the soils varied from 4·9 to 5·5; that in soils associated with this nutritional disorder and excess molybdenum in the herbage have ranged from *p*H 6·5 to 7·8. This corresponds with other observations[7,8] which show that the availability of molybdenum is greatest within the latter *p*H range. It may be of further interest also that, when a fertile soil which contained a total of 0·86 p.p.m. of molybdenum and had a *p*H of 7·8 was used in a pot experiment with *T. subterraneum*, the latter contained 14 p.p.m. of molybdenum, whereas an acid soil of higher total molybdenum content (3·5 p.p.m.) gave a value of 0·5 p.p.m.

It is apparent that this work raises many interesting points in connexion with the treatment of pasture. Investigations are proceeding and will be reported more fully elsewhere. [March 3.

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PRINCIPLES AND APPLICATIONS OF ION EXCHANGE

A SYMPOSIUM on the "Principles and Applications of Ion Exchange" was held at the University of Manchester on March 27 under the joint sponsorship of the Royal Institute of Chemistry, the Chemical Society, the Society of Chemical Industry and the Institute of Petroleum. In addition to the papers contributed, an exhibition of apparatus, with demonstrations, was on view.

In the morning session, on theoretical aspects (chairman, Prof. C. W. Davies, University College of Wales, Aberystwyth), Dr. K. W. Pepper (Chemical Research Laboratories, Teddington) gave the first paper, on "Chemical Structure and Physical Characteristics of Ion-Exchange Materials". He illustrated the concept of ion-exchange resins as insoluble acids and bases by reference to certain aspects of their reactions—for example, equivalence of exchange, reversibility and accessibility of functional groups as exchange sites. After describing the preparation and chemical structure of a number of resins in some detail, particularly the most chemically stable cross-linked polystyrene type, Dr. Pepper gave an account of the characteristic behaviour of the principal types of cation and anion exchangers and indicated the influence of the degree of cross-linking of the polymeric framework on swelling, rates of exchange and equilibria.

In his paper on "Physical Chemistry of Ion Exchange Equilibria and Kinetics", Dr. J. A. Kitchener (Imperial College of Science and Tech nology, London) pointed out that equilibria and kinetics are relevant to practical use of resins since they govern selectivity and speed of operation. Three principal theoretical treatments, complementary rather than contradictory, have been tried involving, respectively, the law of mass action, Donnan membrane equilibrium, and ion exchange as an interaction between individual ions and charged sites. It has become clear that an adequate treatment must make allowance for the work of swelling and particularly for ionic interactions in the resin phase, a matter presenting considerable theoretical difficulty. The kinetics of ion exchange can be broadly explained by a diffusion mechanism; but a detailed quantitative theory in terms of resin structure has not yet been developed.

Dr. E. Glueckauf (Atomic Energy Research Establishment, Harwell) then discussed "Factors Affecting the Operation of Exchange Columns", indicating that while some separations depend on the separating power of the resin, others depend on a complexing produced in the aqueous phase. Resins with higher cross-linking are more suitable for the first type, but a lower cross-linking is better for the second. He referred to the factors, in column operation, which affect the sharpness of chromatographic bands, and distinguished between three different modes of column operation: removal of impurities (as in water softening), displacement chromatography, and development chromatography. The first two lead to fast separations and are preferable for industrial applications, but there is no complete separation into isolated bands. This only happens with the third mode, which lends itself to analytical uses. Dr. Glueckauf mentioned a recent innovation of 'gradient development' which employs an eluting solution of constantly increasing strength.

In the discussion, Dr. Kitchener, replying to Mr. J. A. Dukes, stated that he had referred to the hydrated ion when speaking of the effect of ionic size on exchange kinetics. Mr. D. K. Hale commented upon the large variations in the mass law product which can accompany variations in cationic composition of the resin and quoted supporting results of the cation pair $N(C_2H_5)_4^+$ and H^+, for a sulphonated cross-linked polystyrene. Treatment of the resin with an excess of $N(C_2H_5)_4OH$ causes an irreversible structure-change consistent with a decrease in cross-linking. Mr. Hale also mentioned difficulties which may be encountered when performing chromatographic separations with resins of low cross-linking, and stated that surface sulphonated polystyrene resins may help in difficult separations. Dr. Glueckauf reported experiments by Dr. Barker demonstrating the charged double layer, most pronounced in very dilute solutions, surrounding resin particles. Due to electrostatic repulsion, friction between resin particles is reduced, as shown by the angle of repose of a tilted bed. The effect is not shown by silver resinates.

Dr. D. D. Pratt (director, Chemical Research Laboratories, Teddington) opened the afternoon session on practical applications. In the first paper, on "Practical Applications of Ion Exchange in Water Treatment", Dr. E. I. Akeroyd (Permutit Co., Ltd.) reviewed the various types of ion-exchange materials, their applications in a number of water treatments, and plant and control instruments. He described the deionization of water and discussed the classical two-bed system, the more recent mixed-bed method, and the newer anion-exchange resins which can remove silica and other very weak acids. Dr. J. Hope (Charles Lennig and Co., Ltd.), speaking on "Other Applications", surveyed the uses of ion-exchange materials in the purification of formaldehyde and glycerine, in processing beet sugar, and in the pharmaceutical industry (for example, manufacture of streptomycin). He also described interesting therapeutic applications, such as the treatment of peptic ulcers, heart disease, cirrhosis of the liver, and the estimation of gastric acidity.

In the last paper of the session, on "Laboratory Applications", Dr. J. E. Duncan (Harwell) dealt with three general uses of ion exchange. The first is as adsorbates—for example, in chromatographic separation of ions by direct elution with acids and alkalis, elution with complexing agents, separation of non-electrolytes from electrolytes and separation of trace amounts; such procedures are of interest in both preparative and analytical chemistry and, in the latter case, ion-exchange is easily adapted by a radio-activation procedure and by the isotope dilution method. The other two uses are as laboratory reagents for titration, buffering and catalysis, and as a physico-chemical technique for the determination of ionic charge, ionic concentration, ionic size and molecular size (using dry ion exchangers as molecular sieves). In the last four applications mentioned, a detailed knowledge of the physico-chemical behaviour of the ion exchange is usually necessary.

During the discussion, Dr. B. A. J. Lister briefly described a study of the ionic size, charge and degree of formation of cation complexes in the case of zirconium, and in answer to Mr. E. Foley stated that the hydrolysis scheme for zirconium is not reversible and that hafnium may accompany zirconium in complexes. Dr. Duncan, in reply to Mr. Stevenson, quoted work by Kressman and Kitchener and others on the use of ion exchangers to determine the size of dye molecules. Mr. N. A. Hurt put a question on the removal of ammonia by cation exchangers and its effect on their capacity in water treatment. Dr. Akeroyd stated that 95 per cent of the ammonia could be removed and demonstrated the point of 'break-through' diagrammatically. A question by Dr. E. M. Meade on Sn^{2+}, Cr^{2+} or Ti^{3+} resins as reductors or basic resins in the CrO_4^{2-} or MnO_4^{-} form for oxidations was deferred to the evening session, in view of the comments to be made by Dr. Fairbrother. Dr. Pepper summarized applications of ion exchange in organic chemistry.

Further developments of ion-exchange materials were discussed at the evening session (chairman, Dr. F. Fairbrother, University of Manchester). Dr. R. E. Kressman (Permutit Co., Ltd.), in his paper on "Ion-Exchange Resin Membranes", described continuous sheets and rods made from both cation and anion exchangers, normally produced in granular form, and, in particular, described electrodes made from a sulphonated phenol type of resin. As expected on theoretical grounds, when these membranes separate two pure solutions, identical except in concentration, E.M.F.'s are set up which, within certain concentration limits, are predicted by the Nernst equation $E = (RT/F) \log a_1/a_2$. After discussing the results obtained—for example, with mixtures of salts, or pure solutions of salts having a common cation and different anions—Dr. Kressman concluded from his work that, within certain limits, the electrodes are useful for measuring the activities of ions in solution of salts, provided they contain one cationic species only.

Dr. Fairbrother next gave a review of the work of Prof. H. G. Cassidy (Yale) on electron exchange polymers as oxidation-reduction systems. Quoting a letter from Prof. Cassidy, he stated that the material described (*J. Amer. Chem. Soc.*) was largely dimer and trimer, believed to be produced by a chain-terminating type of reaction of the Diels–Alder class. In more recent work, yet to be published, high polymer has readily been obtained by acetylating the monomer first, polymerizing in the presence of benzoyl peroxide, and then hydrolysing to yield polyvinyl hydroquinone which can be oxidized and reduced. The titration curve obtained was 'smeared out' in that it showed a greater slope than that of pure hydroquinone. This has been ascribed to the statistical effect of having many oxidizable groups with slightly different energies (due to their fixed location on the chains relative to other groups). Several co-polymers have been made and also cross-linked polymers to bead form.

A written contribution from Prof. M. G. Evans (University of Manchester) on possible interesting future developments with such resins was then quoted by Dr. Fairbrother. Prof. Evans likened the 'smearing out' effect to that obtained on titration of polyelectrolytes of acid or basic resins, and arises from the same causes. He pointed out that the fixing of the centres may increase the concentration of the semiquinone forms and recalled the early work of Knorr, who found that oxidation-reduction systems adsorbed on protein and cellulose structures appeared to lead to more stable semiquinones. The possibility is opened up of studying, in more detail than previously possible, the specific reactions of such entities, and it is not to be forgotten that the attachment of prosthetic groups to the protein moiety may lead to similar effects. In writing of the relative positions of the groups, Prof. Evans also referred to the possibility of studying co-operative effects, saying that if one could synthesize a resin of which the oxidation-reduction levels formed a band characteristic of the whole structure, one could imagine a process occurring at one end of the structure influencing a coupled oxidation-reduction at a considerable distance away, an interesting possibility which may arise in biological systems. Finally, he commented that the juxtaposition of two reacting centres might speed up oxidation-reduction reactions involving the simultaneous transfer of two electrons, which are normally slow, and there might be an effect similar to that of catalyst structure where a match of pattern becomes important.

Prof. Davies then briefly summarized the applications that had been discussed and pointed out that they ranged over the whole field of the design and utilization of synthetic high polymers for their chemical properties. The term 'ion exchange' has already been outgrown, and many new developments may be anticipated; electron-exchange resins are a subject of interest, and so are specially selective resins, designed to pick out one substance from a high concentration of other ions. Also, the advantage of a column procedure in pushing an equilibrium to completion can be exploited in directions other than in ion exchange—for example, in dissolving sparingly soluble salts or in the chemistry of comparatively stable complex compounds. The possibility of designing materials in which the number, kind and spacing of reactive groups can be predetermined offers a range of models to the theoretical colloid chemist and to the biochemist, who may find the catalytic properties of such materials to be of special interest. Finally, Prof. Davies said, the behaviour and use of ion exchangers in non-aqueous solvents is a subject overdue for development, and may result in laboratory applications of quite a novel kind.

In the concluding discussion Dr. Glueckauf stated that other work by Dr. Barker corroborated the findings of Dr. Kressman on ion-exchange membrane potentials of alkali solutions. Deviations from the theoretically expected potential slope, as yet unexplained, were, however, observed for calcium chloride solutions. Dr. J. D. Bu'Lock, referring to Prof. Cassidy's work and Prof. Evans's speculations on possible biological analogues of electron exchange polymers, directed attention to naturally occurring materials of this type. He cited, for example, melanin, an animal pigment which is a cross-linked polymer of indole-5 : 6-quinone, individual units of which should have different redox potentials, the overall effect being a smoothing-out of the oxidation-reduction curve of the polymer. Natural melanin is bound to protein, forming granules associated with various enzymatic activities. Dr. Bu'Lock suggested that one function of melanin and similar natural products is to provide a suitable environment for the operation of enzymes by a kind of redox buffer mechanism.

INTERNATIONAL SCIENTIFIC RADIO UNION

THE tenth General Assembly of the Union Radio Scientifique Internationale (URSI) will be held in Sydney, Australia, during August 11–23. Of the previous nine meetings of the Union, all have been held in Europe except the second, which took place in Washington in 1927. At the previous General Assembly of the Union, held in Zurich in 1950, Sir Edward Appleton was elected president of the Union and also its delegate to the parent body—the International Council of Scientific Unions. The other officers of the Union appointed at Zurich were: Dr. J. H. Dellinger (U.S.A.), Father P. Lejay (France) and Dr. D. F. Martyn (Australia) as vice-presidents, Prof. Ch. Manneback (Belgium) as treasurer, and Eng. E. Herbays as secretary of the Union, with headquarters in Brussels.

The scientific work of the Union is organized under seven commissions, the titles and presidents of which are as follows: (1) Measurement and Standardization, Dr. J. H. Dellinger (United States); (2) Troposphere and Wave Propagation, Dr. C. R. Burrows (United States); (3) Ionosphere and Wave Propagation, Sir Edward Appleton (Great Britain); (4) Terrestrial Atmospherics, Prof. H. Norinder (Sweden); (5) Radio-Astronomy, Dr. D. F. Martyn (Australia); (6) Waves and Circuits, Prof. B. van der Pol (Director, C.C.I.R.); (7) Electronics, Dr. G. Lehmann (France).

The British National Committee for Scientific Radio is organized under the auspices of the Royal Society as a constituent member body of the Union Radio Scientifique Internationale. This Committee has nominated the following British delegation to the forthcoming general assembly, the numbers of the commissions to which they are specially responsible being indicated in brackets: Sir Edward Appleton (president), Dr. W. J. G. Beynon (3), Mr. J. A.

Ratcliffe (4 and 7), Mr. F. G. Smith (5 and 6), Dr. R. L. Smith-Rose (1, 2 and Executive Committee).

It is understood that Profs. S. Chapman and H. S. W. Massey will also attend the meeting in Sydney by special invitation.

In accordance with established procedure, the various national committees will submit reports to the General Assembly reviewing the advances made within their own countries in each of the fields of research indicated by the seven commissions. As the results of this work may have an important bearing on associated scientific fields and also on the practice of radio communication, the Union is represented on several other international scientific bodies and also on the appropriate study groups of the Comité Consultatif International des Radiocommunications (C.C.I.R.). This arrangement forms a very satisfactory liaison whereby the fundamental problems confronting the practical radio engineer are brought to the notice of the astronomer, meteorologist and radio-physicist, and whose results can be quickly applied to communications technique.

BRITISH CAST IRON RESEARCH ASSOCIATION

By Dr. J. G. PEARCE, O.B.E.

Director

A FURTHER stage in the progress of the British Cast Iron Research Association was reached on July 2 when the president, Dr. J. E. Hurst, formally opened some extensions additional to those previously reported (*Nature*, 166, 261; 1950). These include chemical and spectrographic laboratories, sands laboratory, heavy stores, and accommodation for operational research, development, and work on foundry atmospheres. A fuels and furnaces building is under construction.

The spectrographic laboratory houses a quantometer, an American direct-reading spectrograph, which is channelled to permit estimations of twelve elements occurring in the cast iron alloys, and which is expected to record the elements spectrographically determined in normal material within one minute. The instrument comprises a high-precision source unit built to reproduce almost any type of electrical discharge, a spectrometer measuring through a photoelectric cell system, and a console recording the photocell current through an electronic system. The use of the instrument was demonstrated, although it is not yet fully calibrated. The technique for the spectrographic determination of elements in cast iron was published by the Association in 1948, its application to the less common elements in 1949, and to foundry slags in 1952. It is anticipated that it may be possible to determine both carbon and also phosphorus (not usually determinable by spectrographic analysis), the only element of those normally required that is still incapable of spectrographic determination being sulphur.

It is not practicable to review in detail the whole of the work accomplished and in progress; but some indication of its scope is given by the fact that during the past two years the Association's *Journal of Research and Development* has published seventy-nine reports, including reports presented to a number of conferences held for members during this period.

The establishment of practical foundry processes since 1948 for producing nodular graphite in the as-cast state by means of cerium or magnesium is now a matter of history. Certain difficulties in effecting perfect nodulization by magnesium, thought to be due to interfering elements, have now been resolved. The Association has established the subversive elements concerned, the range beyond which they are troublesome, and that their ill effects can be removed by the use of cerium in conjunction with magnesium. The Association's research manager, Mr. H. Morrogh, has recently received the McFadden Gold Medal of the American Foundrymen's Society for his work in developing nodular graphite iron. These processes have raised very difficult analytical problems for both the chemist and the spectrographer, on account of the very small amounts concerned, not only of the elements used for securing the nodular structure, added and residual, but also of the interfering elements. The vacuum fusion method is employed for the determination of gases.

An investigation into the fluidity of cast iron has been completed, and active work is proceeding on the vitreous enamelling of cast iron, on chilled irons, and on shrinkage and porosity, these latter defects being studied with the aid of gamma rays.

In the field of moulding sands, the emphasis has moved to a study of the properties at elevated temperatures, at which, of course, they are used in practice. Special apparatus has been acquired for this purpose from the United States, and the Association has designed and built its own apparatus for evaluating the stress–strain characteristics of sand aggregates, both at ordinary and at elevated temperatures, and has already related the results to certain common defects due to sand. High-frequency heating is used for giving temperatures required before the sand bond can be affected by the heat. The property known as 'flowability' is being studied, and considerable work has been done on the use of synthetic resins as bonding materials. These resins are used in the shell-moulding process, which has excited considerable interest in foundry circles, the normal mould being replaced by a thin shell of resin-bonded silica sand.

Progress has been made on the study of foundry atmospheres, particularly with reference to the presence of toxic gases and the measurement of dust and dust movement; in particular, the conventional system of hood-extraction used on pedestal grinders, commonly used in foundries for cleaning castings, has been shown to be entirely inadequate. A design has been evolved by the Association, involving the use of high-velocity air streams above and at the side of the working area, using less power than the normal system, and keeping the breathing zone of the operator clear of dust to a remarkable degree. Co-operation with manufacturers is being arranged.

The Operational Research Team set up in 1950 for visiting foundries with the object of recommending steps for promoting production efficiency has now made more than two hundred visits and collected considerable information. The iron-founding industry is operating in the United Kingdom at a record level of output, approaching 4 million tons of iron castings per annum, employing 150,000 people, and the output per man per annum has increased materially in recent years, by some 28 per cent since 1945 and some 13 per cent since 1948, in spite of difficulties relating to raw materials and personnel.

LACE RESEARCH ASSOCIATION

NEW CENTRE AND LABORATORIES

THE new centre and laboratories of the Lace Research Association at Glaisdale Drive, Bilborough, Nottingham, were formally opened on May 15 by Sir Cecil Weir, and after the ceremony a large number of members of the Association and their guests inspected the work being carried out in the laboratories.

The lace industry of Great Britain is a small but highly specialized, and economically important, industry situated mainly in Nottingham and the surrounding districts; all types of lace are manufactured there, but centres are also to be found near Kilmarnock in Scotland, where the product is lace furnishings, and in the west of England, where plain nets are made. There are very few large firms, the industry consisting in general of small unit firms, some three hundred in number, and the average size is of the order of ten machines. The working force varies between ten and fifteen thousand employees, of which, compared with the other textile industries, a very high proportion is made up of male workers. The conversion value of lace from the raw fibre to the finished fabric is exceedingly high; the trade is worth £10–15 million a year and is concentrated mainly on the export market, certain sections exporting as much as 98 per cent of their products.

The industry consists of six separate branches manufacturing the following types of product: plain net section—all types of plain and figured nets, including dress nets, tulle, mosquito nets, sand-fly netting, etc.; leavers lace section—fancy laces, hair nets, veilings, trimming laces, etc.; lace furnishings section—curtains, table and bed furnishings, etc.; warp lace section—lace produced on a multi-thread warp lace knitting-machine; barmen section—narrow lace and braiding; and embroidery section—pattern lace produced on multi-needle 'schiffli' machines, either on a base of plain net or on a dissoluble fabric. Nearly all the common textile fibres, both natural and synthetic, are used, or can be used, in the industry, but the principal fibre is, of course, cotton. An important subsidiary part of the industry is that concerned with the dyeing, dressing and finishing of lace; these operations are confined to a small number of firms which have the necessary specialized skill, experience and machinery.

The building of lace machines is a highly specialized branch of engineering, and Nottingham is naturally the world centre. In general, the machines are very large, those in the leavers section of the industry being of the order of 200 in. in width, while in the lace furnishing section there are several producing lace of up to 480 in. in width.

The idea of setting up a research organization for the lace industry was first mooted in 1943, and in March 1944 a research committee was formed by the Federation of Lace and Embroidery Employers' Association. From this development a Lace Federation Research Council was started, which was recognized by the Department of Scientific and Industrial Research as a grant-earning body, and a small research staff was assembled in temporary premises in Nottingham. After further discussions with all the interested trade bodies, it was decided to take advantage of the Industrial Organization and Development Act and to raise money for the formation of a research organization by means of a statutory levy from all the manufacturing sections of the industry. The Lace Research Association was finally incorporated in October 1949, and took over, in expanded form, the functions of the Lace Federation Research Council. The Association is financed in part by the proceeds of the statutory levy, in part by subscriptions and in part by a government grant based on the income from industry. Generally speaking, it is very well supported by the trade, and its total basic income is of the order of £17,000 a year.

The new building of the Association consists of administrative and laboratory space amounting to approximately 3,800 sq. ft. The front portion contains the library and council room, director's office, general office and textile-testing room. In the laboratory wing are physics and chemistry laboratories, a dark room, engineering workshop, operational research section, store rooms and offices, and a small canteen and kitchen; this wing is built so as to allow for future expansion, the partitioning being easily altered, and running below the main corridor is a trench carrying all the necessary services, with subsidiary trenches into the individual laboratories. To the rear of the site is a separate building with floor space of 2,000 sq. ft. which holds full-scale narrow-width lace machines and certain auxiliary equipment, and in which experimental and development work on the production side may be undertaken; this building is well insulated and is electrically heated with thermostatic control to maintain a steady temperature. The research work in the laboratory wing has up to now been chiefly concerned with two problems. In the first, a new type of Jacquard string known as 'Lacra' string has been developed which does not change appreciably in length with varying humidity (caused by changes in the weather). These strings are of high-quality linen thread and are used in the Jacquard pattern-forming mechanism of lace-furnishing machines. As the strings are of different length, a certain percentage change due to variation in the humidity will cause different overall changes in length and the pattern will be distorted. The new string has now been in service on a number of machines for some time and is proving highly successful. The other research development has been the production of a new lubricant in place of the powdered graphite normally used for lubricating the fine working parts of a lace machine. Graphite has the disadvantage that, being black, it causes considerable dirt in the factory and soils the lace. A new lubricant, the composition of which is at present a secret, has been developed which allows the production of fabrics which are quite white.

As might be expected, a cordial spirit exists between the research staff, headed by J. C. MacCallum as director of research and secretary of the Association, and the University of Nottingham. Three Nottingham professors serve on the council of the Association, and one of them, Prof. L. F. Bates, is vice-chairman of the Research Control Committee. Relations are also maintained with the Nottingham and District Technical College. This co-operation between the research organization of an industry that has a very strong regional background with the educational and technical-training services of that region is certainly a very happy feature of the Association, and it augurs well for the quality of the scientific and technical work that can be expected from the new laboratories.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

New Procedures for Resolution of Racemic Substances

EXCEPT for Pasteur's original procedure of sorting crystals by hand, the methods practised or suggested for the preparation of substances in optically active form depend on the use of a dissymmetric substance in one of its enantiomorphous forms or on the application of some dissymmetric influence. A recent extension[1] of the hand-sorting process does not require the use of *d*- or *l*-materials or sorting of crystals by enantiomorphous faces. It has been applied only to trithymotide, a substance of molecular constitution lately elucidated[2]. A second extension now applies to a range of substances.

In the first method, a racemic substance forms a crystalline molecular compound with an optically *inactive* substance. The van der Waals forces that normally hold the *d*- and *l*-molecules together as a crystalline racemate are overcome in a rearrangement involving the second component. Instead of *dl*, there crystallize from the solution *Ml* and *Md*, where *M* is the optically inactive substance. This has been found with trithymotide, which forms a series of molecular compounds $2C_{33}H_{36}O_{6}.M$, where *M* may be benzene, chloroform or a large variety of other substances. Most of these molecular compounds are spontaneously resolved.

The optical activity is demonstrated by the growth of one large crystal or an equivalent crop of crystals all derived from the same seed. No enantiomorphous faces develop; but the crystal is known from X-ray diffraction experiments to belong to an enantiomorphous space group and to contain trithymotide molecules of one hand only. Its solution rotates the plane of polarization of light. The trithymotide racemizes rapidly in solution, and therefore the slow growth of a single crystal or homogeneous crop may be controlled so that all the trithymotide is removed in the *d*- or *l*-form, depending on the nature of the seed. Similar resolutions, not necessarily accompanied by racemization, may be expected. When a *dl*-substance forms a crystalline molecular compound with an optically inactive substance, *d*- and *l*-molecules may enter in equal numbers into the structure, and in this case it will not be resolved; but since to form any molecular compound the normal mode of union of *d*- and *l*- must be disturbed, the chance of spontaneous resolution is increased. Any molecular compound that a *dl*-mixture may form therefore seems more likely to be spontaneously resolved than its parent substance.

The second method is suggested by the behaviour of trithymotide described above. The closely related crystal structures of its molecular compounds contain as the second component such varied molecules as carbon disulphide, benzene, ethanol, *n*-propyl iodide or chloroform, and retain this sometimes volatile component very tenaciously. In this they resemble the clathrate type of compound[3], and the structure must consist of an arrangement of trithymotide molecules enclosing a set of cavities. Whether these spaces are closed or open and whatever their precise form may be, the surrounding molecules, which are all *d*- or all *l*- in any one crystal, impose on the cavities a form which is not identical with its mirror image. If, therefore, trithymotide is crystallized from a solvent which is itself a *dl*-mixture and forms with it a molecular compound similar to those discussed above, the cavities of any one crystal will enclose preferentially the *d'*- or *l'*-form of solvent molecule. Any process for separating the *d*- and *l*-trithymotide should separate *d'*- and *l'*- simultaneously.

The process has been applied to resolve secondary butyl bromide. In one experiment a single crystal was grown and in others homogeneous crops were developed from a single seed crystal by repeated division and growth. The crop when dissolved in chloroform showed a large — rotation due to trithymotide. This decayed rapidly through racemization and left a much smaller permanent — rotation due to the secondary butyl bromide.

With trithymotide the method is applicable to a range of substances; but it may be expected to fail with molecules which are too large for the cavities. It could be extended by the discovery of substitutes for trithymotide. Where it is applicable this method of resolution has advantages that may be of importance. Chief of these is that no chemical reaction is involved in the process and no change of configuration can occur. Since sorting is on the basis of molecular shape and space requirements only, there is no need for a reacting group in the molecule. It could, for example, be applied to paraffins. By suitable modification very small amounts of material may be separated. The optical rotation initially observed when a crystal of the molecular compound is dissolved is due to the trithymotide, and may be hundreds of times greater than that of the resolved substance. Observation of the sense of this initial rotation therefore will provide a means of sorting a quantity of material too small to show its own rotation. Still smaller amounts might be handled in mixtures with a carrier solvent. If both carrier and solute enter into the molecular compound formation, sorting by any process should resolve the rare constituent which occupies a few of the cavities. In the special case where the carrier solvent is *d*- or *l*-, only one of the enantiomorphous crystals can develop and no sorting is necessary. From one known absolute configuration of a molecule that is enclosed by trithymotide, and a detailed structure determination, it is possible in principle to determine the absolute configuration of the cavities corresponding to each enantiomorphous form of the crystal. These being known, the absolute configurations of some other molecules could be deduced from observation of the form of trithymotide with which they combined to form the molecular compound.

Both the methods show how spontaneous production of unequal amounts of *d*- and *l*-forms can occur, and illustrate the preferential incorporation of one form in a growing structure. It is possible that somewhat similar processes may be responsible for the original dissymmetry in the chemistry of living matter and for its perpetuation.

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May 20.

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[1] Newman, A. C. D., and Powell, H. M., see reference (2) footnote, and *J. Chem. Soc.* (in publication).

[2] Wilson Baker, Gilbert B., and Ollis, W. D., *J. Chem. Soc.*, 1443 (1952).

[3] Powell, H. M., *J. Chem. Soc.*, 61 (1948).

Natural Moisture-content, Porosity and Compaction of Clayey Deposits

It seems desirable that attention should be directed to the very discordant figures for porosity (or void-ratio) of clayey sediments that are yielded by the two different methods of determination that may be adopted, namely, by direct measurement or by calculation from the natural moisture-content. I cannot but think that the discrepancies must have been commented on during the past two decades as knowledge of natural moisture-contents steadily grew; but my inquiries have failed to produce any reference to a published discussion of their implications.

In the following paragraphs the symbols m and n are those used in geotechnical (soil-mechanics) laboratories, m for the natural moisture-content expressed as grams of water per 100 gm. of solid dried to constant weight at 105–110° C., and n for the porosity calculated from m and expressed in the usual manner as the percentage of the total volume occupied by voids. The symbol P is retained for the porosity determined directly by the standard methods. The void-ratio e is the volume of voids to the volume of solid.

The evaluation of m presents no difficulties; but precautions are necessary to ensure that the samples when tested are as nearly as possible in their natural 'undisturbed' condition (in the engineering sense). Weathered or obviously fissured samples are rejected. Sediments lying below the ground-water table are known to be, with few exceptions, saturated down to a considerable depth, although the precise limit is in doubt. All the samples here referred to came from this zone of saturation.

A small but representative selection of values of m, n and P for some British clayey sediments is given in the accompanying table.

	m	n	P
Pleistocene bedded clay	50	57 per cent	31 per cent
Tertiary clays	28	48	29
Upper Cretaceous Gault	29	44	24
Jurassic, Lias	22	37	24
Triassic, Keuper	12	24	12
Coal measures, shale	18	26	10

By way of contrast to the discordant values shown in the last two columns, the results for n and P in the case of a fine-grained calcareous material such as the Upper Chalk reveal no discrepancy. The mean of a number of values obtained by different investigators with samples from various parts of the country is closely 44 per cent for both n and P. It will be observed that this figure falls into its appropriate place in the age-sequence, between the Tertiary clays and the Gault, in the column for n, but not in that for P.

Since the determinations of m and P for sediments from other European countries and from America, so far as I have been able to trace them, are of the same order of magnitude, horizon by horizon, as those listed in the table, and since the procedure followed is similar, there seems no escape from the conclusion that the standard method of directly determining porosity is not suitable for materials containing an appreciable quantity of clay. It is not feasible to allow sufficient time in the laboratory for the restoration of the structure which previously existed in or around the clay-mineral lattices but which was destroyed when the samples were dried.

It should be noted that the volume-shrinkage caused by drying of the test-specimens seems to be inadequate, at least in most cases, to account for the difference. Even if it did so, the objection to the use of the low P values still remains.

That such low values should have been recorded for P will probably not surprise those familiar with the physical changes in clayey materials (for example, loss of plasticity, lowering of liquid limit, increase of grain-size, etc.) produced after even short periods of air-drying.

The porosities vary, of course, according to which particular clay-mineral species is dominant. In due course, we may hope to compile a table for each dominant species. The few figures that are available for montmorillonoid clays indicate that they will fall into a separate series with values of n much higher (as their swelling capacity would suggest) than those in the above table. Passing reference may also here be made to the abnormally low porosity of boulder clay, first discovered by H. C. Sorby and ascribed by him to exceptionally high compression, possibly by ice-load. The determinations of m have confirmed his observations. An average figure for m is 15, whence n is 28 per cent, Sorby's value for P being 24 per cent. The discrepancy here is smaller than in the case of the other clays mentioned, possibly because of the very different mineralogical composition, the quantity of silt and rock-flour in the matrix being usually considerable.

From the values of P set out in the table, and from other similar direct determinations by the standard methods (for example, on air-dried cuttings from deep well drilling) the void-ratio e appears to be only a third to a half its true value as calculated from m. If additional records confirm this, many inferences that have been drawn from the erroneous figures for e will need to be revised, and calculations relating to depth of burial, gravitational pressures, compaction, bulk-density and volumes of sediments may require substantial adjustment.

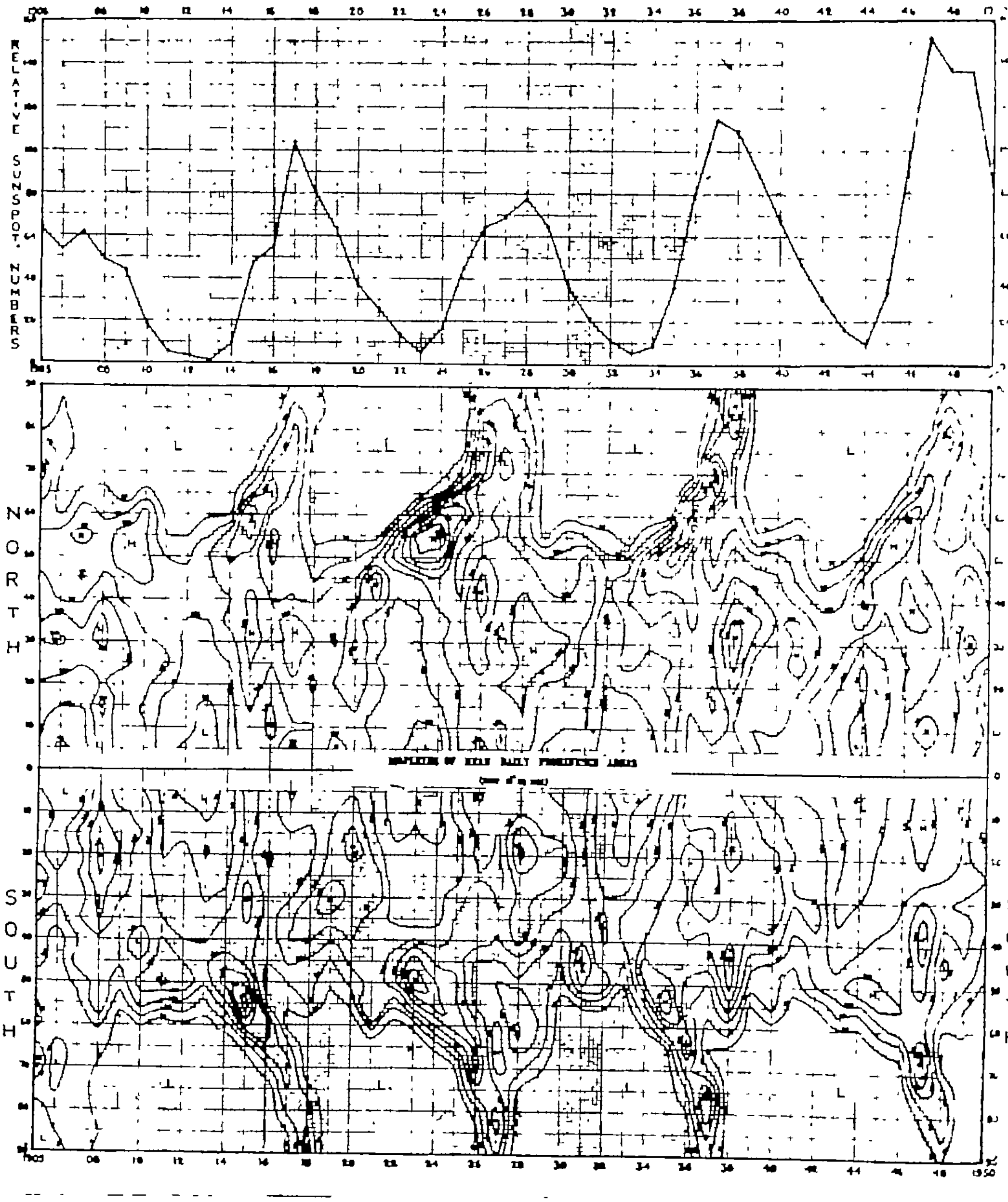
Many other interesting problems are presented by the records of m that have already accumulated. Since these are all too few, however, it is to be hoped that full advantage will be taken of the exceptional opportunities for collecting and testing clayey sediments at present afforded by numerous engineering undertakings and programmes of exploratory and other borings distributed widely throughout Great Britain.

P. G. H. Boswell

Plas Gwyn,
Dyserth, Flintshire.
April 26.

Prominence Activity and the Sunspot Cycle

The relationship that exists between the distribution and frequencies of prominences at the limb of the sun and the sunspot cycle has been discussed by several workers[1]. The most outstanding feature is the existence of two distinct zones of prominence activity in each hemisphere. The low-latitude zones extending from the equator to about 50° are always present, although prominence activity in these zones is least at the epoch of sunspot minimum. The high-latitude zones have a different life-history. Prominence activity in these zones drops very suddenly and becomes quite inconspicuous shortly after sunspot



maximum. About four years thereafter, a centre of activity develops at about latitude 45°–50°. The activity undergoes a rapid increase and at the same time the prominences extend to higher latitudes. The high-latitude zones become fully developed at the epoch of sunspot maximum.

Photographic observations of solar prominences in the *K* line with the spectroheliograph were commenced at Kodaikanal in 1905. The material available up to date covers four sunspot cycles. The Kodaikanal data for the period 1905–14 have been discussed by Mr. and Mrs. Evershed, while the data for the period 1905–28 have been discussed by W. Moss. Half-yearly summaries of prominence observations are published in the *Bulletin of the Kodaikanal Observatory*.

From the mean daily profile areas of prominences computed for each 5° latitude zone, I have prepared the accompanying diagram, which brings out strikingly the relationship between prominence activity and sunspot cycle during the period 1905–50. The contour lines are drawn at intervals of 50×10^{-3} sq. min. of arc of prominence area. Regions of maximum activity are marked *H*, and those of minimum activity *L*. There is some resemblance between this diagram and the well-known 'butterfly diagram' of Maunder. Attention may be directed to an interesting point brought out by this diagram. It is well known that the sunspot maximum of 1947 is one of the highest on record. However, prominence activity has been much less during the latest sunspot cycle as compared with the two previous cycles. The diagram also shows that the region of most intense prominence activity on the sun occurs at about latitude 50°–55° in both hemispheres some three or four years before sunspot maximum.

A detailed discussion of the results of prominence observations made at Kodaikanal during 1905–50 will be published in the *Bulletin of the Kodaikanal Observatory*.

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Solar Physics Observatory,
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Dec. 31.

[1] Ricco, *Mem. della Soc. degli Spett. Ital.*, **20**, 135 (1891). Lockyer, N., and Lockyer, W. J. S., *Proc. Roy. Soc.*, 71, 244, 446 (1903) Evershed, J., and Evershed, M. A., *Mem. Kod. Observ.*, 1, 55 (1917). Fenyi, *Pub. Haynald Observ.*, **2**, 1 (1932). Bocchino, G., *Mem. R. Oss. Astrof. Arcetri*, 51, 7 (1933). Moss, W., *Ann. Sol. Phys. Observ., Cambridge*, **3**, 119 (1946). D'Azambuja, M. and Mme. L., *Ann. Observ. Paris*, **6**, Fas. 7 (1948).

Meson Masses

THE classical electron radius r_e is defined by $e^2/r_e = m_e c^2$. A sphere of constant density with radius r_e possesses a radius of gyration $r_g = (0\cdot4)^{1/2} r_e$. The energy eigenvalues of the rigid rotator are not yet known in the extreme relativistic region; but there one can quantize with integers k as for circularly polarized photons: thus $r_k p_k = k\hbar$. For $k = 1$ and $r_1 = r_g$ it can be deduced that:

$$m_1/m_e = p_1/m_e c = \hbar/m_e c r_1 = \hbar/m_e c r_e (0\cdot4)^{1/2} = 137 \times 1\cdot58 = 216\cdot6. \quad (1)$$

Thus the first rotation level compares with the first meson mass 212 m_e.

The mass of the π-meson requires $r_g = \frac{1}{2} r_e$. This is true for a disk. The non-relativistic eigenfunction P_1^1 consists of a section through the axis. In the extreme relativistic region it will contract and may indeed degenerate into a disk rotating about an equatorial axis.

Levels with $k > 1$ are not impossible. But it seems that the observed higher meson masses can be approximated better by quadratic relations. These can be derived, for example, if one assumes that a sphere with radius r_e can contain n rotators in a row, with radius $r_n = r_e/n$. According to (1), one rotator with radius r_n has a mass $n m_1$. This leads to a total mass $m_n = n^2 m_1$, if all n rotators are of the same kind ($r_g = 0\cdot632 r_n$ or $r_g = \frac{1}{2} r_n$, and $k = 1$). One obtains the following masses:

	$P_{1,0}$	$P_{1,1}$	$P_{2,0}$	$P_{2,1}$	$P_{2,2}$	$\Delta_{3,0}$	$\Delta_{3,1}$	$\Delta_{3,2}$	$\Delta_{3,3}$	$P_{3,0}$	$P_{3,1}$	$P_{3,2}$	$P_{3,3}$	$P_{4,0}$
Calc.	216·6	274	866	951	1,036	1,400	1,523	1,647	1,771	1,949	2,121	2,293	2,466	3,464 m_e
Obs.	212±5	275	796	967	1,125	1,370	1,510				2,203			
	μ	π	V_1	τ	$\varkappa_1$	$\varkappa_4$	$\varkappa_1$				V_1			

The systems are called $P_{n,m}$. The first index specifies the number of rotators contained in the sphere; the second suffix indicates how many rotators possess $r_g = \frac{1}{2} r_n$. The same principle allows the arrangement of three rotators in an equilateral triangle (called Δ), or of four in a tetrahedron (T) within a sphere of radius r_e.

The first seven levels of this scheme seem to have been observed[1]. V_1 compares with the mean of P_3 or T_4 ($T_{4,2}$ = 2,183 m_e). $\varkappa_1$ = 1,510 or 1,550, according to Von Friesen. The observations by Leighton *et al.*[2] can be taken as further evidence for masses $P_{2,0}$, $P_{2,2}$ and $\Delta_{3,1}$.

Incidentally, the proton mass can be obtained if two rotators of the system $\Delta_{3,3}$ gyrate around a twofold symmetry axis. This gyration may, as in ortho-hydrogen, be stabilized by spin symmetry.

The radius r_e can be interpreted as the range of a force with a potential steep enough to balance the centrifugal force due to rotation.

Though the present rotator scheme can represent only a simplified picture of the true eigenfunctions, it already gives the masses of the μ, π, V, τ and ϰ-mesons and has features (symmetry characters, etc.) which should be contained in a final theory.

These results were reported originally at the Bristol Conference on Heavy Mesons, held during December 18–20, 1951.

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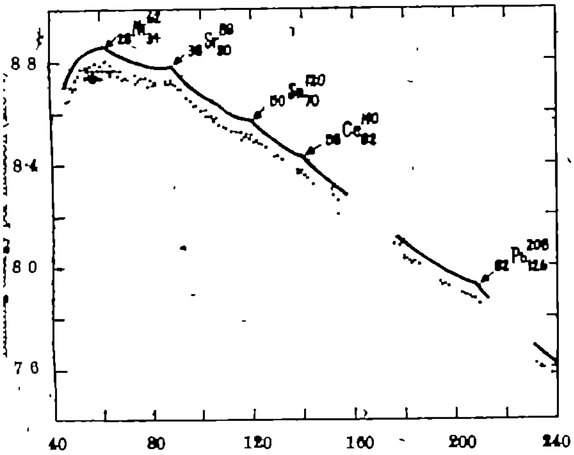
Evidence for Nuclear Shells from Atomic Mass Measurements

THE successful manner in which the single-particle model of the atomic nucleus has accounted for many nuclear properties is well known to those who follow developments in nuclear physics. This model, which pictures nuclei as constituted of shells of protons and neutrons, predicts that closed shells should be exceptionally stable configurations. Both experiment and theory (in that order) have indicated that such closed shells occur[1] with 2, 8, 20, (28), 50, 82 or 126 protons or neutrons. In addition to these primary 'magic numbers', there are predicted a number of secondary ones, marking the closure of sub-shells; but the location of most of these is debatable. It is to be expected that certain mass effects are associated with the closing of these nuclear shells, and it is with this subject that the present communication is concerned.

For some time we have been making mass spectrographic measurements of the masses of many of the heavy nuclides, with the view of studying the gross features of the binding energy per nucleon curve. Descriptions of portions of this work have appeared in the literature. We are taking this opportunity to present briefly the significant results of our investigations to date, some of which are based on unpublished work while others appear only when the data are examined *in toto*.

In the accompanying graph, the binding energy per nucleon is plotted against mass number for approximately 115 of the heavier stable nuclides ($Z > 21$). About half these values have been obtained mass spectrographically, while the remainder have been computed from these using disintegration transmutation and microwave absorption data. On this plot the completion of a nuclear shell should be indicated by a sudden change in the slope, in keeping with the view that a completed shell represents an exceptionally stable configuration to which additional nucleons are rather loosely bound. The fact that such sudden changes in slope are found experimentally can be seen from the graph. Attention will now



Curve of binding energy per nucleon for stable nuclides with $Z > 21$

be directed to certain of these breaks in the curve which have special significance.

(1) There is the well-known break in the curve occurring at $_{82}\mathrm{Pb}^{208}_{126}$, presumably due to the completion of the 82-proton shell *and* the 126-neutron shell. The change in nuclear stability in the lead region was observed[3] by Dempster many years ago and is, of course, borne out by the fact that all nuclides heavier than Pb^{208}, with the single exception of its neighbour $_{83}\mathrm{Bi}^{209}_{126}$, are radioactive.

(2) Clearly shown is the sudden break in the region of mass 90, which is to be attributed to the closure of the 50-neutron shell. This sudden change n slope appears to occur at $_{38}\mathrm{Sr}^{88}_{50}$.

(3) There is an unmistakable break in the 82-neutron region, probably located at $_{58}\mathrm{Ce}^{140}_{82}$.

(4) The stabilizing effect of the 50-proton configuration has a pronounced effect on the curve, giving rise to a definite plateau which breaks off at or in the neighbourhood of $_{50}\mathrm{Sn}^{120}_{70}$.

(5) The maximum of the curve occurs at $_{28}\mathrm{Ni}^{62}_{34}$. It may or may not be significant that the maximum is located at this particular isotope of nickel, but it is almost certainly significant that it is an isotope of nickel, the proton number of which is 28.

These five features of the curve of binding energy per nucleon against mass number for the heavy masses are now well authenticated. In addition to these, as can be seen in the graph, there are suggestions of other fine structures which need more careful study and, also, there are several unexplored regions. It s gratifying that the present results are concordant with the predictions of the single-particle model. They should be useful in determining the magnitude of the closed-shell contribution to the stability of the nucleus.

It should be noted that A. O. C. Nier and his group at the University of Minnesota and S. A. Goudsmit and his group at Brookhaven have measured[4] many heavy atomic masses in the past few months. The agreement between these recent results and ours is generally satisfactory. The accompanying graph, however, is based, so far as the mass spectrographic work is concerned, on measurements made n our own laboratory. This set of values is more likely to be internally consistent than one compounded from several sources and, also, for a large number of the nuclides shown in the graph, our masses are still the only ones available.

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Polarization Field and the Acoustic Modes of Oscillation of Alkali Halide Crystals

IN a recent paper[1], the frequency of the principal lattice oscillation of an alkali halide crystal, in which the lattice of the alkali ions oscillates with respect to the lattice of the halide ions, was calculated on the basis of the simple Born model. It was found that the electric polarization of the crystal that accompanies this oscillation leads to a polarization field of the Lorentz type which tends to increase the relative displacement of the two lattices and has thus a marked influence on the principal frequency. Microscopically, this polarization may be regarded as due to small dipoles located at the lattice points. Because of the small amplitude of the oscillation, these dipoles will be practically point-dipoles, and since they are also cubically arranged, the polarization field will have just the Lorentz value, namely, $4\pi/3$ times the polarization per unit volume. (Indeed, this appears to be the only case where the conditions postulated by Lorentz for obtaining the factor $4\pi/3$ are rigorously satisfied.)

The important part which the polarization field plays in determining the resonance frequency of the crystal is indeed to be expected from other considerations. Let us consider, for example, the dielectric constant of the crystal, and confine attention to the contribution from the relative displacements of the positive and the negative ions, as distinguished from the electronic polarizations of the ions themselves. Then the effect of the polarization field on the dielectric constant may be taken into account in two alternative ways. We may regard the effective field that produces the polarization as consisting of not only the 'field in the medium', but also the polarization field, in which case we obtain a formula of the Lorentz type:

$$\frac{K_e - 1}{K_e + 2} = \frac{C/3}{\Omega_t^2 - \omega^2}, \qquad (1)$$

in which Ω_t is *not* the resonance frequency of the crystal but a certain hypothetical frequency which the crystal would have, had there been no polarization field to affect it. Resonance will occur when the right-hand side of (1) tends to unity, that is, when

$$\omega^2 \to \omega_t^2 = \Omega_t^2 - C/3. \qquad (2)$$

Alternatively, we may regard the effect of the polarization field as confined wholly to changing the hypothetical frequency Ω_i to the actual resonance frequency ω_i of the crystal, in which case we obtain the Drude formula:

$$K_\infty - 1 = \frac{C}{\omega_i^2 - \omega^2}, \tag{3}$$

in which C has the same value as in (1).

The relation between the two frequencies ω_i and Ω_i may also be expressed in the form:

$$\Omega_i^2 = \omega_i^2 \left(\frac{K_0 + 2}{3}\right), \tag{4}$$

or more generally,

$$\Omega_i^2 - \omega^2 = (\omega_i^2 - \omega^2) \left(\frac{K_\infty + 2}{3}\right). \tag{5}$$

The acoustic modes of oscillation also lead to a finite polarization of the crystal, since the amplitudes of the two ions are in general different, as a result of the difference in their masses. Though the polarization now is much smaller than in the optical oscillations, the resulting polarization field is still comparable with the field due to the electrostatic and the repulsion interactions between the ions displaced by the acoustic wave.

We have studied the effect of this polarization field on the low-frequency acoustic oscillations in detail, and we find that the polarization field affects considerably the relative amplitudes of the two ions, but their frequencies remain completely unaffected by it (unlike the optical frequencies). This is very satisfactory, since otherwise the well-known Christoffel relations connecting the velocities of propagation of acoustic waves in the crystal with its elastic constants will be disturbed.

Note added in proof, June 30. Detailed investigations on the effect of the polarization field on the acoustic modes of oscillation have since been published (Krishnan and Roy, *Proc. Roy. Soc.*, A, 210, 481 (1951)).

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Direct Calculation of Viscosities of Liquids

In my viscosity equation for liquids[1]:

$$\eta = \frac{hNb}{V^{2/3}(V-b)^{4/3}} \cdot \exp(1{\cdot}091\,\gamma V^{2/3} N^{1/3}/RT). \tag{1}$$

η is viscosity, V is molar volume, γ is surface tension, T is the absolute temperature, h is Planck's constant, N is the Avogadro number, R is the gas constant and b is the volume occupied by the molecules in the liquid state per mole. It was shown that $b \approx 0{\cdot}33\, V_c$, V_c being the molar critical volume, and that b was a function of temperature. It appeared to me that a direct calculation of viscosity was possible if only b could be obtained by a method not involving viscosity, as all other values on the right-hand side of the equation could be independently obtained.

Applying the equation to benzene and carbon tetrachloride, which have widely differing chemical constitutions, gives results shown in the accompanying table. These indicate that although b and are both functions of temperature, $(V - b)$ is practically independent of temperature. An analogou constancy of $(V - b)$ values is obtained with othe normal liquids such as chloroform (8·37), carbo disulphide (0·38), etc. The necessary data for computation have been taken from the Internationa Critical Tables, any data not directly recorded therei having been calculated from reliable formulæ give in the same Tables. The constancy of $(V - b$ observed here is rather surprising in view of the fac that it is contrary to the existing views about th behaviour of liquids. Perhaps the term $(V - b)$ a used here is an oversimplified expression, whic should await further clarification.

Temperature (° C)	$V - b$	$\eta_{obs.}$	$\eta_{calc.}$
Benzene			
0	9·36	9·00 × 10⁻³	8·81 × 10⁻³
10	9·49	7·57	7·57
20	9·56	6·47	6·50
30	9·55	5·61	5·63
40	9·58	4·92	4·95
50	9·64	4·36	4·38
60	9·54	3·89	3·90
70	9·48	3·50	3·50
	Mean 9·52		
Carbon tetrachloride			
7·15	7·13	1·19 × 10⁻³	1·27 × 10⁻³
21·21	7·17	0·95	0·94
35·21	7·21	0·79	0·79
49·51	7·20	0·66	0·66
62·87	7·22	0·57	0·57
74·16	7·25	0·50	0·51
	Mean 7·20		

The next step is to compare values of $V -$ obtained from my equation with those obtained b other methods. A good review of various method for estimating free volumes in the liquid state ha been given by Fowler and Guggenheim[2]. From th coefficient of thermal expansion and the compressibility, for a large number of liquids with non-pola molecules[2], $V - b \simeq 8$ c.c./mole. Such values ar in good agreement with those obtained from m equation for benzene, carbon tetrachloride an chloroform[2], but not for carbon disulphide.

From the formula given by Lennard-Jones an Devonshire[3] and its analogue by Eyring and Hirschfelder[4], Fowler and Guggenheim[2] give for chlorofor at ordinary temperatures, as a typical example $V - b \sim 0{\cdot}44$ c.c./mole. This value is considerabl lower than that obtained either by my equation o from the ratio of the compressibility and coefficien of thermal expansion[2]. But, for carbon disulphide for which $V^{2/3}$ is not much different from that fo chloroform, the value of $V - b$ from the formul under consideration is in good agreement with tha from my equation.

Fowler and Guggenheim[2] describe another metho of estimating free volume from the vapour pressure choosing chloroform at its boiling point as a suitabl illustration, they find $V - b \sim 1$ c.c.

Eyring *et al.*[5] utilize the velocity of sound in liquid to obtain the free volume by a formula which gives for benzene at 15° C., $V - b = 0{\cdot}49$ c.c.

We thus see that the values of free volumes obtaine by different methods are not only not concordan but also they are often widely divergent. However it may be concluded that the values of $V - b$ fro the viscosity of my equation are of a reasonable orde of magnitude.

Viscosities have been calculated from my equatio by using the mean value of $V - b$ empirically deermined from the equation and recorded in the table nd by substituting all the values for the symbols n the right-hand side of the equation. The results hows that the agreement between the calculated and he observed values of η is good provided that $V - b$ correctly chosen. Further, since $V - b$ is found o be independent of temperature, using my equation s the basis, if a reliable value is available for one emperature, viscosity at other temperatures can be alculated directly with a reasonable degree of ccuracy. However, a clear interpretation of the $- b$ term is needed and further work in this con exion is in progress.

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Effect of Drying upon the Absorption Spectra of Hæmoglobin and its Derivatives

It was shown by Zeynek[1] that on drying eoxygenated hæmoglobin *in vacuo* at 40°, its haracteristic one-banded absorption spectrum is eplaced by that of a hæmochromogen with two ands at 556 and 528 mμ, the first band being much tronger than the second. On re-introducing water ontaining oxygen, the absorption spectrum of the æmochromogen is rapidly replaced by that of xyhæmoglobin. These important observations were ecently confirmed and extended by Haurowitz[2], who ut forward the view that the formation of this nhydro-hæmoglobin is due to the removal of the ater molecule occupying the sixth co-ordination ond of the iron atom, followed by polymerization f the resulting products, in which the iron of one is nked with the protein of another.

Haurowitz[3] also dried oxyhæmoglobin over phoshorus pentoxide in presence of sufficient air (c. 00 mm. mercury) to maintain the pigment in the xygenated state. Once the anhydrous oxyhæmolobin is formed, it cannot give up its oxygen in a igh vacuum.

Since the iron both of hæmoglobin and oxyhæmolobin is in the divalent state, it would appear teresting to determine the effect of drying upon ethæmoglobin, the corresponding ferric compound.

The methæmoglobin used in these experiments was repared by treating a strong solution of recrystallized orse oxyhæmoglobin in dilute sodium carbonate H ~ 9) with ferricyanide and dialysing against ater until completely free from ferricyanide. A rown solution of acid methæmoglobin (pH $\ngtr 6$) howing a distinct absorption band in the red region about 630 mμ, when dried in a desiccator, gives distinctly red product with two absorption bands, 567, β 534 mμ, of which the β-band is much wider d stronger than the α-band. The red colour and e two-banded spectrum of the dry product are aracteristic of a parahæmatin. On treating this ied product with water it rapidly dissolves, giving a clear brown solution with the absorption spectrum of acid methæmoglobin. On the other hand, fluoride methæmoglobin similarly dried retains its characteristic colour and absorption spectrum with its band at 605 mμ. The same applies to azide-methæmoglobin, except that here the phenomenon is more difficult to observe since the complex shows a certain spectroscopic resemblance to a parahæmatin. Cyanmethæmoglobin can also be dried unchanged under reduced pressure (½ atmosphere) over phosphorus pentoxide and dry potassium cyanide.

The experiments on drying hæmoglobin and methæmoglobin strongly support the view that the sixth bond in the octahedral complex of iron in these compounds is occupied by a molecule of water. In typical hæmochromogen and parahæmatin compounds, both the fifth and the sixth covalent bonds of iron are occupied by nitrogenous groups. It thus follows that on drying hæmoglobin or methæmoglobin the water molecule bound to their iron is replaced by a nitrogenous group in the protein either of the same or, as was suggested by Haurowitz[2], of another molecule of the pigment. In this connexion it is important to note that compounds in which the water molecule bound to iron is replaced by oxygen, as in the case of oxyhæmoglobin, or by fluoride, azide and cyanide ions, as in the case of the corresponding derivatives of methæmoglobin, show no change in their colour and absorption spectra when they are dried.

This study of the desiccation of methæmoglobin thus confirmed the results of our previous experiments on the effects of low temperatures on the absorption spectra of acid and alkaline methæmoglobin, where it was shown that the sixth position around iron in acid methæmoglobin is occupied by a molecule of water[4]. The formation of alkaline methæmoglobin therefore involves the loss of a proton[5] instead of the addition of a hydroxyl ion.

Although we have been able to confirm Haurowitz's conclusion that the dehydrated form of oxyhæmoglobin does not give up its oxygen in a high vacuum, we find that this conclusion is not adequately established by the experiment recorded in his Fig. 3. In fact, the positions and the relative heights of the bands α and β in the curve representing "anhydrous oxyhæmoglobin" indicate that a considerable part of the oxyhæmoglobin had been oxidized to methæmoglobin which, on drying, was converted to globin parahæmatin. When dissolved in sodium carbonate solution, such dry material would yield a mixture of alkaline methæmoglobin and oxyhæmoglobin. That such a mixture was indeed obtained is strongly suggested by the relative heights of the bands in the second curve of the same Fig. 3. By working rapidly we have been able to obtain both the anhydrous oxyhæmoglobin and its solution in carbonate showing the absorption spectrum of pure oxyhæmoglobin. There is therefore no doubt as to the correctness of Haurowitz's conclusion, notwithstanding the experimental results that he has given.

The reversible appearance of a hæmochromogen or a parahæmatin absorption spectrum during the drying of hæmoglobin or methæmoglobin respectively indicates that the drying process is accompanied by some reactions not unlike the reversible denaturation observed for the first time by Anson and Mirsky[6] on hæmoglobin treated with acid or salicylate. Moreover, it is well known that hæmoglobin is much less resistant to denaturation by alkali and acid than is oxyhæmoglobin. A similar difference between methæmoglobin and oxyhæmoglobin can be demonstrated simply by shaking these solutions with chloroform, when only the former is denatured and is precipitated. When the water molecule bound to iron in methæmoglobin is replaced by fluoride or azide ions, however, the pigment acquires resistance to chloroform treatment. These results are exactly parallel to those observed in the desiccation experiments, which demonstrated an increased resistance of hæmoglobin and methæmoglobin to denaturation when their iron-bound water molecules are replaced by oxygen, fluoride or azide.

The reactions taking place during the drying of hæmoglobin and methæmoglobin, although perfectly reversible, appear to be of a more complex nature than the simple polymerization envisaged by Haurowitz[3], and to involve reversible changes in the architecture of the whole hæmoprotein molecule.

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Transaminases for Pyridoxamine and Purines

Braunstein's[1] demonstration of the transaminase reaction as a mode of formation of amino-acids has been broadened recently to include a wide variety of transaminases in bacteria[2], animal tissues[3] and plants[4]. In the present communication, we wish to report the formation of compounds other than amino-acids by the transaminase reaction.

Vacuum-dried cells of *Escherichia coli*, strains *B* and Crooks's, were used as sources of enzyme. Extracts were prepared by grinding cells with an equal weight of 500-mesh 'Carborundum', the cell debris removed by centrifugation and the clear, cell-free supernatant used directly, or after fractionation by precipitation with ammonium sulphate, followed by protamine treatment.

Table 1. TRANSAMINASES FOR PYRIDOXAMINE, ADENINE, GUANINE AND CYTOSINE

Reaction volume, 1 ml., containing

M Phosphate buffer, *p*H 8 3	0 1 ml.
Alpha ketoglutarate	25 μ*M*
Amino-donor	25 μ*M*
Pyridoxal phosphate, calcium salt	10 γ
Cell extract	approx. 15 mgm. cells

Incubated 60 min., 37° C. Reaction stopped with 0 1 ml. 100 per cent trichloroacetic acid, 0·02 ml transferred to paper and chromatogram developed with phenol/water (80/20). The μ*M* glutamic acid (*R_F* = 0·36) formed per ml. were estimated from the chromatograms by comparison with the size and density of spots shown by known amounts of glutamic acid

Enzyme and substrate	μ*M* Glutamate formed/ml. from amino-donors				
	No addition	Pyridox-amine	Aden-ine	Guan-ine	Cytos-ine
Extract	0 5	0 5	0 5	0 5	0 5
Extract, α-keto-glutarate	0 5	8	6	6	6
Extract, α-keto-glutarate, pyridoxal phosphate	0·5	8	6	6	6

The occurrence of a series of transaminases in these cell extracts is indicated by the results shown in Table 1. These preparations catalyse glutamate formation from alpha ketoglutarate in the presence of pyridoxamine, adenine, guanine and cytosine as amino-donors. The presence of ammonia does not lead to glutamate formation, thus indicating a transamination reaction. As shown in Table 2, the transfer of the amino-group of pyridoxamine to alpha ketoglutarate is dependent on the presence of the 'transaminase', pyridoxamine, alpha ketoglutarate and pyridoxal phosphate. The reversal of this reaction has been shown to occur with glutamic acid as amino donor and pyridoxal as amino-acceptor.

Table 2. PYRIDOXAL PHOSPHATE REQUIREMENT OF PYRIDOXAMINE TRANSAMINASE

Reaction volume, 1 ml All samples contained 0·1 ml. *M* phosphate buffer, *p*H 8 3, enzyme, and additions as indicated. Substrate and coenzyme concentrations as in Table 1

Additions	μ*M* Glutamate formed/ml.		
	Dried cells, 15 mgm.	Cell-free extract, approx. 15 mgm. dried cells	0 23–0·3 saturated ammon. sulphate fraction, approx. 15 mgm dried cells
None	2	0 5	0
α-Ketoglutarate	2	2	0
α-Ketoglutarate, pyridoxamine	8	6	0
α-Ketoglutarate, pyridoxamine, pyridoxal phosphate	8	8	8

These observations suggest a mechanism of formation and interconversion of the purines and pyrimidines, and a route from pyridoxamine to pyridoxal. The importance of the transaminase reaction as a general mechanism of amino-transfer in living organisms is suggested.

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Formation and Breakdown of Pentose Phosphates by Liver Fractions

It has previously been shown in this laboratory that at least two liver factors are necessary for the oxidation of D-ribose-5-phosphate by ammonium sulphate precipitated fractions of horse or rat liver one being an aldolase and the other a dehydrogenase specific for coenzyme II. Ribose-5-phosphate i oxidized most rapidly by a combination of live fractions *A* (0·4–0·5 saturation with ammonium sulphate) and *B* (0·5–0·6 saturation), the forme being richest in glucose-6-phosphate dehydrogenase and the latter most active in splitting ribose-5 phosphate, as judged by the disappearance of pentose using the orcinol method[1]. The breakdown of ribose 5-phosphate, unlike the oxidation, is independent o coenzyme II and oxygen and never proceeds beyond 66–72 per cent disappearance of pentose.

Ketopentose phosphate formation has been detected by the cysteine–carbazole[2] and orcinol nethods, both during the oxidative decarboxylation of 6-phosphogluconate by liver fraction *C* (0·6–0·7 aturation) and during the splitting of ribose-5-phosphate by fraction *B*. This is in accord with Horecker and Smyrniotis[4], who found that a purified 6-phosphogluconic acid dehydrogenase from yeast first decarboxylated 6-phosphogluconate to ribulose-5-phosphate before conversion into ribose-5-phosphate. It would thus now appear that at least three liver factors are necessary for the oxidation of ribose-5-phosphate, namely, a pentose phosphate somerase, an aldolase and a dehydrogenase specific or coenzyme II. It is of interest in this connexion hat crystalline muscle aldolase does not split ibose-5-phosphate.

On attempting to synthesize ketopentose phosphate rom triosephosphate and glycolaldehyde, the same ketopentose-1-phosphate was readily formed both with crystalline muscle aldolase and liver fraction *B*. This presumably is identical with the ketopentose-1-phosphate synthesized by Racker[5] with muscle ldolase and more recently by Hough and Jones[6] with pea aldolase, the latter workers identifying the ketopentose as xylulose. It is oxidized slowly by ombined liver fractions *A* and *B*, the oxidation in he absence of coenzyme II, presumably due to oxidation of glycolaldehyde, being approximately half the ate of the oxidation in the presence of coenzyme II. The ketopentose-1-phosphate is relatively acid-labile, he hydrolysis constant in *N* hydrochloric acid at 00° being 86 × 10^{-3}, in comparison with 2·5 × 10^{-3} or synthetic ribose-5-phosphate.

Although glycolaldehyde is generally assumed to e the C_2 fragment resulting from enzymic breakown of ribose-5-phosphate, experiments with liver ractions do not support this view. Glycolaldehyde as never been detected during the breakdown of ibose-5-phosphate by liver fraction *B* even under naerobic conditions, and does not disappear on ncubating with this liver fraction, although it is lowly oxidized, in the absence of coenzyme I or I, by combined *A* + *B* + *C* liver fractions. Morever, although normally the breakdown products of bose-5-phosphate are rapidly converted into hexose-monophosphate, in the presence of glycolaldehyde no exosemonophosphate is formed but instead the same etopentose-1-phosphate accumulates as is synthesized from triosephosphate and glycolaldehyde.

Most of the ribose-5-phosphate broken down by ver fractions has been accounted for by hexosemonophosphate formation, which has previously been hown to be formed from ribose-5-phosphate by ver[7] and hæmolysed erythrocytes[8]. Hexosemonohosphate has been determined by measuring the xygen uptake on addition of coenzyme II and liver action *A* (rich in glucose-6-phosphate dehydrogenase ut completely inactive in oxidizing ribose-5-phoshate and glycolaldehyde) to heat-inactivated ribose-phosphate digests by liver fraction *B*, and also by measuring the rate of reduction of coenzyme II at 40 mμ either on addition of liver fraction *A* or of a urified *Zwischenferment*[9]. At least 75 per cent of the bose-5-phosphate broken down is converted into exosemonophosphate, fructosemonophosphate being rmed first and gradually converted into glucose-6-hosphate. This is much greater than the 50 per nt conversion which could occur by aldolase connsation of the triosephosphate formed from ribose-phosphate, and indicates that the rest of the pentose olecule must be incorporated. Synthesis of hexoseonophosphate does not proceed via fructosediphosphate, since these liver fractions are devoid of fructosediphosphatase and, moreover, fructosediphosphate is not oxidized at all even by combined *A* + *B* + *C* liver fractions, which actively oxidize fructose-6-phosphate, glucose-6-phosphate and ribose-5-phosphate.

This work will be published in detail elsewhere.

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Glucuronide Decomposition in the Digestive Tract

THE discovery of an enzyme decomposing glucuronide in the rumen of the sheep[1] has been followed by the detection of similar enzymes in the large intestine of the horse[2] and in locust crop liquor[3]. It seemed possible that such enzymes are concerned in the digestion of polysaccharides containing β-linked glucuronic acid residues, such as hemicellulose and hyaluronic acid, and a survey was therefore made of their occurrence in different parts of the alimentary tract in various species of animal. Typical results are shown in the accompanying table. It should be pointed out that these results are only of qualitative value, since the enzyme assays were carried out under conditions which are optimal for the sheep rumen enzyme[1], but are not necessarily so for the enzymes from other sources. Moreover, in the rumen, omasum, cæcum and colon, the enzymes may well be of microbial origin, as has been shown for the sheep rumen enzyme[1], and therefore surrounded by membranes of varying toughness and permeability. A further factor which was not controlled was the diet of the animals, some of the material being obtained from the slaughter-house.

In spite of the reservations made above, the results in the table are of considerable interest in showing the occurrence of very active enzymes of this type in the digestive tracts of all species of animal studied. So far as any generalizations are possible, it may be said that enzyme activity was appreciable in the fore-stomachs of ruminants, and very high in the large bowel of all species. Activity was low or lacking in the stomach, abomasum or gizzard. Appreciable activity was frequently noted in the small intestine. This may have been due to secretion of animal tissue β-glucuronidase into the lumen or to sloughing of epithelial cells.

Enzymes from many sources were tested for inhibition by 0·00025 *M* saccharo-1 : 4-lactone. In this concentration, the lactone causes complete inhibition of mouse liver β-glucuronidase, but only 50 per cent inhibition of the enzyme from the rumen of the sheep[4]. In the present experiments it caused

DISTRIBUTION OF ENZYMES DECOMPOSING GLUCURONIDE IN THE ALIMENTARY TRACT
(μgm. Phenolphthalein liberated in 1 hr. at 37° and pH 6·1 (phosphate buffer) from 0·0005 M phenolphthalein glucuronide by 1 ml. strained gut content)

Animal	Rumen	Omasum	Stomach or abomasum	Duodenum	Ileum	Caecum	Colon (proximal)	Colon (distal)
Sheep	112	161	0	174	143	3,880	2,700	3,425
Cow	31	166	37	82	65	1,168	154	1,292
Horse	—	—	0	not done	2	107	515	229
Rabbit	—	—	0	19	9	2,000	2,100	
Rat	—	—	0	114	127	4,300	2,800	
Pig	—	—	20	0	45	968	1,020	189
Cat	—	—	0	126	116	392	331	
	Crop	Gizzard						
Fowl	46	0	empty	221	363	8,080	189	

complete inhibition of the enzyme in the duodenum and 35–64 per cent inhibition of the enzyme in the rumen or large intestine.

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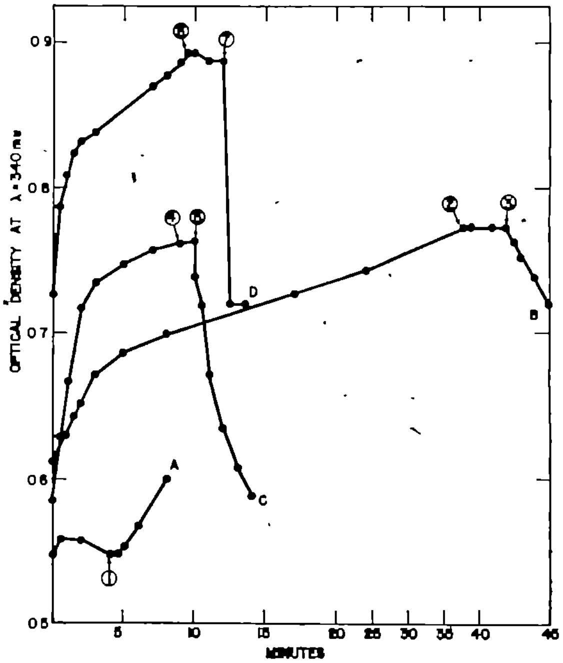
Triosephosphate Dehydrogenase and Glucose-6-Phosphate Dehydrogenase in the Pea Plant

THERE is considerable evidence indicating that the mechanisms of carbohydrate catabolism are the same in higher plants, yeast and muscle[1]. However, it has been reported that mature pea plants do not oxidize triosephosphate[2].

We find that extracts of roots, stems and leaves of pea plants, 16 and 22 days old, prepared by treatment of the tissues with 0·1 M disodium hydrogen phosphate and ammonium sulphate fractionation, contain enzymes catalysing the oxidation of glyceraldehyde-3-phosphate by the pyridine nucleotides. There appears to be two enzymes in stem and leaf, one requiring triphosphopyridine nucleotide, the other diphosphopyridine nucleotide. The enzyme of the root is active only with the latter nucleotide.

Oxidation of the triosephosphate with diphosphopyridine nucleotide does not occur until the extracts are incubated with cysteine even when freshly prepared. Oxidation with triphosphopyridine nucleotide occurs in extracts without cysteine. Both enzymes are inhibited by iodoacetamide, but that requiring triphosphopyridine nucleotide appears less sensitive. The accompanying graph illustrates the activity of the triosephosphate dehydrogenases as indicated by reduction of the nucleotides by glyceraldehyde-3-phosphate. Reactions were run in Beckman quartz cuvettes (d = 1 cm.) with a total volume of 3·0 ml., and readings were made against a water blank. All reaction mixtures contained veronal buffer, pH 8·0, 52 μM sodium arsenate, 60 μM sodium fluoride. Curve A indicates the effect of cysteine on the enzyme requiring diphosphopyridine nucleotide. Curves B–D indicate reduction of the nucleotides by the aldehyde and subsequent reoxidation by means of yeast alcohol dehydrogenase or rabbit muscle lactic dehydrogenase. The slow oxidation of reduced triphosphopyridine nucleotide by means of the alcohol dehydrogenase, which is specific for diphosphopyridine nucleotide (curve B), indicates the presence of an enzyme converting reduced triphosphopyridine nucleotide to the reduced diphosphopyridine nucleotide[3].



Curve A. Effect of cysteine on activity of coenzyme I linked triose phosphate dehydrogenase. 1·5 μM glyceraldehyde-3-phosphate, 0·03 ml. fresh leaf extract, 0·17 μM diphosphopyridine nucleotide. At arrow 1, 12 μM cysteine added.
Curve B. Reduction of triphosphopyridine nucleotide by leaf enzyme. 0·14 μM triphosphopyridine nucleotide, 0·03 ml. of three-week old 40–50 per cent ammonium sulphate fraction of leaf extract. Reaction started by addition of 1·5 μM glyceraldehyde-3-phosphate. At arrow 2, 50 μM acetaldehyde added; at arrow 3, crystalline yeast alcohol dehydrogenase added.
Curve C. Reduction of triphosphopyridine nucleotide by leaf enzyme and reoxidation with lactic dehydrogenase. 0·14 μM triphosphopyridine nucleotide, 0·03 ml. of same leaf fraction used in curve B, 12 μM cysteine. Reaction started by addition of 1·5 μM glyceraldehyde-3-phosphate. At arrow 4, 50 μM sodium pyruvate added; at arrow 5, rabbit muscle lactic dehydrogenase added.
Curve D. Reduction of diphosphopyridine nucleotide by leaf enzyme and reoxidation by alcohol dehydrogenase. 0·17 μM diphosphopyridine nucleotide, 0·03 ml. fresh leaf extract incubated 6 min. with 12 μM cysteine. Reaction started with 1·5 μM glyceraldehyde-3-phosphate. At arrow 6, 50 μM acetaldehyde added; at arrow 7, crystalline yeast alcohol dehydrogenase added

The roots, stems and leaves also possess a glucose- -phosphate dehydrogenase which is active only with :iphosphopyridine nucleotide. This activity is not ffected by iodoacetamide or fluoride but is increased y cyanide. Triphosphopyridine nucleotide reduced y the glucose-6-phosphate dehydrogenase can be -oxidized by the extracts of the leaf and stem with -phosphoglycerate in the presence of adenosine riphosphate.

Since the triosephosphate dehydrogenase requiring riphosphopyridine nucleotide was found only in parts f the plant containing chlorophyll, it is of interest to peculate that it participates only in photosynthesis, hat is, in the conversion of phosphoglycerate to riosephosphate, whereas the other dehydrogenase is oncerned in carbohydrate catabolism. The presence f a glucose-6-phosphate dehydrogenase indicates hat plant tissue may degrade hexose by a mechanism imilar to that of yeast[4] or animal tissue[5].

Full details of this investigation, which was carried ut at Brookhaven National Laboratory under the uspices of the U.S. Atomic Energy Commission, will e published elsewhere.

I am indebted to Prof. E. Baer for a generous gift f the dioxane addition compound of *dl*-glyceraldeyde 1-bromide 3-phosphoric acid. I am also inebted to Dr. Ralph DeMoss for many helpful uggestions.

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Glycerol as a Nutritive for *Vibrio choleræ*

IT has been found that glycerol, incorporated in a edium suitable for growing *Vibrio choleræ*, increases he number of organisms yielded. This effect of lycerol is strongly enhanced when phosphates are resent as well. Glycerol, in a concentration of 2·2 er cent (corresponding to 1·5 ml. glycerol per 100 ml. edium), doubles the harvest obtained from a solid asal medium containing 1 per cent peptone and ·5 per cent sodium chloride. Omitting the glycerol nd adding phosphate (0·25 per cent disodium ydrogen phosphate) to the basal medium raises the rop only slightly.

A more than sevenfold yield, however, is due to he combined action of glycerol and phosphate in he concentrations stated above. This manifold nprovement in growth is nearly the same for two ifferent strains used in vaccine production, namely, gawa and Inaba.

It is intended to publish a fuller report of this work lsewhere.

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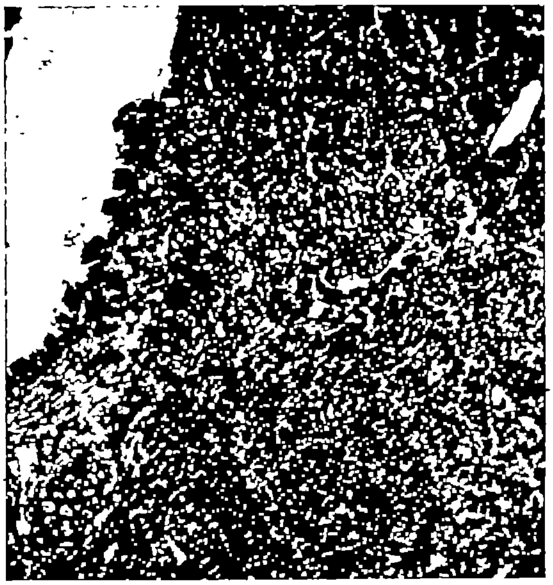
Lepine and Sautter's Disease in Great Britain

THE first guinea pig lung showing symptoms like that of the subclinical virus disease described by Lepine and Sautter[1] was found in Great Britain two years ago. Since that time, examination of guinea pigs from various sources has shown that this condition causing microscopical lung hepatization is widespread in Britain.

As in the cases of Lepine and Sautter, the animals exhibited no clinical symptoms. The only macroscopical change is that the lung is a lighter pink than usual; the hepatization of the lung can only be detected on microscopical examination, and is the sole means of identification.

Histopathological changes observed in the lung can be divided into two groups.

(1) *Peribronchial condensation in the lung.* This is characterized by proliferation and accumulation of a variety of cells, including fibroblasts, reticulocytes, developing cells of the lymphoid series, and a large number of small lymphocytes (see photograph). With reticulum staining, these areas show an abundance of reticular fibres.



Type I condensation (hæmatoxylin-eosin). × 100

(2) This type of condensation is characterized by a thickening of the alveolar wall due to cellular proliferation, involving particularly the capillary endothelium. No inclusion bodies could be detected in any of the condensations, either with neutral red (Duffet) or phloxyn-tartrazin (Lendrum) staining.

Since bacteriological examination was negative, it is logical to assume that the disease was caused by virus. I have been unable to determine whether this condition is identical with that described by Lepine and Sautter; nevertheless, the extent of distribution warrants a more extensive investigation.

My thanks are due to Mr. R. C. James for his technical assistance.

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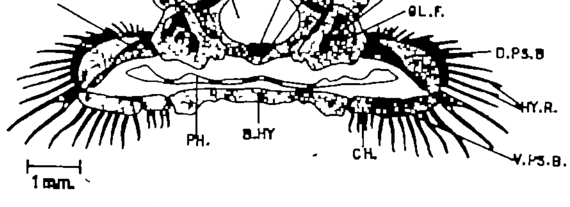
Hyoid Arch of Rhinobatidæ

The skeleton of the hyoid arch of Batoidei has been for many years the subject of discussion by morphologists. Gegenbaur[1] considered the hyoid elements bearing hyal rays and lying posterior to the hyomandibular cartilage to represent the ceratohyal of Selachoidei, which became disconnected from the ventral edge of the hyomandibular and extended upwards behind it. Krivetski[2] and de Beer[3] considered these hyoid elements as pseudohyoid and formed by the fusion of the proximal ends of the hyal rays. Such a phenomenon occurred during the phylogenetic divergence between Batoidei and Selachoidei, and was largely associated with the increased distance between the mouth and first gill slit in Batoidei. Thus the pseudohyoid elements were necessary for providing a support for the hyal rays, as well as the anterior wall of the first gill slit. During the enlargement and extension of these pseudohyoid elements, the original ceratohyal in Batoidei has disappeared.

The study of the hyoid arch of Rhinobatidæ, as represented by *Rhinobatus halavi* and *Rhynchobatus djiddensis* from the Red Sea, supports the view of both Krivetski and de Beer. As a matter of fact, both *Rhinobatus halavi* and *Rhynchobatus djiddensis* are transitional forms between Selachoidei and Batoidei (Bridge[4], Regan[5] and Goodrich[6]). It is found that in these two fishes the original ceratohyal, which has completely disappeared in specialized Batoidei, is still persisting in addition to the pseudohyoid. This ceratohyal, which is relatively much reduced, bears the correct relations of a selachoid ceratohyal to the afferent hyoidean artery, being immediately dorsal to it. Also it is still bearing hyal rays. The originally direct connexion between the hyomandibular and ceratohyal of Selachoidei can be traced by the presence of a ligamentous vestige between the hyomandibular and this reduced ceratohyal. Also the afferent pseudobranchial artery, on running forwards from the efferent hyoidean artery, is median to the pseudohyoid, whereas it is lateral to both the hyomandibular cartilage and the reduced ceratohyal.

Thus the pseudohyoid is a structure altogether distinct from the ceratohyal. Accordingly, the peculiar articulation between the ventral pseudohyoid bar and the reduced ceratohyal is a secondary one. It is gained by the depression of the ceratohyal due to the ventral extension of the ventral pseudohyoid bar. That such an extension has taken place is supported by the fact that the more ventral hyal rays are loosely attache to the ventral pseudohyoid bar while the dorsal ray are completely fused with it. It is to be noted als that the amount of depression of the ceratohyal i *Rhinobatus halavi* is relatively greater than that i *Rhynchobatus djiddensis*. This shows that thes transitional forms represent different steps toward the highly specialized Batoidei, where the ceratohy is completely missing. The condition of *Rhinobatu halavi*, possessing a smaller ceratohyal, seems to b somewhat beyond that of *Rhynchobatus djiddensi* towards the more specialized Batoidei. This agree with the conclusion arrived at by Melouk[7] fro embryological considerations.



Rhinobatus halavi. Reconstructed posterior view of neurocranium and hyoid arch.
AUD C., auditory capsule; *B HY.*, basihyal; *CH.*, ceratohyal; *D.PS.B.*, dorsal pseudohyoid bar; *END.FO.*, endolymphatic fossa; *F.M.*, foramen magnum; *GL.F.*, glossopharyngeal foramen; *HM.*, hyomandibular cartilage; *HY.R.*, hyal rays; *M.A.F.*, median articular facet for anterior vertebral plate; *N.*, notochord; *OC.A.*, occipital arch; *OC.C.*, occipital condyle; *PH.*, pharynx; *S.OT C.*, supraotic crest; *V.PS.B.*, ventral pseudohyoid bar; *VG.F.*, vagus foramen

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Epidermal Glands in Centipedes

The epidermis of a centipede is virtually a epithelium of unicellular glands, their secretion bein extruded over the surface of the cuticle[1]. In additio to the general epidermal glands, there are loca groups of much larger glands histologically simila to the generally distributed glands. Their secretion are chemically similar and, furthermore, they hav similar properties to the sclerotin and pro-sclerotin of the cuticle.

Opening on the sternites of Geophilomorphs ar batteries of large columnar gland cells. The secretio from these sternal glands in *Haplophilus subterraneu* is a white mobile fluid when extruded, but it rapidl hardens into an amber-coloured material on ex posure to the air. Attems[2] has described a simila secretion from the sternal glands of *Himantarium gabrielis*. Similar batteries of glands are found i Lithobiomorphs, though they do not appear to hav been described. They open by numerous pores on th inner, morphologically posterior face of the four dista podomeres (femur, tibia, tarsus and metatarsus) o the last two pairs of legs. They may be referre to as the 'telopodal glands'. Like that of the sterna glands their secretion hardens on exposure, formin a material which is amber-coloured when seen in mas but is normally extruded as long sticky fibre resembling silk. This secretion has been noted b Verhoeff[3] and Willem[4], although they both stat incorrectly that the material is extruded from th coxal glands ('glandes filières' of Willem).

Telopodal glands have been examined in severa species of *Lithobius* and in the related genus *Lamycte* Like the general epidermal gland secretions[1], tha of the sternal and telopodal glands colours wit sudan black. It is intensely positive to Millon' reagent and also gives a positive ninhydrin test. Th secretion thus appears to be a lipoid-protein comple or mixture. It is very similar in this respect to th sclerotin and pro-sclerotin of the cuticle, in whic phenolic groups, probably tyrosine residues, ar ewise abundant[1]. The resemblance of the secretion silk recalls Trim's comparison of the protein-itin complex of the insect cuticle with silk[5]. It has een suggested that the lipoid material from the meral epidermal gland cells of centipedes, having een extruded over the surface of the cuticle, under- oes some change which renders its outer surface rd and inert[1]. Since the secretion from the sternal d telopodal glands appears to be a similar substance d possesses the property of spontaneous hardening, is suggestion may receive further support. A milar relation between the general and special gumental gland secretion and the outer layers of e cuticle has been demonstrated in certain rustacea[6,7].

It is hoped to publish a full account of these special-ed glands in centipedes, together with notes as to eir possible function, in the near future.

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'Infra-Red' Brooding and the Crooked-Toe Problem in Chicks

LAST season, following the reports that rearing der the bright emitter type of 'infra-red' lamp used an increased incidence in chicks of a crooked-e deformity, we reared several hundred chicks from r own stock on solid floors so that we could study e problem at first hand. Despite the fact that we d everything possible to induce the condition, for ample, varying the height of the lamp above e chicks, damping the litter, and using various ets, we failed to produce a single case of crooked e.

Towards the end of the season, with the co-operation the National Agricultural Advisory Service, we re able to obtain some growing birds from an out-le source, which had been reared under 'infra-red' d which showed the deformity. Although these rds were obtained primarily for X-ray examination, ey were reared to maturity and bred from for perimental purposes.

Chicks, apparently normal on hatching, from the oked-toed parents have been reared along with me of our own chicks under the same 'infra-red' mp, and whereas 100 per cent of the progeny from e crooked-toed parents have developed the de-rmity, our own chicks have remained quite normal. hen second batches of chicks from both sources re reared together, using ordinary electrical heat-g, neither the progeny from the crooked-toed parents r our own stock developed the malformation.

It would therefore appear that this particular type crooked toe is of a hereditary nature, the suscept-ility being inherited by some strains whereas others e resistant. The indication is that the manifestation this type of crooked toe appears in susceptible ains of chicks under the particular environmental conditions provided, possibly by the combination of bright emitter 'infra-red' lamps—or perhaps prolonged exposure to artificial light—with rearing on solid floors.

If this is the case, then it would appear that certain non-susceptible strains of chicks can be reared successfully under luminous 'infra-red' lamps without the risk of crooked toe deformity appearing: and starting with a 'susceptible' strain it should be possible, by selection, to breed for resistance to the development of crooked toes under 'infra-red' rearing.

While cases of crooked toe in chicks have been previously reported, this hereditary relationship to 'infra-red' brooding has not hitherto, so far as we are aware, been described.

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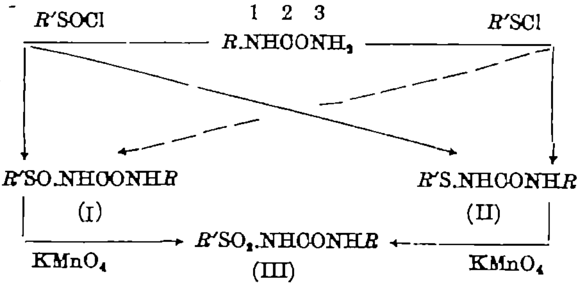
Sulphinylureas and Sulphenylureas

THE interaction of aromatic ureas with carboxylic acid chlorides in pyridine solution under restrained conditions yields N-carbonyl-N'-arylureas[1]. The corresponding reaction with sulphonyl chlorides, however, occurs with simultaneous dehydration and formation of N-arylsulphonyl-N-arylcyanamides[2]. In continuation of the latter work, the action between aromatic ureas and sulphinyl chlorides has been studied. The results obtained necessitated the examination of the corresponding reaction involving sulphenyl chlorides.

Unlike sulphonyl halides, which appear to attack the substituted urea molecule at the oxygen atom (2), forming unstable intermediate O-sulphonylureas $[R\text{NH.C}(:\text{NH}).\text{OSO}_2R']$ [2,3], sulphinyl chlorides substitute at the nitrogen (3), yielding N-arylsulphinyl-N'-arylureas (I) as one of the main products. Considerable quantities of N-arylsulphenyl-N'-arylureas (II), presumably formed by an oxidation-reduction mechanism operating during the reaction, are also isolated. Both products of the reaction are oxidized by alkaline permanganate to sulphonylureas of known formula (III); this observation establishes the structures of the sulphinyl- (I) and sulphenyl-ureas (II); hydrolytic fission of the compounds under various conditions provides further evidence in support of the suggested formulæ. Finally, N-arylsulphenyl-N'-arylureas are found to be almost the exclusive products of the interaction of arylureas and sulphenyl halides.

Thus, for example, the interaction of phenylurea (1 mole) and toluene-*p*-sulphinyl chloride (2·5 moles) in pyridine at 45° for five minutes gave lustrous



plates of N-phenyl-N′-toluene-*p*-sulphinylurea (melting point 164°, decomp.) and opaque needles of N-phenyl-N′-toluene-*p*-sulphenylurea (melting point 172°, decomp.) (each in 25–35 per cent yields), together with smaller quantities of *p*-tolyl toluene-*p*-thiolsulphonate and di-*p*-tolyldisulphide. The analogous reaction with toluene-*p*-sulphenyl chloride gave the sulphenylurea and sulphinylurea in 65 and 3 per cent yields respectively. Similar results were obtained with other members of the urea series.

In their reactions with arylureas, sulphinyl and sulphenyl chlorides thus resemble halides of carboxylic acids rather than those of sulphonic acids. Further experiments in connexion with this work, particularly its extension to the thiourea-series, are in progress, and a detailed account will appear elsewhere in due course.

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Feb. 9.

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[1] Walther and Wlodkowski, *J. Prakt. Chem.*, 59, 271 (1899).

[2] Kurzer, *J. Chem. Soc.*, 1034, 3029, 3033 (1949); 3260 (1950); 1258 (1951).

[3] Oxley, Partridge, Peak, and Short, *J. Chem. Soc.*, 1514, 1618 (1948); *Chem. and Indust.*, 419 (1949).

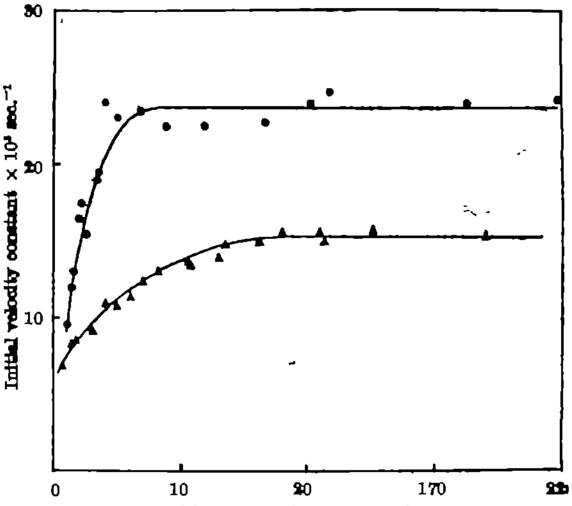
Unimolecular Chlorohydrocarbon Decompositions

THEORIES of gaseous unimolecular reactions have often been discussed[1]; but very few examples of processes occurring virtually completely by this mechanism have been used to compare theory and experiment. Thus the decompositions of azomethane, nitrous oxide and nitrogen pentoxide, which have been exhaustively examined from this point of view, are not now considered to be simple unimolecular reactions[2]. It is desirable, therefore, to have authenticated examples, and some evidence has already been presented that the homogeneous, first-order pyrolyses of ethyl, *iso*propyl and *tert.* butyl chlorides and of ethylidene dichloride are of this type[3]. This evidence is found mainly in comparisons with the obvious radical chain-decompositions of 1.2 dichloroethane and the tetrachloroethanes[4]. In contrast with the latter, the former show no induction periods, no inhibition by propylene, little sensitivity to oxygen and chlorine, and, in the case of ethyl chloride, there is reasonable agreement between the experimental activation energy and that calculated by the semi-empirical method.

These apparently unimolecular processes are now being examined at low pressures in an apparatus essentially similar to that used previously[3,4]. The rate-constants for the decompositions of ethyl chloride and ethylidene dichloride have been shown to fall from the high-pressure values less than $p = 6$ mm. of mercury at 456° C. and 17 mm. at 412° C. respectively. The accompanying graph illustrates the results obtained. It may be noted that at high pressures the reported rate-constants agree satisfactorily with those calculated from the rate-equations given by Barton and Howlett[3].

The classical theory of unimolecular reactions:

$$k = \frac{A\{\exp(-E/RT)\}\,(E/RT)^{s-1}}{(s-1)!}$$



●, Ethyl chloride; ▲, ethylidene dichloride. Note change of scale above 20 mm.

may be used in conjunction with the inflexion poin in the curve of rate-constant against pressure t estimate the number of vibrational degrees of freedom (*s*) contributing towards the activation energy[5]. By assuming collision diameters of 6 A. in eac case[6], the values of *s* are calculated to be 15 fo ethyl chloride and 7 for ethylidene dichloride.

The order of reaction for ethylidene dichlorid pyrolysis begins to rise perceptibly above unity a pressures less than 4 mm. mercury and reache approximately 1·5 at 1 mm. pressure. Thus th evidence that these reactions are truly unimolecula is considerable. Further work is in hand and will b fully reported shortly.

K. E. HOWLETT

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Feb. 10.

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[1] Compare, for example, *Chem. Rev.*, 10, 1 (1932), symposium on th kinetics of homogeneous reactions. Kassel, L. S., "Kinetics Homogeneous Gas Reactions" (Chem Catalogue Co., 1932 Hinshelwood, C. N., "Kinetics of Chemical Change" (Oxf. Uni Press, 1940). Glasstone, S., Laidler, K. J., and Eyring, H "Theory of Rate Processes" (McGraw-Hill, 1941).

[2] See Hinshelwood, C. N., *loc. cit.*, p. 124. Glasstone, G., Laidle K. J., and Eyring, H., *loc. cit.*, p. 296. Pease, R. N., "Equilibrium and Kinetics of Gas Reactions", 129, 188 (Princeton Univ. Pres 1942). Ogg, R. A., *J. Chem. Phys.*, 15, 337 (1947).

[3] Barton, D. H. R., and Howlett, K. E., *J. Chem. Soc.*, 165 (1949 Barton, D. H. R., and Onyon, P. F., *Trans. Farad. Soc.*, 45, 72 (1949). Barton, D. H. R., and Head, A. J., *Trans. Farad. So* 46, 114 (1950).

[4] Barton, D. H. R., and Howlett, K. E., *J. Chem. Soc.*, 155 (1949 Howlett, K. E., *Nature*, 165, 860 (1950); *Trans. Farad. So* 48, 25 (1952). Barton, D. H. R., and Howlett, K. E., *J. Che Soc.*, 2033 (1951).

[5] Compare Hinshelwood, C. N., *loc. cit.*, p. 81.

[6] Computed from the viscosity data for ethane, by analogy with t variation in the chloromethanes, see Partington, J. R., "A vanced Treatise on Physical Chemistry", 860 (Longmans, 194

Chlorogenic Acids in Fruit Trees

WORK on the chemical composition of the vario parts of fruit trees, particularly apple and pear, proceeding at Long Ashton and East Malling Researc Stations and the Ditton Laboratory. The proble being studied are not quite the same in each la oratory, but discussions of common interests ha disclosed certain overlapping findings. For th reason, we wish jointly to report the presence of chlorogenic acid in both mature and immature apple and pear fruits, and of this substance and a substance similar to, or identical with, *iso*chlorogenic acid of coffee[1] in leaves and shoots of pear.

Details of the work will be given in independent publications elsewhere.

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East Malling, Kent.

A. H. Williams

Long Ashton Research Station,
University of Bristol.

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[1] Barnes, Feldman and White, *J. Amer. Chem. Soc.*, **72**, 4178 (1950).

The Symmetrical Spherical Top

The plastic toy top described by C. M. Braams[1] recalls a similar top described in some detail in Prof. John Perry's "Operatives' Lecture of the British Association Meeting at Leeds, September 6, 1890", or in his book "Spinning Tops", 67–74 (Society for Promoting Christian Knowledge, 1890). He gives the reason for the unusual behaviour of the top in terms of the rule: "Hurry on the procession and the body rises in opposition to gravity", and ascribes the theory of the effect to Lord Kelvin (1874). Perry's Fig. 35, which is on p. 75 of "Spinning Tops", is almost the modern "Tippe Top".

G. N. Copley

17 Calderstones Avenue,
Liverpool, 18.

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[1] *Nature*, **170**, 31 (1952).

"Library Services in the British Colonial Territories"

The thoughtful and well-informed article on this subject in *Nature* of May 24 will be keenly appreciated by all who also regard the establishment of adequate public library services in these territories as a matter of high priority, being a prerequisite of both economic and social development. The Library Association, with the full co-operation of the Colonial Office, has recently appointed a Committee to advise on all aspects of library provision in the Colonies.

The Library Association warmly supports the contention that "There is clearly a need for a body with driving force capable of providing the finance to establish public libraries and the ability to organize and direct their development until the local governments are able to take over" the responsibility.

Nevertheless, there are difficulties which it would be wrong to under-estimate. First, it is a basic constitutional principle that the Metropolitan Government does not direct Colonial development, or indeed interfere any more than is necessary in local affairs. Thus it is not possible for the British Government to impose any pattern or standards; it can only encourage and guide. Consequently its functions, however implemented, must be limited to initiating and financially aiding pilot or demonstration projects, assisting in schemes for professional education, and affording advice, bibliographical services and the like. Some of this help must be on a short-term basis, preferably diminishing as local support increases. But it is cardinal that initial help should not be withdrawn until the local support is sufficient, otherwise all that has been achieved is thrown away. Yet that is what is in danger of happening, for example, in the Eastern Caribbean. Moreover, all these pilot schemes must enjoy a measure of security, as otherwise planning is impossible, and those who undergo training for librarianship must be assured that they will have permanent scope and employment.

The second great difficulty is that no sound library services can be started or maintained without properly selected, trained and experienced staff. It is, therefore, though obviously unintentionally, misleading to suggest that "the cost of establishing adequate library systems throughout the British Colonial Empire would be very small, and no more than a small team of librarians working in the field would be required". The idea of such a team starting one scheme in one Colony and then moving on to another and so on may seem attractive but is actually impracticable. Each scheme needs two or three first-class, thoroughly experienced leaders capable of starting the job and seeing it through, and of building up well recruited and trained local staff to maintain the services permanently, a task which will occupy a great part of their professional lifetime. We must avoid thinking of library services as inexpensive undertakings. Good libraries must be expensive, which does not prevent their being worth while; on the contrary, the inexpensive are the least worth while. It is absurd to imagine that nation-wide public libraries can, in a year or two and at small cost, be established in the towns and throughout the country districts of a multi-lingual, multi-culture Colony with scarcely any vernacular literature, which will be adequate for the needs of those who can read and those who will be able to read as fundamental education projects begin to achieve full results.

If it is reasonable to argue that any particular Colonial Government cannot afford to maintain adequate libraries, then the case for aid from the British Government is all the stronger. For one thing is absolutely sure: that without education, and the libraries that are the essential accompaniment of educational development, these people will never be able to afford libraries, or anything else beyond bare subsistence. Without adequate library services, the British Colonial territories will never be able to achieve proper standards of living for their peoples, and the ideal of democratic self-government will either remain a dream or prove a tragic failure. Therefore, we would urge all who have a sense of responsibility in this matter to support the Colonial authorities in their educational and library development policies and to urge that the British Council, in co-operation with the Colonial Office, be enabled to resume its library work in these territories, and to resume it with much greater resources than were ever enjoyed before.

Lionel R. McColvin
(President)

The Library Association,
Chaucer House, Malet Place,
London, W.C.1.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturers (Grade B) **in the Department of Chemistry and Applied Chemistry**—The Principal, Royal Technical College, Salford (August 2).

Bacteriologist (with good honours degree and research experience), for work concerned with aspects of the microbiology of the gut flora of the bovine, the pig and the chick used as experimental animals—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (August 2).

Supervising Geologist in the Geological Section of the Department of National Development, Canberra, to be responsible for the supervision of field operations of the Sedimentary Basins Subsection, including geological mapping and assessment of petroleum possibilities of sedimentary basins in Australia, and to prepare reports relating to the occurrence of oil in Australia—The Deputy High Commissioner, Australia House, Strand, London, W.C.2, endorsed 'For the attention of the Senior Representative, Division of Industrial Development' (August 7).

Assistant (with an honours degree in bacteriology, or its equivalent) **to the Advisory Bacteriologist**—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (August 9).

Demonstrator (with an honours degree in chemistry or biochemistry) **in the Department of Chemistry and Biochemistry**—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (August 9).

Scientist, Grade II (with a good university honours degree, or equivalent, in chemistry or physics, chemical engineering, or fuel technology) on the staff of the Director of Scientific Control at London headquarters—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, endorsed TT/500 (August 9).

Soil Conservation Officers (with a degree in conservation, agriculture, agricultural engineering or pure science)—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (August 10).

Assistant Physicist to work on medical applications of radioactive isotopes—The House Governor and Secretary, Royal Cancer Hospital, Fulham Road, London, S.W.3 (August 11).

Assistant Lecturer in Psychology—The Registrar, University College, Hull (August 12).

Director (qualified in archæology or natural history, with experience of the organization of art exhibitions) **of the Art Gallery and Museum**—The Town Clerk, Town Hall, Doncaster (August 14).

Agricultural Economist, and **Assistant Agricultural Economists**—The Registrar, The University, Manchester 13 (August 15).

Lecturer in Chemistry, and a **Lecturer in the Department of Mining and Geology**—The Principal, Wigan and District Mining and Technical College, Wigan (August 15).

Research Officer (with university honours degree, or equivalent qualification) to undertake some fundamental studies into the colloidal properties of a flour-water dough, at the School of Applied Chemistry, N.S.W. University of Technology, Sydney—The Director, Bread Research Institute of Australia, 111 Pacific Highway, North Sydney, Australia (August 15).

Assistant Lecturer in Bacteriology—The Registrar, The University, Manchester 13 (August 18).

Senior Technical Officer in the Coal Research Section, Delhi Road, North Ryde, Australia, to assist in a survey of the physical and chemical properties of Australian coals, with special emphasis on the supervision of staff engaged on the selection and preparation of samples—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (August 23).

Leader (with a first- or second-class honours degree in physics or metallurgy, or an equivalent qualification, with at least three years postgraduate research experience) **of the Metal Physics Group** of the Metallurgy Department, Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.196/52A (August 29).

Lecturer in Mathematics at University College, Dundee—The Secretary, The University, St. Andrews (September 1).

Lecturer in Physics at New England University College (University of Sydney), Armidale, N.S.W.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 1).

Lecturer in Plant Physiology in the Department of Botany, Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 8).

Lecturer in Experimental Pharmacology—The Secretary of University Court, The University, Glasgow, W.2 (December 31).

Agricultural Chemist—The Director, Tea Research Institute of Ceylon, Talawakelle, Ceylon.

Assistant (Grade A) to teach **Mathematics** up to Degree standard—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex.

Assistant Lecturer (Grade B) **in the Physics Department**—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Assistant Lecturer in the Physiology Department—The Warden and Secretary, Royal Free Hospital School of Medicine, Hunter Street, London, W.C.1.

Chemist, to study the degradation of leather in wear, and other related problems—The Director, British Boot, Shoe and Allied Trades Research Association, Satra House, Rockingham Road, Kettering, Northants.

Chemist/Assayer in Northern Rhodesia, to carry out assays and analyses of ores, minerals and rocks in the laboratory of the Geological Survey Department—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. 27106/57/52.

Engineer in the Ministry of Supply near Sevenoaks, to engineer electronic and radar equipment for flying trials—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.290/52A.

Engineer with wide experience in the application of electronic and servo-mechanical methods to the control of operations—The Printing, Packaging and Allied Trades Research Association, Patra House, Randalls Road, Leatherhead, Surrey

Experimental Assistant (with a knowledge of chemistry and physics up to degree standard) for research on chalk products—The Director of Research, Research Council of the British Whiting Federation, 245 Ampthill Road, Bedford.

Graduate Assistant Biochemist (experience in hospital biochemistry and a higher degree in chemistry or biochemistry are essential)—The Medical Superintendent Western General Hospital, Edinburgh.

Head of the Department, and a **Plant Breeder**, in the Department of Hop Research—The Registrar, Wye College, Wye, Ashford, Kent.

Head of the Department of Power Engineering and Electrical Technology in the Indian Institute of Science, Bangalore—The Ministry of Labour and National Service (A.S 12), Almack House, 26 King Street, London, S.W.1, quoting A.12/1.30E.

Lecturer in Physiology—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

Mechanical and Electrical Engineers in the Works Department of the Air Ministry, in connexion with the design, operation and maintenance of ground mechanical and electrical works services on R.A.F. stations at home and overseas and on Civil Aviation stations—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.290/52A.

Physicists and Engineers (Principal Scientific Officer and Senior Scientific Officer grades) at Ministry of Supply London headquarters, for work concerned with the development of guidance and control systems and the application of specialist techniques including radio, radar and electronics to such systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.206/52A.

Professor of Telecommunication Engineering under the Government of India—The Ministry of Labour and National Service (A.S.12), Almack House, 26 King Street, London, S.W.1, quoting A.12/ITU/193/52.

Soils Chemist or **Physicist** (postgraduate experience is essential), a **Chemical Engineer** for research and advisory work, a **Plant Pathologist** for research on diseases of Hevea, a **Plant Physiologist** or **Biochemist** to study the physiology of latex formation, a **Botanist** to work in Malaya and America on the taxonomy of Hevea, a **Botanist** for preliminary training in the United Kingdom in soil microbiology prior to work in Malaya, a **Chemist** for preliminary training in the United Kingdom in microbiology and bacteriology prior to work in Malaya on rubber latex, and an **Agriculturist** (graduate) for Smallholders' Advisory Service, in the Rubber Research Institute of Malaya, Kuala Lumpur—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, South Kensington, London, S.W.7.

Technical and Research Assistant (honours graduate in oceanography, meteorology, general physics or mathematics) for subjects related to tides—The Director, The Observatory, Birkenhead.

Wool Textile Research Council Fellowships: (*a*) in Organic Chemistry, for work on the chemistry of the wool fibre and allied materials, (*b*) in Physics or Physical Chemistry, for work on the structure of wool and related fibres—The Principal, Technical College, Bradford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Annual Report of the Royal Zoological Society of Scotland for the Financial Year ending 31st December 1951. Pp. 24. (Edinburgh: Royal Zoological Society of Scotland, 1952.) [125

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 888, Vol. 244: Large Elastic Deformations of Isotropic Materials, 9, The Deformation of Thin Shells. By J. E. Adkins and R. S. Rivlin. Pp. 505–531. (London: Cambridge University Press, 1952.) 6s. 6d. [125

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences No. 634, Vol. 236: On the Nervous System of Saccoglossus cambrensis (Enteropneusta). By E. W. Knight-Jones. Pp. 315–354 + plates 32–35. 15s. No. 635, Vol. 236. Water Movements in Lakes during Summer Stratification; Evidence from the Distribution of Temperature in Windermere. By Dr. C. H. Mortimer. Pp. 355–404. 11s. 6d. (London: Cambridge University Press, 1952.) [125

Other Countries

The Selection of Military Manpower: a Symposium. Edited by Leonard Carmichael and Prof. Leonard C. Mead. (Publication 209.) Pp. vii+269. (Washington, D.C.: National Research Council, 1951.) 2.50 dollars. [85

World Health Organization. Technical Report Series No. 50: Expert Committee on the International Pharmacopoeia; Ninth Report, including Third Report of the Subcommittee on Non-Proprietary Names. Pp. 33. (Geneva: World Health Organization; London: H.M. Stationery Office, 1952.) 2s.; 25 cents; 1 Swiss franc. [125

World Health Organization. Second Seminar for European Sanitary Engineers, Rome, 11–17 November 1951. Pp. v+280. (Geneva: World Health Organization, 1952.) [125

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STATE EXPENDITURE ON UNIVERSITIES IN GREAT BRITAIN

THE grant in aid of the universities and colleges in Great Britain, which in the Civil Estimates of 1951–52 amounts to more than £23 million, and which, according to the Chancellor's statement on February 21, is to rise to £25 millions in 1956–57, apart altogether from non-recurrent grants, is by far the largest of the grants in aid of services at home of which detailed accounts are not available to the Comptroller and Auditor-General. No other grant exceeds £200,000, and most of them are less than £20,000. Moreover, any balance issued but not spent by the end of the financial year is not liable to be returned to the Exchequer.

It is generally recognized that certain non-Governmental bodies which derive the main part of their finances should yet, in the public interest, be allowed to retain the maximum degree of independence. Chancellors of the Exchequer and the Treasury itself, no less than the University Grants Committee, have repeatedly emphasized the desirability of preserving the autonomy of the Universities. Nevertheless, the Committee of Public Accounts for 1948–49 expressed the wish to see more effective means of securing adequate Parliamentary control over this large expenditure of public money. Particularly in view of the steep increase in this expenditure in post-war years, it pressed the Treasury to consider whether, without impairing the independence of the universities, any further means could be adopted of informing Parliament more precisely how the grant in aid proposed in the estimate is to be spent and assuring Parliament that grants to the universities are wisely used. The Treasury agreed with this view, and, in a subsequent report from the Committee for the session 1950, it was stated that before arrangements were settled for the next quinquennium, the Treasury would make a very close review in conjunction with the University Grants Committee of what had been achieved. Eventually the Committee of Public Accounts for the session 1950–51 recommended that the books and accounts of bodies which receive the greater part of their income from public funds should normally be open to inspection by the Comptroller and Auditor-General, and this recommendation was welcomed by the Treasury in a Minute dated November 29, 1951.

For reasons which are well explained by Dr. Basil Chubb in his recent book "The Control of Public Expenditure"*, this was as far as the Committee of Public Accounts could pursue the matter. The Select Committee on Estimates, however, is not limited to the examination of the estimates or accounts but is able to pass in review the organization concerned. Its Fifth Report for the session 1951–52† records an examination not so much of university finance as of the functioning of the University Grants Committee and the control it exercises over the expenditure of Treasury grants. The inquiry has been prompted by the considerations already indicated, and it can be said that the University Grants Committee emerges with credit from the scrutiny and that its continued existence is regarded as providing the best solution to the problem of maintaining control.

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* The Control of Public Expenditure. Financial Committees of the House of Commons. By Basil Chubb. Pp. viii+291. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 25s. net.

† Fifth Report from the Select Committee on Estimates, Session 1951–52: The Grant in aid of Universities and Colleges. Pp. 70 (London: H.M.S.O., 1952.) 4s. net.

As this report shows, Treasury grants have now risen from about one-third of university income before the War to two-thirds, and it will be recalled that in a "Note on University Policy and Finance in the Decennium 1947–56" issued in August 1946, the Committee of Vice-Chancellors and Principals concluded that during this decade the pre-war combined annual revenue of the universities would need to be multiplied threefold, and that of this total revenue about three-quarters would have to come from Government sources by way of the University Grants Committee. No fears appear then to have been entertained on the side of the Universities that, with the device of the University Grants Committee, such increased financial reliance on the State need impair their academic independence. On the contrary, this Note stated explicitly: "The Universities entirely accept the view that the Government has not only the right but the duty to satisfy itself that every field of study which in the national interest ought to be cultivated in Great Britain is in fact being adequately cultivated in the University system and that the resources which are placed at the disposal of the Universities are being used with full regard both to efficiency and to economy".

There has in the meantime been no indication of dissent from the view then expressed by the vice-chancellors that the universities may properly be expected not only individually to make proper use of the resources entrusted to them, but also collectively to devise and execute policies calculated to serve the national interest. Both individually and collectively they appear so far to have welcomed an increasing measure of guidance from Government. The main question is as to the form in which that guidance and supervision should be exercised; this question is at the root of the report from the Select Committee on Estimates. Its examination of the functioning of the University Grants Committee is, moreover, of wider interest at the present time, first because of the way in which certain matters such as the expansion of higher technological education affect other bodies besides the universities, with which the University Grants Committee have not even advisory relations, and secondly because of a disposition to suggest the application of a like device in other fields in which State assistance is given.

The University Grants Committee was appointed in 1919: "To inquire into the financial needs of University Education in the United Kingdom, and to advise the Government as to the application of any grants that may be made by Parliament towards meeting them". Although the Committee was merely expected to advise the Treasury on the application of public money granted to the universities of Britain, in practice it has since become also an executive body. The Treasury has left it to th Committee to allocate the money among the universities and to do all the office work in connexion wit this allocation and with the extensive building programme which has proceeded since 1947. Thi position was officially recognized by the Governmen in July 1946, when the terms of reference of th Committee were revised to correspond with th responsibilities which the Committee was actuall discharging. A secondary effect was a substanti reduction of the average age of the members of th Committee by the inclusion of people still engaged i academic work; the Committee now consists of sixtee members, assisted by a staff of twenty-four, an various specialist sub-committees.

Except in one respect, the Select Committee o Estimates makes no criticism of the personnel aspec of the University Grants Committee. Nowhere i this report does it suggest, as was argued in a recen debate in the House of Lords, that the Committee o its staff is obviously overburdened. On the contrary the Estimates Committee was much impressed b the University Grants Committee's close contact wit the universities, the apparent mutual confidenc which exists, largely as a result of the smooth interchange of ideas between the universities and th Committee by frequent informal contact, and th wide understanding of the subject which that Committee displayed. Witnesses were unanimous in thei assurances that consultations always ended in agreement, and that there was no question of the Committe forcing ideas upon unwilling universities.

The Estimates Committee recognizes in this repor the practical efficacy of these frequent and informa meetings which form the basis of the work of th University Grants Committee; but it also gained th impression that much could also depend upon particular personalities, and especially the chairman an the secretary. It comments pointedly on the nee for ensuring continuity in the senior full-time post and particularly on the apparent absence of a arrangement for succession to the post of secretary although the grade of the secretaryship has bee purposely raised to compensate for the absence of full-time deputy chairman. That consideration shoul be given to ensuring continuity in these senior full time posts is one of the five definite recommendations.

It is in the interests of the Chancellor of th Exchequer, the Treasury and the University Grant Committee, on one side, and of the universities, on th other (especially in view of their increased dependenc on public money and the absence of direct Parliamentary control over its expenditure), that eac university should recognize its responsibility to ensur that its affairs are managed with due economy an in the best interests of the nation; and given thi no serious conflict should arise between the tw sides because of the general desire to maintai the independence of the universities and the nee for the exercise of proper financial control bot by the University Grants Committee and b Parliament. That Committee exercises its control i three main ways: through supervision of quin quennial staff requirements, through the receipt of annual returns of staff, students and expenditure, and through the continuous process of unofficial audit by personal contact with the heads and various governing bodies. The last is regarded as the most effective and is manifestly the reason why the Estimates Committee considers the continued existence of the University Grants Committee as providing the best solution to the problem of maintaining control.

The effectiveness of the University Grants Committee lies largely in the fact that the universities are probably best understood by a body consisting mainly of university professors and persons eminent in the academic world acting on behalf of the Treasury. Such a Committee is in a position to suggest the most effective means of meeting new requirements, even if the need for central co-ordination may tend to diminish during a period of consolidation. The confidence entertained in such a body by the universities may be as important a factor as its financial influence in initiating changes and securing new developments; and no factor requires closer consideration than this by those who are considering the adoption of a similar device in other fields of public policy. For here, confidence is based on mutual understanding. Above all, the universities can express their requirements and views to the Committee without the time-consuming necessity of detailed explanations as is often the case where a finance committee is not *au fait* with the problems involved.

Nevertheless, the Estimates Committee does not suggest that the position be left entirely as it is. It recommends the insertion in the Estimates each year of a note reconciling the amount of quinquennial grant proposed for the academic year with the total figure of recurrent grant shown in the Estimates for the financial year. Further, the fullest possible information should be supplied to Parliament, preferably in the estimates, whenever changes in the amount of recurrent grants are made, either as a result of the quinquennial review or at other times, showing the reasons for any change and the basis on which it is calculated. It also recommends that the practice, by which the books and accounts of bodies which receive the greater part of their income from public funds are normally open to inspection by the Comptroller and Auditor-General, should be extended to cover all money advanced by way of non-recurrent grants to the universities for capital development.

The Estimates Committee does not consider that the extension of this practice would in any way encroach on the freedom of the universities, and it will be clear that, having regard to the obligation of the universities to accept the lowest tender, the existing arrangements offer strong safeguards against extravagance already. What seems to be required is not so much closer control as fuller explanation and interpretation of their plans to the ordinary citizen, whether members of Parliament or not, so that the bearing of those plans on the national welfare and particularly the implication of the demands made on the national economy can be clearly understood. This is essential in such matters as the expansion of higher technological education, the organization of scientific and technical research and the problem of earmarked grants for recurrent expenditure. On this last point, the system is regarded, and not only in academic circles, as a serious encroachment on academic freedom. It is strongly disliked in the universities, and in its last report the University Grants Committee, while recognizing that the device was a necessary condition of securing that the developments judged to be desirable in the national interest are rapidly effected, was opposed to its permanent adoption when a satisfactory level of development had been reached in any of the special fields. With this view the Estimates Committee appears to agree in essence. It suggests, however, that when an earmarked grant is discontinued in favour of provision for the recurrent expenditure in the block grant, close scrutiny of the amount involved is desirable and not a mere addition to block grant of the amount of the former earmarked grant. There are occasions, it suggests, when the universities themselves are not in a position to be the best judges of what studies most need to be developed in the national interest. When some important new development needs to be promoted, and the expenditure on this can be isolated from other expenditure, an earmarked grant may afford the best means for keeping Parliament in close touch with the progress of the development.

Concern has been expressed elsewhere that the development of economic and social research in some universities might be impeded if the newer social science departments had to compete for their share of a block grant with the established departments in natural science, for example, instead of continuing to receive the earmarked grant. To that extent, support can be found for the view of the Estimates Committee. In general, however, this report affords no real evidence that the same result in regard to new developments could not be achieved by voluntary agreement or arrangement with the universities. On all that is said in this report it is difficult to imagine the universities refusing to accede to the expressed wishes of the University Grants Committee when based on reasoned argument and in the context of the mutual confidence and continuous informal exchange of views to which this report testifies.

The University Grants Committee thus emerges well from this scrutiny of the Select Committee on Estimates, as indeed it had earlier from that of the Committee of Public Accounts. There is no reason for supposing that the University Grants Committee will fail to take note of the broad hints given in this report as to the desirability of giving both Parliament and the public such further information as will assist in the formation of an intelligent appreciation of what the universities are doing, and a sound public judgment as to the place of the universities in the community and the return that is received from the expenditure of these large sums of public money. The report should dispose, too, of any suggestion that the Committee is over-burdened, or that it could not undertake fresh responsibilities, like that for the supervision of higher technological education.

MORAL PHILOSOPHY AND SOCIAL ANTHROPOLOGY

Experiments in Living

A Study of the Nature and Foundation of Ethics or Morals in the Light of Recent Work in Social Anthropology. By Prof. A. Macbeath. (The Gifford Lectures for 1948–1949 delivered in the University of St. Andrews.) Pp. xii+462. (London: Macmillan and Co., Ltd., 1952.) 30s. net.

PROF. A. MACBEATH has observed that most moralists and writers on ethics "simply ignore the moral judgments of other times and places, and the problems which the differences between the moral judgments of different peoples present for their theories", and realized that our own moral judgments as well as those of other peoples are the result of social conditioning. He is satisfied that there are no fundamental and innate differences between the primitive and the civilized mind, and he sets out to break down the 'iron curtain' between moral philosophy and social anthropology by studying the former in the light shed by the latter.

This purpose is a wholly admirable one, but unfortunately he starts by misstating his premises. He says: "The ways of life of different peoples I regard as experiments at giving concrete embodiment to the formal moral ideal. Each of them is the result of a co-operative effort to work out a way of living which will satisfy the main needs of man". He later qualifies this by saying that the experiments are largely blind; but it is a complete fallacy to suggest that they are experiments at all.

Consider our own code of morals. It is, of course, derived largely from what is known as Christian ethic; but that ethic contains many discrepancies. Let me give an example. In the Ancient East, in accordance with a system which has survived until recent times in Japan, Nepal and Fiji, the kingship was divided into two. There was the war king, whose duty it was to fight against demons, and their human representatives the foreigners, criminals and disturbers of the rites; and above him was the law king, who secured the prosperity of his people by the orderly performance of the rites, and who, since he stood for life, must not come into contact with death in any form. This dualism was taken over by Christianity, and as a result the Christian Church can embrace the soldier, the butcher and the hangman as well as those to whom these trades are abominable. There is a similar discrepancy, also due to ancient religious practices, between the ideals of chastity and of family life. We also have moral notions derived from other sources—the ideals of chivalry acquired by the Crusaders, Greek philosophy as interpreted by the schoolmen, and the Protestant speculations of the Geneva school. All these were foreign, and it was not until the end of the sixteenth century that Englishmen such as Bacon and Hooker began to have ideas of their own on the subject of morals. In spite, however, of more than three centuries of philosophy, there is very little in the moral code of Great Britain that can be supposed to have originated in this country or to have any special reference to the needs and desires of its people. When, therefore, the author quotes with approval the saying of Ross that our rules of conduct "embody the accumulated wisdom of our ancestors", he is propagating a fallacy.

The same applies to the so-called 'primitive' peoples. We know that they have not always lived in a state of isolation, but are where they are as the result of migrations, some of them quite recent. We know that they have all been in contact from time to time with higher cultures, and that there are few primitive areas in which archæologists do not dig up relics of cultures different from, and more advanced than, those now in being. It is true that primitive cultures are functioning wholes, but that is not because they are the result of successful experiments; it is because the odd pieces from various sources of which they are composed have been rubbed or worn down until they fit in together.

Prof. Macbeath supposes that the Australian Blacks have derived their totemic beliefs from their own experience. He might as well suppose that the peasants of Europe have derived their beliefs in the Lamb of God and the Holy Dove from their own experience. These beliefs are, of course, neither totemic nor primitive; but there can be little doubt that they as well as totemism spring from a system of animal symbolism which originated in Asia.

After ably summarizing accounts of the cultures of various primitive peoples, Prof. Macbeath discusses the alleged innate mental inferiority of primitives, and has no difficulty in showing that there is no evidence for such inferiority. In doing so, however, he and his authorities have missed the most important point. He quotes Prof. Lowie as saying that the Crow Indians are not given to systematic thinking. Of course they are not, for systematic thinking is possible only to people who can put their ideas into writing and then arrange them. Illiterates are mentally inferior simply because they are illiterate. It has been held against the African Negroes that they never produced a scientist; but what kind of a scientist would he be who had no weights and measures, no clock or calendar, and no means of recording his observations and experiments? And if it be asked why the Negroes did not invent these things, the answer is that neither did any European people, and for the same reason—namely, that the rare and perhaps unique conditions which made their invention possible were absent. Many learned men seem to fail to realize that if they had not been taught to read and write they would be at best rule-of-thumb craftsmen, the highest skill to which an illiterate can attain.

Prof. Macbeath then sets out to establish "that primitive morality is independent of religion in the sense that the moral ideals of primitive peoples do not derive their goodness, or their moral rules their rightness, from a religious source". Malinowski held that all morality is religious, and the author shows that Malinowski was wrong; but to jump, as Prof. Macbeath does, from the fact that some morality *is* secular to the conclusion that all morality *was* secular is quite illegitimate. He says that "there is a tendency for morality to acquire a religious sanction". This, namely that the secular readily becomes the sacred, is an assumption constantly made by theorists, but nobody has produced a scrap of evidence that it has ever happened; everything that is sacred now was sacred when first heard of. Let us take the example of dancing; if anyone were to maintain that all dancing is religious, it would be easy to show that he was wrong. But there is no doubt that much dancing is religious; and while there is no reason to believe that a secular dance has ever become sacred, there is good reason to believe that all dancing was originally religious. It is easy enough to forget the original purpose of a dance, especially if it has never been written down, and just as easy to forget the origin of a moral rule, especially if it seems natural and obvious, as most of the allegedly secular rules do.

One could go on to show that the differences between civilized and primitive morals are not so great as Prof. Macbeath supposes, and that therefore his refutation of the intuitionist theory neither requires nor receives much support from anthropological data; but it is time to bring this review to a close by expressing regret that so able, accurate and lucid a writer has so often been led astray by those who, whatever their scientific reputation, are careful describers rather than logical thinkers.

RAGLAN

SMITHSONIAN METEOROLOGICAL TABLES

Smithsonian Meteorological Tables

Sixth revised edition, prepared by Robert J. List. (Smithsonian Miscellaneous Collections, Vol. 114: Publication 4014.) Pp. xi+527. (Washington, D.C.: Smithsonian Institution, 1951.) n.p.

THE sixth edition of the "Smithsonian Meteorological Tables" reflects the improvements in meteorological practice and the increase in accuracy of measurement of physical constants which have taken place since the publication of the fifth edition in 1931. The new edition contains 174 tables and an index in 527 pages, against 115 tables and index in the 282 pages in the fourth edition. The increase in the number of physical tables is actually greater than 59, because the tables of international codes and symbols used in transmitting and plotting meteorological observations and the list of observing stations have very reasonably been omitted from the new edition.

Since 1931 the advantages of representing the dynamic state of the upper atmosphere by plotting temperatures and heights for fixed pressures rather than the fields of temperature and pressure at fixed heights have been universally recognized, and tables for the construction and use of charts for fixed pressures appear in the new edition. The mass of water vapour in a kilogram of dry air, the humidity mixing ratio, has become for good reasons a much-used measure of atmospheric humidity, and a table, the first to be printed at sufficiently close intervals of pressure and temperature, is given for obtaining it. This table would perhaps have been more useful for British and American meteorologists if the temperature argument had been in Fahrenheit degrees instead of centigrade. Geopotential metres, in accordance with a resolution of the 1947 International Meteorological Organization Conference, replace geodynamic metres. Very detailed information, including a density altitude nomogram and tables of altimeter correction factors, are given for the American (N.A.C.A.) standard atmosphere; this is a little different from the standard used in Europe. It is, however, impossible to enumerate here more than a fraction of the new tables.

An improvement in arrangement is the placing of the explanation of each table immediately before it, instead of placing all the explanations at the beginning of the book. The new arrangement probably requires more space but will save much turning of pages. The explanations and references to sources are fuller and more critical than before. The compilers have decided, for reasons fully stated, to adhere to 980·665 cm. sec.$^{-2}$, adopted in 1892 by the International Commission for Weights and Measures, for the value of g at sea-level at latitude 45° in connecting the absolute unit of pressure with the length of the mercury column and not the more recently determined value 980·62. They naturally use the United States nautical mile, which is 0·2 ft. longer than the British one, with repercussions on the relation of the knot to other measures of velocity. The index is very full; an error noted in it is that the density of mercury is given for p. 3 instead of p. 4.

Meteorologists all over the world will be grateful to the Smithsonian Institution and the United States Weather Bureau, whose staff did most of the work, for producing this new edition of an indispensable work of reference.

G. A. BULL

HYDROGENATION OF OILS AND FATS

Hydrogenation of Fatty Oils

By Prof. H. I. Waterman, with the collaboration of C. Boelhouwer and L. J. Revallier. Pp. ix+254. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1951.) 42s.

THIS book, as the author states in his preface, is a review of developments in fatty oil hydrogenation in the light of investigations undertaken during recent years by the author and his collaborators at the Delft Technical University. Prof. H. I. Waterman has produced a stimulating book, which has been translated by Dr. S. Coffey in a competent manner.

As a whole, the book is concise and the subdivisions of chapters is clear and systematic. The appropriate references are conveniently placed at the bottom of the relevant page, and attention is directed to standard treatises; there is a bibliography at the end of the book, together with author and subject indexes. It is not intended to be a complete survey of the subject, and it may seem unbalanced to some readers. This is perhaps understandable, since Prof. Waterman is mainly concerned to show the contribution of himself and his collaborators. Most of the criticisms which may be made against it are on emphasis rather than of substance. Certain sections are treated as an elementary introduction to the fatty oils industry, while in other sections the author would seem to require the reader to have prior knowledge of the subject.

The first part of the book, four chapters comprising a hundred and thirty pages, is a general description of processes utilized in the winning and refining, possibly with a bias towards Dutch practice, of fats, and of the analytical methods used in their technical and fundamental characterization. The section on methods of examination could have been improved by differentiating, on one hand, between those techniques which have become generally accepted by all the leading authorities and, on the other, those not universally favoured.

The remainder of the book is a study of the hydrogenation process. Certain aspects are well done. There is a detailed treatment, in relation to the researches of the Delft school, of the mechanism of hydrogenation, and a critical survey is made of the important subject of selectivity. Adequate attention has been given to methods of representation of the course of hydrogenation of mixed glycerides.

Many readers may be disappointed to find that the technology of fat-hardening is dealt with in seventeen pages and the production of hydrogen, one of the essentials in the process, is inadequately covered in a book with such a title; and no assessment of the principal industrial methods has been attempted.

Despite its limitations there is much to be learnt from this book. The hundred and twenty pages on hydrogenation contain a valuable original approach to the fundamental chemistry of the hydrogenation of oils and fats, and for this reason Prof. Waterman's book will be of interest to advanced students and to chemists and technologists in the fatty oils industries.

H. Jasperson

MINERAL NUTRITION OF PLANTS

Mineral Nutrition of Plants

Edited by Emil Truog. (Published in celebration of the Hundredth Anniversary of the Founding of the University of Wisconsin.) Pp. xiii+469. (Madison: University of Wisconsin Press, 1951.) 6 dollars.

This volume, published under the nominal editorship of Prof. E. Truog, comprises eighteen contributions by different authors, based on papers communicated at a symposium held in the University of Wisconsin. The main object of the symposium was to provide an opportunity for the exposition of the latest views on mineral nutrition, for the mutual benefit of those concerned in the investigation of particular aspects, and for the guidance of those engaged in the practical cultivation of plants, in fertilizer manufacture and in food industries.

Since potential purchasers of a specialist treatise of this type are to some extent influenced by the reputation of the contributors, it is appropriate that these should be indicated in this notice. They are C. E. Kellogg and A. C. Orvedal, E. Truog, C. E. Marshall, R. Overstreet and L. A. Dean, H. Jenny, J. B. Page and G. B. Bodman, A. G. Norman, T. C. Broyer, H. Burström, O. Biddulph, D. Boynton, J. B. Hester, D. I. Arnon, W. F. Loehwing, R. A. Steinberg, R. B. Withrow, C. H. Wadleigh and L. A. Richards, and H. F. Clements. It is at once clear that there assembled at Madison as distinguished a group of mineral nutrition specialists as is likely ever to be gathered together in one place.

The articles are arranged in logical sequence, starting with the soil and the availability of nutrients therein, then passing to the mechanism of entry of mineral nutrients into and their translocation within the plant, leading to the role of minerals and to the disturbances in metabolism resulting from mineral deficiencies. The introductory article, by Kellogg and Orvedal, presents the thesis that, given the proper application of existing knowledge of soil science and the intensification of research where necessary, the extent to which the food-producing capacity of the world can be increased is practically unlimited. Articles of a specialist nature follow, including a particularly lucid discussion by Burström of the mechanism of ion absorption, and a clear exposition by Jenny of the contact theory of mineral uptake. Papers of an applied nature are provided by Boynton and Hester, relating respectively to the cultivation of the apple and of the tomato and other vegetables used in the canning and soup-manufacturing industries. The second of these is of particular interest, not only on account of the array of statistics, such as that the United States tomato crop takes eighteen tons of zinc from the soil annually, but also because of the instance which it provides of the rapid and successful application of academic research results to the commercial cultivation of crops.

There is inevitably a risk of repetition in a composite volume of this type, and in fact the Lundegårdh theory of active ion absorption receives the consideration of three different authors. A good deal of what is contained in the book was already in print elsewhere, adequate references being in most cases provided; but it is undoubtedly advantageous to have all this information, relating as it does to intimately connected but, for administrative reasons, often quite separately pursued fields of inquiry, assembled together within one cover—for the first time, so far as I am aware.

The book will make a very useful addition to the libraries of those concerned with soil science, plant nutrition and cell physiology. This felicitous arrangement whereby the University of Wisconsin marks its own centenary by an act of signal assistance to those engaged in the study of the plant in relation to the soil is in keeping with the well-established traditions of the University.

G. Bond

PSYCHICAL RESEARCH DISSECTED

The Psychology of the Occult

By D. H. Rawcliffe. Pp. iv+551+11 plates. (London: Derricke Ridgway Publishing Co., Ltd., 1952.) 21s. net.

This stimulating and highly provocative book is an attempt to describe and analyse the part "played by various types of psychological anomaly in the creation and perpetuation of occult beliefs and practices". The author has cast his net wide and deals briefly with a large number of subjects ranging from lycanthropy to *PK* (psychokinesis). Following in the tradition of the late Ivor Tuckett (1911), the authors of the famous "Dreimännerbuch" (1925), and more recently Joseph Rinn and Johann Kruse, Mr. Rawcliffe is completely unmoved by the flood of modern propaganda in favour of the reality of so-called psychic phenomena. Even the evidence for mental phenomena such as telepathy and clairvoyance leaves him cold. "There is not even a *prima facie* case," he writes (p. 21), "for the existence of 'psi-phenomena', judged from the scientific standpoint." As for the physical phenomena of the séance room, Mr. Rawcliffe finds the evidence scarcely worth considering. To him the whole of the studies of the psychical research worker are mere examples of magic and superstition dressed up in modern garb and often presented behind a façade of statistical jargon which is intended to disguise the faulty character of the original data.

In support of his position he has skilfully put together a mass of material in which the incompetence and credulity of not a few workers in this field are cruelly displayed. Yet he has omitted much that would have strengthened his case and, it must be added, a good deal that would have weakened it. It is clear that he is of the opinion that an explanation of all parapsychological phenomena is to be sought in facts already known, and that there is no need whatever to invoke anything "psychic", which, in is opinion, implies a return to the mystical, the cult and the supernatural.

In favour of this thesis Mr. Rawcliffe has been at ains to examine a good deal of the literature and as selected a number of instances which illustrate is point of view. Indeed, in one or two cases he is e first to attempt what he calls a "rational" xplanation. Thus he considers endophasic enneurosis nconscious whispering) to be the chief explanation f the majority of the experiments in extra-sensory erception, citing in support of his theory the work f Lehmann and Hansen (1895) and the more recent onclusions in the well-known case of the Latvian easant girl, Ilga Kirps.

It is when Mr. Rawcliffe attempts to deal with the etter class of experiments that his explanations egin to appear somewhat unconvincing. Thus his efutation of the validity of the conclusions drawn y Dr. Soal for some of his work will, I think, scarcely ear expert examination, and his omission of any iscussion of the phenomena of such mediums as). D. Home, Mlle. Tomczyk or Mrs. Piper suggests a ias which is to be regretted.

In spite of its deficiencies, however, this book emains a useful handbook for those who suspect hat much of what passes for psychical research and hich is often unfortunately supported by leading arapsychologists is scarcely worth the paper on hich it is recorded. The book has a useful glossary f technical terms and a selected list of authorities; ut the text contains more than the usual number f printers' errors.

E. J. DINGWALL

BIOLOGY OF HUMAN STARVATION

he Biology of Human Starvation

y Ancel Keys, Josef Brožek, Austin Henschel, Olaf ickelsen, Henry Longstreet Taylor. Vol. 1. Pp. xxii+764. Vol. 2. Pp. viii+765–1386. (Minneaolis: University of Minnesota Press; London: xford University Press, 1950.)

THE physiological effects of a shortage of food occupied the attention of many people during he Second World War, and plans were laid by arious committees in Great Britain to study them nmediately hostilities ceased. In the United States n 1944 Prof. Ancel Keys and his four colleagues ecided to put the matter to the test of experiment. hey received little encouragement from official ources; but, with the financial aid of various eligious and commercial bodies, they launched their reat 'Minnesota Experiment'. Sir Jack Drummond, ho visited Prof. Keys and saw the experiment in rogress, writes that he had rarely come into touch ith an investigation "so meticulously planned and o enthusiastically carried through".

The subjects were young men who had registered s conscientious objectors and who were serving in arious Civilian Public Service Camps. More than a undred volunteered for the experiment; thirty-six ere selected and, of these, thirty-two stayed the ourse. After a control period of twelve weeks, uring which time the men ate an adequate diet and ere subjected to a battery of tests, the period of emi-starvation started. Two meals a day were erved, consisting largely of whole wheat bread, otatoes, cereals, turnips and cabbage. These foods rovided each man with an average of 1,570 calories a day. The semi-starvation period lasted for twenty-four weeks, and by the end of this time the subjects had lost about 25 per cent of their body weights. The photographs at the end of Vol. 2 provide convincing evidence of this. Then followed the twelve weeks of rehabilitation. For this, the men were divided into four groups of eight, each group receiving a different number of calories, varying from 1,930 to 2,940 a day. These calorie groups were further sub-divided so that some of the men in each received supplements of protein or of vitamins. It was soon realized that the allowances of food during this period were too small and they were increased; but it seems likely that, even so, they were not large enough. In any event, when twelve of the men were given the opportunity to eat as much food as they wanted after the official period of rehabilitation had ended, they managed to consume enough food to provide them with 7,000–10,000 calories a day. The whole experiment ended in December 1945.

The investigators had by this time amassed a vast amount of information about the reactions of the bodies and minds of their subjects to a shortage of food, and they were faced with the problem of putting it all together. They decided to make as complete a job of it as they could, and to try to give a comprehensive survey of world knowledge of human starvation in addition to presenting their own findings. The results of their labours are contained in the two large volumes, running to nearly fourteen hundred pages, at present under review. The work of putting all this literature together demands fully as much admiration as the carrying out of the experiment. The morphological, biochemical and physiological effects of starvation are dealt with in the first volume, and the psychological problems are considered in the second, along with special problems such as the relationship of undernutrition to diabetes, neoplastic disease, and to infectious diseases, particularly tuberculosis.

The various results of the Minnesota Experiment take their place among the findings of all the other authors to whose work reference is made. This makes it difficult to visualize the results of the Minnesota Experiment as a whole; but, on the other hand, it is of great value to compare results obtained under experimental conditions with observations made 'in the field' on undernourished populations. The kinds of foods which the subjects ate during the period of semi-starvation were those which the populations of France, Belgium and Holland were forced to live on during the War, and they were the foods which were most readily available in Germany during the period of greatest food shortage in 1946. Prof. Keys and his colleagues conclude that the changes they observed were due first and foremost to a deficiency of calories and not to any specific protein or vitamin deficiencies. This was exactly in accord with the conclusion of workers who had the opportunity of observing the undernourished peoples of Western Europe.

The second volume closes with a list of three thousand references which, the authors write in the introduction, they have consulted in the original. Even if all the authors shared equally in this task, it means that each of them must have read and abstracted at least six hundred papers. Little wonder that they acknowledge "the forbearance of their wives throughout the years of dedication of time and effort to the present work".

E. M. WIDDOWSON

Steroid Hormones and Tumors

Tumorigenic and Antitumorigenic Actions of Steroid Hormones and the Steroid Homeostasis ; Experimental Aspects. By Dr. Alexander Lipschutz. Pp. xi+309. (Baltimore, Md. : Williams and Wilkins Company ; London : Baillière, Tindall and Cox, 1950.) 46*s*. 6*d*. net.

PROLONGED or excessive dosage with œstrogen may lead, in either sex, to hyperplasia or metaplasia of certain tissues. This effect, like other effects of œstrogens, can usually be prevented by the simultaneous administration of progesterone or androgens. Allowing for the large number of gonadally active steroids now available, and for the possibility that certain of the growths induced by œstrogens may ultimately become neoplastic, it will be seen that there is here a prolific field of research.

Among those who have worked in this field, Lipschutz and his colleagues occupy a very prominent place, and their extensive and systematic contributions are summarised in the book under review, especially on experimentally induced fibromata. Lipschutz's thesis is briefly as follows. Production of abnormal growth by œstrogens requires that the stimulus shall be not only prolonged but also continuous. Such continuous œstrogenization can easily be effected experimentally, but in the normal animal is usually prevented by homeostatic mechanisms, notably by the capacity of the liver to inactivate œstrogens. Before any of the œstrogen-induced tumours can be regarded as neoplastic, they must be shown to be autonomous, irreversible and independent of the original stimulus. Unless and until that point is reached, the growth can be inhibited by the simultaneous administration of other steroids which antagonize œstrogens. Lipschutz also directs attention to the fact that to a lesser extent the same thesis applies to androgens. The book ends with a useful discussion of the causes and effects of endogenous hormone imbalance.

Prof. Lipschutz is to be congratulated on having written an informative and stimulating book which will be most useful to those who wish to get a sound grasp of this complicated subject. A. S. Parkes

Physical Chemistry for Schools and Colleges

By H. L. Heys. New edition revised. Pp. 453. (London : George G. Harrap and Co., Ltd., 1952.) 9*s*. 6*d*.

MR. H. L. HEYS'S gift of clear exposition and his avoidance of advanced mathematics have long made this book popular with teachers and particularly suited to the average pupil taking the former Higher School Certificate or equivalent examinations.

To the difficult task of bringing the text into line with such of the present-day theories as can be presented at school-level, and at the same time retaining the simplicity of treatment, Mr. Heys brings a commendable courage and a sound critical judgment. Thus he introduces and justifies the Brönsted–Lowry conception of acids and attempts to apply it ; but he avoids the theory of Lewis. Again, besides discussing the covalent and co-ordinate bonds, he repeatedly shows their relation to chemical behaviour. Besides adding a new chapter in which he has grouped some related phenomena under the heading of "Electrochemical Series", Mr. Heys has extended almost every section, as well as bringing in additional topics such as chromatography, the structure of metals and over-voltage. As a consequence, the size of the book has been increased by 117 pages. The revision has been thoroughly well done, and the book can be strongly recommended.

Les biocatalyseurs

Par Prof. Max-Fernand Jayle. Tome 1 : Enzymes substrats, vitamines et hormones. Pp. 260. (Lons le-Saunier : Impr. M. Declume, 1951.) 950 francs.

THIS is, in fact, the first volume of a treatise on biochemistry, and deals with the biochemical reactions of living organisms and the agents which assist them. (A second volume is announced which deals with clinical biochemistry, especially of blood and urine.) This book can be described as an excellent elementary account which medical students and students of biochemistry and physiology could read with profit. It is up to date in many directions, for example, in giving what is known about the structure of insulin. Some 'anti-vitamins' are mentioned ; but no account is offered of natural antibiotics—possibly because their mode of action is still obscure. The book suffers greatly from a complete absence of references. Many names are mentioned, but nothing to indicate where the student could look for further information.

Atlas of Human Anatomy

By Franz Frohse, Max Brödel and Leon Schlossberg. Explanatory Text by Dr. Jesse Feiring Williams. New edition. Pp. 88. (London : George Allen and Unwin, Ltd., 1952.) 16*s*. net.

THIS new revised edition of the "Atlas of Human Anatomy" reproduces, in pocket size, the Frohse–Brödel wall charts and the Leon Schlossberg's supplementary charts. In addition, there is a short explanatory text by J. F. Williams.

Most of the illustrations are reproduced in colour ; but, in many instances, they have been reduced too much to be of any real value. One or two of the new illustrations, for example, those on pp. 63 and 66, are made very much too large for the details they show. A number of the illustrations, such as the upper figure on p. 55, are confusing. No explanation is given of what structures have been removed.

The text in many places is very vague and often inaccurate ; for example, on p. 20 the following statement is made : "The left ventricle pumps blood *over* the entire body (page 41) except the lungs which are supplied by the action of the right ventricle". Many statements are made which are much too generalized, even for a book of this description.

W. J. Hamilton

The Chemical Technology of Dyeing and Printing

Vol. 2 : Substantive, Basic, Acid and Pigment Colors, Aniline Black, and Dyestuffs for Acetate Rayon and Synthetic Fibers. By Dr. Louis Diserens. Translated and revised from the second German edition by Paul Wengraf and Herman P. Baumann. Pp. xii+446. (New York : Reinhold Publishing Corporation ; London : Chapman and Hall, Ltd., 1951.) 96*s*. net.

THIS is by no means a 'readable' book, though it may be of value to the practical man as a collection of recipes and instructions which appear to be authentic and are certainly specific in detail. The price alone seems likely to limit its sale to those who will find it of practical value in their everyday work. S. M. Neale

NATIONAL PHYSICAL LABORATORY, TEDDINGTON

OPEN DAY

AFTER the extended series of Open Days held at the National Physical Laboratory last year in celebration of the Laboratory's jubilee, the corresponding function this year was confined to a single day, May 23, which was also made the occasion of the annual visitation and meeting of the General Board. In a day of ideal summer weather, nearly one thousand visitors were entertained at the Laboratory. The number of items of research on show was much less than was exhibited last year; but more than one-quarter was concerned with new work.

In the Light Division, a demonstration was given of a development which has recently created considerable interest, namely, transparent electrically conducting films on glass. As a result of methods developed at the Laboratory, it is possible to deposit on glass exceedingly fine films of gold, of the order of a quarter of a millionth of an inch thick, which have an electrical resistance as low as 10 ohms between the opposite sides of a square sample, and an optical transmission as high as about 80 per cent. These results are closely reproducible, so that, although these effects have so far been produced only on small areas of glass, the extension of the idea for the purpose of de-icing aircraft windows and like applications appears to be possible. Also in this Division, further exhibits were shown of recent developments in the manufacture of diffraction gratings by the Merton–N.P.L. process. Gratings so far produced with five thousand lines to the inch are finding a ready application in the field of infrared spectroscopy, where they are replacing costly prisms of such materials as lithium and calcium fluoride in the work of exploring molecular structure.

Several demonstrations were given by the Aerodynamics Division which are of particular importance in the subject of high-speed flight. One of the problems being investigated concerns the effect which may be produced when the boundary layer on a wing or other body moving at high speeds meets a shock wave. In these circumstances it may thicken or separate from the surface, and thus the shape and strength of the shock wave may be modified. Interaction problems of this type are important, and it is essential to understand them in order to allow for the scale effects which result from the use of small-scale models in high-speed wind tunnels. Detailed studies of this type of interaction have been in progress at the Laboratory for several years, and recently a small wind tunnel has been built in which the range of Mach and Reynolds number which can be covered is greater than had been possible previously. The Mach number can be varied from 1½ to 4 by changing the shape of the nozzle used to produce the supersonic flow. The stagnation pressure of the air entering the tunnel can be varied between ¼ and 20 atmospheres absolute, thus giving Reynolds numbers from $0 \cdot 5 \times 10^6$ to 20×10^6 on the flat plate. Results obtained so far indicate that changes of the Mach or Reynolds number have a considerable effect on the interaction. Another section of the work concerns research on delta and arrowhead forms of fighter aircraft. An arrowhead wing was shown in the low-turbulence tunnel, where it was forced to oscillate in pitch by applying a reciprocating force through a spring; movements in the wings were recorded photographically. This work is of importance as this particular type of aircraft, especially when travelling at high speeds, is liable to give rise to undamped pitching oscillations, which make the machine unstable and difficult to control.

The Electricity Division had on show a method for the precise measurement of dielectric constants of pure liquids. These measurements are being carried out in the first instance on benzene, which is being regarded as a standard liquid. The measuring cell consists essentially of electrodes in the form of concentric tubes of platinum fitted with a guard ring, which are mounted in a glass container. Benzene, which is supplied in a highly purified form, is distilled direct into the cell after it has undergone treatment to remove traces of dissolved gases and water. The capacitance of the cell is measured when the dielectric medium is first air (or a vacuum) and then benzene, and the ratio of one capacitance to the other gives the dielectric constant of the benzene. The measurements are being made in the first place at 1,000 c./s. and over a temperature range of 5–30° C. The High Voltage Laboratory has continued work on the measurement of surge voltages, and a divider for use in such measurements was shown. These dividers can be constructed from resistors or capacitors or combinations of both; but, whichever is used, the essential requirement is that the wave-shape of rapidly changing phenomena should be faithfully produced at the oscillograph with a reduction ratio which can be accurately determined. The chief source of error for all forms of divider arises from the earth capacitance of the high-voltage arm; but the effects of inductive residuals in the low- and high-voltage arms cannot be neglected for surges occupying a microsecond or so.

The pilot model of the Automatic Computing Engine which was designed and made in the Electronics Section of the National Physical Laboratory has now been transferred to the Mathematics Division, where it is being used for high-speed computational work. Although the pilot model was originally intended merely as the forerunner of the final machine, it has proved to be particularly useful and will continue to be used while an engineered version and also the final machine are being produced.

In the Metallurgy Division a new method was demonstrated for the preparation of small specimens for tensile tests. In the preparation of specimens of the order of 1/16 in. in diameter, the strain produced in the surface layer by machining is important, although for larger specimens it can usually be ignored. The problem of obtaining small specimens by some other method was solved by making the specimen the anode in a rather unusual electrolytic cell. A jet of suitable solution plays on the blank while it is rapidly rotated and at the same time moved to and fro along its axis at a uniform speed. A current passed between the blank as the anode and a cathode in the jet causes the blank to be dissolved away gradually and uniformly until the desired size is reached. If the current density is high enough and the electrolyte suitable, a truly electropolished surface is produced which is free from irregularities under a high-power microscope, as well as being free from strain. Another exhibit shown by the Metallurgy Division concerned the production of titanium. Although titanium is the fourth most abundant metal in the earth's crust and is widely distributed, it is only since the development of the magnesium-reduction process within the past decade that the metal has shown industrial potentialities. Previously it had not been possible to prepare the metal in a sufficiently pure state, and its true properties are shown only when in this condition. Research is being carried out at the Laboratory on new methods of preparation of the metal and on the constitution of titanium–oxygen and titanium–iron–oxygen alloys. In connexion with research on atomic structure, an X-ray spectrometer capable of dealing with large and small specimens has recently been constructed in the Metallurgy Division. In this instrument, the X-ray intensity is recorded by a Geiger–Müller counter which can be positioned to an angular accuracy of ± 17 seconds of arc. The pulses in the counter are amplified and recorded, and in this way quantitative measurements of diffraction maxima can be achieved in a fraction of the time required to expose and process a photographic plate. To eliminate errors due to variation of the X-ray source, a monitor Geiger–Müller tube is used for measuring the beam incident on the specimen. When the monitor tube has received a predetermined number of counts, it automatically stops the diffraction tube, the count of which thus corresponds to a fixed quantity of X-radiation on the specimen. The overall accuracy attainable is about 0·5 per cent.

Demonstrations were given in the Metrology Division of emitters of highly reproducible waves of light which are being used in connexion with the measurement of distances of up to 0·5 m. to an accuracy corresponding to one-millionth of an inch in ten inches. These sources use pure isotopes either of mercury or of krypton, both of which are now obtainable in sufficient quantity. During recent months, four N.P.L. gauges, the largest being 10 cm. long, have been sent to two other standards laboratories in Europe for measurement in terms of these wave-lengths of light. The results obtained at the three laboratories are in very good agreement, all the measured values for each gauge lying within a range of $\pm 1 \times 10^{-6}$ in. Measurements are also continuing with radio waves 12·5 mm. in length for the purpose of being able to measure up to distances of about 1·6 m. by interferometry. The accuracy so far attained is of the order of 0·0001 in., and the technique which has been developed shows considerable promise of extension to distances of 30 m. or more. A re-determination of the density of mercury is to be carried out in connexion with the National Physical Laboratory standard barometer, and in order to do this a 3½-in. cube of sintered tungsten carbide has been prepared in the Metrology Division workshop with a standard of workmanship which is thought to be unsurpassed. The faces of the cube have been lapped to within 10×10^{-6} in. of flatness, and a little short of this in parallelism, while the edges and corners have also been carefully finished. It is hoped that this perfection of geometric form will permit the volume to be determined from interferometric measurements of the linear dimensions. The cube will then be weighed in air and in mercury in which, by virtue of its density, it will just sink. The accuracy which it is hoped to attain corresponds to better than 0·001 mm. of mercury in the measurement of atmospheric pressure and less than 0·0001° C. in the measurement of temperature at the steam point.

In the Physics Division a new method has been devised for measuring the elastic properties of materials over a temperature-range from near the absolute zero to above red heat. In the new equipment the specimen is lightly suspended in the centre of a long tube and either cooled by surrounding it by cold liquids jacketed in a special form of Dewar flask, or else heated by electrical means. The specimen has attached to it long nickel filaments which can be used for setting it into oscillation and also for measuring the oscillations, since nickel has the property of changing magnetic variations into vibrations and vice versa. The precision obtainable is of the order of 0·03 per cent in favourable circumstances, and thus enables a knowledge of the elastic moduli and of the anelastic behaviour to be obtained. This information is of particular value because of the present tendency for materials, such as turbine blades, to be stressed very highly, even at temperatures in excess of 1,000° C. In another part of the Physics Division, a new Smith bridge has been built for the purpose of measuring normal temperatures to an accuracy of ± 0·0001° C.

In the Ship Division, developments have taken place in the technique for cutting propellers. In the latest method thin steel templates are first cut from an enlarged drawing through a pantograph mechanism, a scale ratio of 5 : 1 being employed. Then the templates are clamped around cylindrical formers in such a way that they give a correct skeleton replica of the face or back of the screw. The formers are mounted on a shaft carrying the screw, and this shaft is rotated and advances so that a follower maintains contact with the template while an electrically driven bandcutter traces the correct section on a metal screw blank. On the final version of the machine it is hoped to cut all four blades at once. A new torsionmeter which had been designed and made in the former Engineering Division workshop was also shown. Although the operating principle is similar to that of the commercial type of instrument, the deflexion is transmitted from one end of the gauge length to the other by means of a small tube lying parallel to the shaft instead of by a shell concentric with it. Thus a very considerable reduction in the size and weight of the instrument has been achieved. The instrument is carried on hardened points bearing on the shaft and is clamped to it by chains ; a range of shaft diameters of 14–22 in. can be accommodated. Experiments are being carried out in the water tunnel on the effect on the cavitation characteristics of a ship's screw arising from a non-uniform velocity distribution of the water. Gauzes of varying mesh inserted in the tunnel circuit are used for producing the appropriate variation in velocity.

In the High Temperature Mechanical Properties Section, an investigation is in progress on the variation of fatigue strength over a speed-range of 10–8,000 cycles per minute on a mild steel for temperatures up to 500° C. It has been found particularly important to investigate the effects resulting from the use of the higher frequencies.

Visitors were also able to inspect the various items of routine test work in the Test House and to discuss problems connected with the maintenance of standards of quality.

VIRUS DISEASES OF FRUIT CROPS

By Dr. A. F. POSNETTE and Dr. R. V. HARRIS

East Malling Research Station, Kent

RECENT developments in the study of virus diseases of fruit crops, with special reference to strawberry and tree-fruits, was the subject of a 'Members' Day' at East Malling Research Station on July 2, when about a hundred visitors were present. The bulk of work on raspberry virus diseases, started in 1920, was transferred in 1942 to the intensive raspberry-growing districts of south-eastern Scotland and continued under the auspices of the Agricultural Research Council and the direction of East Malling; the staff of this investigation was transferred to the newly formed Scottish Horticultural Research Institute in April 1951. The considerable progress made during this period of nine years in our knowledge of the many viruses infecting cultivated *Rubus* species and their complex associations is the subject of a series of research reports at present in course of publication. Work on viruses of blackcurrant and the other *Ribes* species begun in the early 'twenties has recently been resumed at East Malling with the identification of three new viruses, two on blackcurrant and one on gooseberry.

Strawberry Virus Diseases

This work started in 1930 with the distinction of two symptom-types in field plantations, yellow-edge and crinkle. In more recent analytical work, for which Dr. I. W. Prentice was chiefly responsible, these diseases were interpreted in terms of combinations of viruses assigned to three principal groups, (1) mild crinkle, (2) yellow-edge and (3) severe crinkle, on the basis of their differential persistence in the insect vector *Pentatrichopus fragaefolii*. With this advance in the knowledge of the causal viruses, the early grouping of strawberry varieties as virus-tolerant or virus-sensitive is now being superseded by a more exact description of the reaction of each variety to the various viruses and their associations; work on this aspect of the problem is at present seeking a virological interpretation of the loosely called 'break-down' of virus tolerance (in its early sense). This degeneration is a common and disturbing phenomenon in plantations of the leading commercial varieties, Huxley's Giant and Auchincruive Climax. Evidence was recently obtained of a degenerative effect on a clonal race of Huxley, infected only with so-called mild-crinkle virus, when it became infected with a further virus in this low-persistence group. Infection of virus-free Climax plants with the viruses of this group 1 complex, together with group 2 viruses, caused some stunting; but evidence has been obtained recently that another distinct virus is responsible for the severe 'break-down' frequently found in plantations.

Two other diseases, which are prevalent in plantations of the recently introduced Auchincruive Climax variety and are complicating the diagnosis and control of the virus diseases noted above, are being studied. 'Green-petal disease', in which flower and fruit abnormalities are associated with a leaf chlorosis, is thought to be of virus origin, and tests of transmission by grafting and insects are being made. Chloroses similar to descriptions of the 'June yellows' disease in North America are also causing disquiet among growers and propagators of planting stock, and two distinct symptom categories have been distinguished: transient chlorosis of the young leaves in the spring, and a chimæral streaking and speckling which persists throughout the season. The latter form, which has also been observed in varieties other than Climax, is commonly associated with a reduction in vigour. Neither of these forms has so far proved to be transmissible by graft. A third disease, 'sudden yellows', which produces symptoms on Royal Sovereign strawberry easily confused with those of severe yellow-edge, has been shown, however, to be non-virological in origin. Its real cause still remains obscure.

The information from this analysis and evaluation of the viruses concerned in the economic diseases, and from the study of their insect-vector relations, provides the basis for the following studies bearing directly on the problem of control: (1) natural virus ingress and spread in the field plantation, and methods for checking it, and (2) the production and maintenance of planting stocks (runners) free from virus diseases. An approach to the former is being made from four directions, namely, a search for alternative vectors, and for alternative virus-hosts, a determination of the seasonal times of spread of each of the virus components, and, with the Entomology Section, a study of the modification of the pattern of virus spread following the control of insect vectors by means of insecticides. The recent discovery of new aphis vectors was reported in *Nature*[1], and two species of *Potentilla* have been shown to be, in one case a potential, and in the other case an actual, alternative host of strawberry viruses. Time of seasonal spread is being studied by the successive exposure for limited periods of *Fragaria vesca* indicator plants in a plantation of commercial varieties where the viruses are known to be present. The effect of control of vectors by insecticides on the pattern of spread of a virus is being determined from data collected from replicated plots planted with virus-free Royal Sovereign and *F. vesca* plants and subject to complete, partial and nil schedules of spraying with a systemic insecticide.

The selection and maintenance of healthy planting stock, the second objective, is based on transmission tests to indicator species and varieties by grafting and by artificially manipulated insect-vectors, followed by intensive methods for the rapid preliminary multiplication of the selected plants under insect-proof glasshouse conditions.

Finally, experiments on the application of heat-therapy to varieties of which no completely virus-free clones are obtainable have yielded positive results. Thus runners of certain varieties infected with viruses of group 1 and subjected to heat treatment have afterwards failed to induce any detectable symptoms on *F. vesca* indicators. This work is being extended.

Virus Diseases of Tree Fruits

Preliminary observations and experiments on certain suspected virus diseases of apple, pear and cherry were started by Prentice in 1948, and this programme was enlarged and intensified with the arrival of Posnette in 1949. Since then, research has followed two complementary lines: (1) the classification and description of visual symptoms found in orchards, and (2) a critical examination of material thus located by attempted graft-transmissions from trees showing each type of symptom and comparable trees not showing them, to a range of possible indicator varieties and species. In the course of this work an appropriate range of standard indicator hosts for each virus group is being determined, and improved grafting techniques for obtaining quick test results have been devised and put into general use.

The problem as it concerns the scion and rootstock of tree fruits is a dual one, the effect of a rootstock infection being a permanent and growing source of tree infection unless it is eliminated, and that of scion-tree infection more localized and more likely to be eliminated in the normal course of propagation. Also, a combination of stock and scion each infected with different viruses may synthesize complex diseases, which may be disseminated if stocks on which grafts have failed are regrafted or returned to stoolbeds for continued propagation. In this brief survey of present early trends and discoveries, the scion and stock problems will therefore be dealt with separately.

Virus diseases in scion varieties.

Apples. Apple mosaic virus was found to exist in several strains of different virulence, and strains causing extensive leaf chlorosis and defoliation of a variety will probably affect its yield. But varieties differ greatly in their sensitivity to these strains, so that a strain can only be defined as severe in relation to a specified variety, and hence the danger of 'top-grafting' a sensitive on to a tolerant variety. The effects of the rubbery wood virus on a wide range of varieties, additional to the sensitive variety Lord Lambourne, is being determined, following the discovery of the wide distribution of these diseases through infected stoolbeds (see below).

Pear. Besides stony-pit, two diseases of the vein-banding and leaf-flecking type have been identified and appear to have a stunting effect on quince-seedling indicator plants. The possible importance of these viruses in stock-scion incompatibility phenomena is being studied.

Cherry. Four groups of symptoms have been identified and are being studied by graft transmission to a range of species and varieties: rasp leaf, tatter leaf, rosette and rusty mottle. The three latter have reduced the vigour of a clonal rootstock (*F*12/1) by about 20 per cent (girth and height) in two years. Rasp leaf is a more severe disease in its effects, not on *F*12/1, but on most commercial varieties. As its occurrence is comparatively rare, total loss from rasp leaf is probably much less than that from more commonly distributed viruses such as rusty mottle.

Plum. The common vein-banding or line pattern leaf symptoms in plum are probably caused by several viruses. In general, plums are more tolerant to virus diseases than are cherries, and viruses from almost symptomless plums have been found to cause severe leaf-necrosis on cherry. Two recently discovered symptom types on plum, a leaf roll and a bark splitting, are both potentially serious diseases on certain varieties, particularly the gages.

Virus diseases in root-stocks.

Vegetative races of root-stocks hitherto developed at East Malling without reference to the ingress and subsequent dissemination of viruses are being extensively surveyed, with the following results to date.

Apple root-stocks. Some stools of *M*I and *M*IX at East Malling were found in preliminary tests to be infected, without symptoms, with rubbery wood virus. Other varieties of the Malling series from commercial sources were also found to be extensively infected with this virus, and arrangements are in hand to continue the survey on a wider basis with the aim of re-selecting and developing virus-free clones where necessary.

Quince root-stocks (for pear) are under investigation and some infection has been identified.

Plum root-stocks are mainly symptomless carriers, and preliminary tests have detected a widely distributed virus in common plum and Marianna stock. There is some, but probably less, infection in the Myrobalan *B* and Brompton stocks.

Cherry root-stocks. Some clones of Mazzard selections have been found to be infected with ringspot; but the most important selection, *F*12/1, is mainly free from virus. The latter stock, unlike those of plum, commonly shows symptoms when infected, and beds can then be 'rouged' at sight; *F*12/1 is, in fact, used as an indicator-host in our studies of stone fruit viruses.

Selection of healthy propagating stock and indexing of trials. The first step towards the control of these diseases of tree fruits is their elimination from the material used for propagation. This involves not only the re-selection and raising of virus-free root-stocks, but also the selection and distribution of virus-free scion material. This work has already begun, and a survey, by graft-indexing, of virus diseases in existing trials at this Research Station is being undertaken. Plans are also contemplated for investigating the natural vectors of these diseases.

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[1] Posnette, A. F., *Nature*, 169, 837 (1952)

EDUCATION AND TRAINING OF METALLURGISTS

THE presidential address by Prof. Hugh O'Neill to the Institution of Metallurgists given on June 26 was concerned, first, with the education of metallurgists and, secondly, the maintenance of a high standard of professional conduct.

Whether the founders of the Institution intended it or not, it is a company showing a strong resemblance to the early craft guilds. The three grades of membership, like the corresponding degrees at the universities, were grades through which every common man could pass. They were not social classes; they were degrees and not castes. Professional qualifications were required in many countries during the Middle Ages before a man could practise as a metallurgist. Thus in 1438 Charles VI of France decided that nobody in any town, village or hamlet in Dauphiné could make iron or steel if his competence had not been officially recognized. The old worker, and those who wished to become workers, were examined by an official assisted by two or three experts, who judged their aptitudes and experience. Just as in the days of the Guilds when the apprentices were not only taught the trade, but also received some general education, so is the Institution interested in the training of its members. It is recorded that a goldsmith's apprentice in 1494 agreed to serve ten years instead of nine, provided that his master would keep him one year at a writing school. Among the goldsmiths, fines were inflicted for failing to have the apprentices taught reading and writing. These craft guilds were friendly societies, concerned with the welfare of the *whole* man. They had their religious observances and their festivities.

There is still an element of dissatisfaction, which university teachers themselves share, with the training at present given to many students of metallurgy. Someone wrote to me to say that after interviewing several hundred science graduates he concluded that in all the British universities insufficient attention is directed to the underlying science and philosophy of the subject. He believed that teaching in the history and philosophy of science, plus an account of scientific method, with further philosophical teaching on the nature of truth, are essential ingredients in the training of any man of science who wishes to describe himself as well educated. A further criticism of current training is that: "The educated scientist knows that his science is derived only from a part of experience, and that it does not, and cannot, concern itself with the most important aspects of human life. The universities are to blame. They were instituted to give an education, but to their science students they give little more than technical training. They are, in general, expending far less effort in making wise men and good citizens, than in turning out good employees for commerce and industry. This can be remedied in part at least by insistence that the study of the nature of science should be a necessary part of the training of scientists, and should enter into every final examination".

Exactly one hundred years ago there was penned in Birmingham a famous discourse entitled "Knowledge Viewed in Relation to Professional Skill". John Henry Newman was outlining his ideas about universities, and advocating "liberal education" combined with specialist studies as a definite means of "cultivating the intellect". According to Newman ". . . the man who has learned to think and to reason and to compare and to discriminate and to analyse, who has refined his taste and formed his judgement, and sharpened his mental vision, will not indeed at once be . . . an engineer, or a chemist, or a geologist . . . but he will be placed in that state of intellect in which he can take up any one of the sciences . . . with an ease, a grace, a versatility, and a success, to which another is a stranger".

Some writers would claim that science itself is an adequate basis for the life of a university or nation, especially because of its sociological developments. I must, however, mention a hilarious essay written in this connexion by a serious scientist, which ends thus: "We can, and should, laugh out loud at scientists and this will be the very best way to prevent them from regulating us, or averaging us, or conditioning us to synthetic happiness. For what are they doing? The most laughable thing in the world. They are all crowding round and bowing low before a Sacred Cow". Without being cynical about science we need not become worshippers. In the last century it avoided metaphysics, whereas to-day we have Schrödinger stating: "I consider science an integrating part of our endeavour to answer the one great philosophical question which embraces all others, the one that Plotinus expressed by his brief—*who are we?*, and more than that; I consider this not only one of the tasks, but *the* task of science, the only one that really counts". Sir Walter Moberly, in discussing how the universities should attempt to implant a wide culture, has recommended a limit to religious neutrality, and an active probing of the common values which are held by most men.

It is generally agreed that intense specialization at the undergraduate stage should be avoided. In the words of Prof. Woodward, no one should receive an honours degree without showing "that minimum of general understanding which differentiates education from technical skill". Fortunately in Britain, with its independent universities, we have largely avoided what an American professor has sadly described as the assembly-line technique: "The *part* affixed in this industrial process is the *course*. . . . The course is a neat unit of knowledge, complete in itself, duly fastened to the student's mind, inspected, passed—forgotten. Once it is on, it is on, and we do not have to worry about it any more. When a student has had all the courses bolted on, we look him over to see that nothing has been forgotten, we add up the credits that the courses are worth, and if what we find agrees with the specifications . . . we give him a degree which signifies that he has a college education". The dilemma arises, however, in connexion with the distribution of time for all the work to be done. Some will take the view that the life of Britain depends upon the discovery, development and export of high-quality specialities. For this first-class men of science are required. It still seems to me, however, that we should maintain the broad basis for the bachelor's degree, and intensify specialization in postgraduate work.

The question may be asked: is there such a thing as 'cultural metallurgy'? Prof. John Read recently developed an earlier opinion that "Chemistry itself may become a cultural and humanistic instrument of high value". To that may be added the following statement of Lord Waverley (formerly Sir John Anderson) in his 1951 May Lecture to the Institute of Metals: "I wish it could be universally recognized that scientific studies no less than the humanities have a cultural value, and that applied science is not inferior academically to pure science". For metallurgy to have any humanistic qualities it would probably have to include the history of the subject, and this indeed was the main point of Read's lecture.

How are we to set up and maintain a high standard of professional conduct? This is a moral matter, and increasingly one hears the expression that there is no morality or culture without religion. If we pursue the analogy with the craft guilds mentioned earlier, we find a general understanding that guild conduct should be based on definite religious principles. There would, of course, be hostility from some quarters at attempts to bring Christian principles directly into the sphere of professional conduct, but one cannot help noticing that at a meeting of the representatives of British, French, German and Italian steel industries at Caux, the great need for absolute moral standards in industry was emphasized. There is, however, another direction in which metallurgists in high positions may have to take a definite line regarding their professional conduct. In the development of primitive regions metallurgists should use their influence to see that the conduct of the enterprise corresponds with the natural rights of mankind.

I would conclude by a quotation from a letter signed by "A Professor", presumably American, on "What do we in the Universities believe?":

". . . Underneath our devotion to the fictitious reality, which the physicist at the Einstein level has destroyed, lies sleeping a faith in the existence of a moral universe; in the existence of a natural law which gives to man certain inalienable rights; in a Divine Creator of which we are each a tiny spark. . . . But we are scarcely aware of these foundations far beneath our everyday lives. . . . Only when man-made laws challenge man's inalienable rights do we realise whence comes our belief in these rights".

F. C. THOMPSON

OBITUARIES

Sir Lindsay Scott, K.C.B.

SIR LINDSAY SCOTT, who died on June 17, was an outstanding example of the finest tradition of the amateur in the field of humane studies. A Civil servant fulfilling the exacting duties of a senior official in a war department in peace-time and during hostilities, he nevertheless made a notable place for himself in British archæological research by his resolute determination to match his work against nothing less than that of the highest professional standards in the field or in the museum and library. With a naturally vigorous and original mind, sharpened and disciplined by academic training, he brought to his studies of British prehistory a freshness and directness of approach which was always well ballasted by precise and detailed documentation, and illuminated by direct personal experience. He was, in the eighteenth-century sense of the word, a 'curious' person: his reading was wide and unconventional, and in particular his knowledge of the byways of English literature from its beginnings to the nineteenth century was as varied and unexpected as it was entertaining to his friends, and to this he added a robust and competent command of the practical skills of the countryman and the sailor.

His work was specifically directed to problems of Scottish prehistory, and his main excavations were carried out in the Outer Isles, where perhaps he felt most at home; but these local studies were invariably made within the framework of European prehistory as a whole, and he carried on an amused, but none the less sincere, campaign against provincialism and isolation in such researches. Always provocative (sometimes deliberately and healthily so), his contributions to the archæology of Scotland, both in the form of excavations admirably carried out and meticulously recorded, and in subsequent comment upon the wider aspects of the problems involved, will remain as a permanent memorial to his immense energy and to his devotion to exacting standards of scholarship. These, and his work on the Council for British Archæology and as president of the Prehistoric Society, have ensured him a place among the more powerful forces in the post-war development of prehistoric studies in Great Britain.

STUART PIGGOTT

Mr. F. W. H. Migeod

FREDERICK WILLIAM HUGH MIGEOD was born on August 9, 1872, in Chislehurst, Kent, and went to school in Folkestone. When he was seventeen he joined the pay department of the Royal Navy, and although he had a love for the sea and an interest in those who serve in ships, he was not destined to devote his life to it. After nine years he left the Navy and in 1900 he joined the Colonial Civil Service. All his subsequent service was in Africa, and most of it in West Africa, though he made several important and hazardous journeys across the continent. His curiosity concerning the languages and customs of the various races was insatiable, and his researches resulted in five volumes on languages and four quite considerable travel books. Wherever he went he observed closely, and he amassed a store of natural history knowledge that he used in later writings.

In 1925, when the British Museum East Africa Expedition was left leaderless through the death of W. E. Cutler, Migeod volunteered from England for the post, and intermittently for the next four years or so he acted as general overseer of the operations. On the whole, he had little success in this, and it is paradoxical that through the nature of the work he came into the public eye much more than he ever did through his able and successful studies in folk-lore and language. It is only fair to say that Migeod in these later years did not claim much for his East African adventure.

Migeod's years of retirement in Worthing were characteristically busy. He wrote a book, "Earliest Man", and another volume, "Aspects of Evolution", which displayed a rather fundamentalist point of view; but also revealed a surprising range of observation and width of knowledge of the literature. He also wrote a survey of Worthing.

Migeod was a Fellow of the Royal Geographical and the Royal Anthropological Societies for many years. He had been president of the Worthing Archæological Society in 1927 and he was re-elected in 1938. He also entered local government as a town councillor, eventually becoming an alderman both of Worthing and of the County of Sussex. He was for many years chairman of the local sea-cadet force.

His manner of speech and bearing sometimes gave an impression of arrogance; but in fact he was a kindly and friendly man and an admirable host. Fortune seldom shone on him. His married life was happy but brief, and his wife died many years ago. For the last year or two he had been ill and much alone, and the end came on July 8.

W. E. SWINTON

Prof. Tadeusz Estreicher

PROF. TADEUSZ ESTREICHER (Thaddaeus Estreicher-Rozbierski), a member of an ancient and cultured Polish family and one of Poland's most distinguished and versatile men of science, died in Cracow on April 8. Son of Karol Estreicher, bibliographer and director of the University library, he was born in Cracow on December 19, 1871. He enrolled as a student in the famous Jagiellonian University of Cracow, founded in 1364, where he became a favourite pupil of Karol Olszewski, the celebrated chemist. In 1894, at the request of Sir William Ramsay, Olszewski had begun experiments on the liquefaction of argon; Estreicher participated in this work with distinction, and graduated Ph.D. in 1897. After working in the laboratories of van 't Hoff (Berlin), Ostwald (Leipzig) and Ramsay (London), he returned to Cracow as a *Docent* in inorganic and analytical chemistry; at the same time he helped to modernize Olszewski's laboratory. A further year's work with Abegg (Breslau) was followed by his appointment, in 1906, as professor of inorganic and analytical chemistry at the University of Fribourg, in Switzerland, a chair which he occupied until he was recalled to succeed Olszewski in Cracow in 1919.

Here he was faced with the difficult task of rehabilitating a department which had been devastated during the First World War. In 1923–24 he was dean of the faculty of arts, and in 1926 he was made director of the Pharmaceutical Department in the University of Cracow; his work in the latter capacity resulted, in 1947, in the elevation of this Department to the dignity of a faculty. Meanwhile, at the outbreak of the Second World War, he was doomed to undergo the terrible experience of imprisonment in the concentration camp at Sachsenhausen, following the arrest of himself and many others on November 6, 1939. In this camp a score or so of his colleagues perished, among them his brother Stanislaw, who held a chair in the faculty of law. Although Estreicher survived, he never regained his normal health. When he returned to Cracow upon his liberation the University had ceased to function, and for a time he was obliged to eke out a meagre living as a proof-reader. With the re-opening of the University he resumed his chair; but his health deteriorated so gravely that he soon felt called upon to resign.

Estreicher was vice-president of the Committee of the Polish Pharmacopœia and an active member of the Committee of Pharmaceutical Science of the Polish Academy of Arts and Sciences. He was also a leading organizer of the garden of medicinal plants in Cracow. His researches dealt particularly with the behaviour of gases at very low temperatures. On this theme he published many original papers in German, Polish and British scientific journals. In 1905 he translated into German Travers's well-known work on the experimental study of gases, and in 1915 he published his own book entitled "Kalorimetrie der niedrigen Temperaturen". For the "Polish Biographical Dictionary" he wrote authoritative notices of Kostanecki, Wróblewski and Olszewski, three Polish men of science of the first rank.

First and foremost a chemist, Estreicher was a man of great erudition and varied interests. He was an accomplished classical scholar, a fluent linguist, and a lover of music and the fine arts. Himself an artist of merit, he assembled a fine collection of modern Polish paintings. His writings included essays on the Polish language and literature, and he published also an interesting monograph on the 'Jagiellonian Globe', a valued relic dating from 1510 and preserved in the Jagiellonian Library at Cracow. He cherished a life-long ambition to write a history of Polish chemistry; but although he collected much material and had the ideal equipment for this task he was never able to find time for it. Towards the end of his life he lost both sight and hearing; but as his letters (often dictated in German) testified, he kept to the end his marvellous memory and his clear and alert mind. This remarkable man of science might well have taken for his motto: *Homo sum: humani nihil a me alienum puto.* JOHN READ

NEWS and VIEWS

Electrical Engineering in the Manchester College of Technology: Prof. J. Hollingworth

PROF. JOHN HOLLINGWORTH, who retires from the chair of electrical engineering in the Faculty of Technology in the University of Manchester at the end of August, was educated at Bradfield College, Peterhouse (University of Cambridge), and the Central Technical College (University of London). During the next nine years he was in turn demonstrator at the Central Technical College, lecturer at the College of Technology, Manchester, and held a commission in the Royal Air Force. He was appointed scientific assistant at the National Physical Laboratory, a position which he held for eleven years. During this period he published a number of papers on the propagation of radio waves and allied subjects. In 1932 he was appointed professor of electrical engineering in the College of Technology, Manchester, and under his direction the department has developed in many directions, notably in the teaching of electronics, servo-mechanisms and high-voltage engineering.

Dr. Eric Bradshaw, M.B.E.

DR. ERIC BRADSHAW, who succeeds Prof. Hollingworth on September 1, was born in 1909 and was educated at the King's School, Grantham, and at the Faculty of Technology, University of Manchester, where he graduated in 1930, taking his master's degree a year later. After a course at the works of the British Thomson-Houston Co., Ltd., Rugby, he joined the staff of the Royal Technical College, Glasgow, where he remained until 1944, during which period he took his Ph.D. degree. He was then appointed special lecturer in high-voltage engineering at the College of Technology, Manchester. He is joint author of a number of papers in the fields of high-voltage measurement and electric power-supply. Dr. Bradshaw has served on several committees of the Institution of Electrical Engineers and is now vice-chairman elect of the North-West Centre of the Institution. He has for some years been tutor and lecturer at the Ministry of Education Engineering Summer Schools. He founded and is now editor of the *Bulletin of Electrical Engineering Education*.

Radio-Frequency Allocations in Europe: Conference in Stockholm

THREE of the study groups of the International Radio Consultative Committee met in Stockholm during May 15–27; and these were followed by a European Broadcasting Conference during May 28–June 30. This Conference had been called to consider the assignment of very high frequencies (ultra-short wave-lengths) for sound and television broadcasting in Europe. The work of the Committee was of a technical nature, designed to establish the basis upon which a scheme of frequency-sharing could be devised. For this purpose, one of the study groups presented wave-propagation curves showing the field-strength likely to be obtained from transmitting stations at distances well beyond their normal service area. Another group had studied the discrimination which it is desirable to attain in order to avoid interference between television stations operating in the same frequency-channel. By a combination of these results, the geographical separation desirable between stations sharing the same frequency-band could be established. The Stockholm broadcasting conference has produced an agreement on three plans for the assignment of frequencies to European broadcasting (including television) within the three bands 41–68, 87·5–100 and 174–216 Mc./s. The General Post Office, which is the responsible administration in Great Britain, has stated that the Conference accepted the assignments which the United Kingdom has made for the five high-power and five low-power television stations being established by the B.B.C. For the second band (87·5–100 Mc./s.) the British delegation was successful in securing alternative sets of frequencies for amplitude and for frequency modulation, respectively. The agreement was signed on behalf of the administrations of twenty-one of the thirty-one countries represented at the Conference.

Anatomical Nomenclature

An international meeting of anatomists was recently held in London to discuss a proposal to establish an agreed anatomical nomenclature. The first attempt to reach a similar agreement was the work of a small committee, predominantly German in constitution, which was convened by the German Anatomical Society at its Leipzig meeting in 1887. This committee devised a list of terms, now known as the BNA, which was adopted at a meeting in Basle in 1895. The BNA has been endorsed by a number of countries; but nevertheless is not an internationally approved scheme. In 1933 the Anatomical Society of Great Britain and Ireland approved an English revision, and a German revision was published in 1936. The recent London meeting agreed that any new international nomenclature should be based on the BNA, which it was hoped would require a minimum of change. It was also agreed that each country was at liberty to translate the official Latin terms of the BNA into its own vernacular for teaching purposes; but that, wherever possible, official Latin terms should be used in publications. The revision of the BNA is the responsibility of professional anatomists; but it was decided that it would be in the best interests of all if physiologists, pathologists, clinicians, and others concerned in the education of medical students, should communicate any views they might have about anatomical nomenclature to the committee. According to a recent letter to *The Lancet* (July 5, 1952), Prof. T. B. Johnston (Guy's Hospital, London, S.E.1) is undertaking the task of collating such proposals in Great Britain. The various sub-committees dealing with this matter hope to submit a report to the International Congress of Anatomists to be held in France in 1955.

History of Science

Last year the attention of readers of *Nature* was directed to the publication, by E. Munksgaard, of Copenhagen, of the first two numbers of *Centaurus*, a new quarterly devoted to the history of science and medicine (*Nature*, 167, 841). Three further numbers have since appeared, containing fifteen original articles on a variety of subjects of scientific, medical, biographical and bibliographical interest. Among these may be noted, in Vol. 1, No. 3, a critical article by Prof. Benjamin Farrington on Francis Bacon's "Temporis Partus Masculus", and, in the first number of Vol. 2, Prof. Edward Rosen, of New York, discusses when Galileo made his first telescope. Under the heading "Varia", in Vol. 1, No. 4, is a description of the recently established Belgian Museum for the History of Science, situated in Ghent. First planned in 1939, war delayed its opening until 1948. It was first housed in the Archæological Museum, but latterly was moved to more spacious accommodation in the Museum of Fine Arts. The Museum is stated to be especially rich in old medical and surgical instruments, a new acquisition being a collection of surgical instruments representative of ancient Egypt and the Middle East. Documents, both printed and manuscript, bearing on the history of the sciences also form part of the collections. Each number of *Centaurus* contains several book reviews and there are also extensive lists of books received. The high standard of printing and illustration is maintained, and this quarterly is one well worth the attention of British readers interested in the history of science and medicine.

Gamma-Ray Sources for Radiography

A committee of the Industrial Radiology Group of the Institute of Physics has recently prepared a "Memorandum on Gamma-Ray Sources for Radiography" (obtainable from the Institute; pp. 23; 1952; 3*s*. 6*d*.), which provides a brief statement of the physical characteristics of the gamma-ray sources for radiography by means of which a wide range of radiography can be carried out without X-ray equipment. In addition to the older, costly and somewhat rare, radium there are now available sources consisting of radon obtainable from the Radiochemical Centre, Amersham, and three artificial radioactive sources—cobalt-60, tantalum-182 and iridium-192—from the Atomic Energy Research Establishment, Harwell. Attention is directed in the memorandum to radiographic technique, protection of personnel and precautions to be taken when handling or transporting the sources, and to the cost of installation of the necessary equipment for gamma-radiography. Useful data sheets, summarizing essential information and obtainable from official sources, are included as an appendix to the memorandum. For example, cobalt-60, which has a half-life of 5·3 years and is recommended for the radiography of steel 2–6 in. thick, costs £40 approximately for the equivalent of 1 gm. of radium; the radium can be supplied on loan at a rental of £225 a year. The activity of radium remains sensibly constant with time whereas that of the other sources decreases; but the artificial sources can be returned to the atomic pile for reactivation. With regard to the technique of gamma-radiography, it is mentioned that the technique is simpler than that using X-rays, but the interpretation of the results is a skilled job. Though the radiographer must have an adequate knowledge of protection and must be a responsible person, his training need not be so broad in scope as that for X-radiography, since no high-voltage circuits are involved. Training facilities, though limited, are available in Great Britain, and particulars of these can be obtained from the Institute of Physics, 47 Belgrave Square, London, S.W.1.

Twenty Years of Work at the Jungfraujoch

The November 1951 issue of *L'Astronomie* contains a number of interesting articles, two of which are connected with the scientific station of Jungfraujoch, and are contributed by M. D. Chalonge, director of the station. The first of these refers to the celebration of the twentieth anniversary of the inauguration of the station in 1931, which took place on September 26 and 27, 1951, at Interlaken and afterwards at the Jungfraujoch itself. A short account is given of the various activities of the station in the physics of cosmic rays, astrophysics and the physiology of high altitudes (laboratories have been installed for work in other fields as well). The initiative in the project is due to W. R. Hess, professor of physiology in the University of Zurich, who spent two years in the work of organization, interesting various institutions of other countries in the scheme, and obtaining the necessary financial support to carry it out. Several institutions have combined to endow the station with a small observatory specially well placed for research on spectroscopy and spectrophotometry in the infra-red and ultra-violet regions. The Observatory of Paris and the University of Paris, and also the Observatory of Uccle, have generously presented certain instruments to the station, and the Observatories of Geneva and Basle and the Institute of Astrophysics, Paris, have a scheme for mounting a 40-cm. Cassegrain telescope which will give astronomy an important place at the Jungfraujoch. The second article gives the results of ten years of astronomical observations and refers to the schemes for new research in various fields; it shows the intense keenness of the Director, and everyone will wish him great success in his programme. In concluding the article, he thanks all those who have contributed to the progress of the work, including a group of young students from the Universities of Basle and Zurich, some of whom are now teachers in different places. The list of publications, commencing in 1933, given at the end of the second article, shows the activities of the station and is very creditable to the Director and his staff.

Geography in the Secondary School

At the request of the Executive Committee of the Geographical Association, two of its members have prepared a memorandum on the teaching of geography in secondary schools and, particularly, in modern schools. No young people, they suggest, ought to leave school without the fullest and most understanding picture possible of the locality, the land, and the world in which they will begin to earn their living and live their adult lives. These young people should have some real appreciation of man's dependence in all parts of the world upon the land in which he lives; upon the warmth and moisture without which his crops cannot grow; upon natural resources that he employs to meet his needs, whether simple or complex; upon the essential and irreplaceable few inches of soil which sustain him in his many millions throughout the world. In a world where great distances no longer separate men as they once did, geographical knowledge forms the background essential to an understanding of international affairs and to an appreciation of the differences of outlook which still divide peoples from one another. To help the geography teacher, the writers of the memorandum devote considerable attention to the content and organization of the geography course, the study of geography out of doors, and the use of equipment, including maps. The memorandum has been well conceived and carefully prepared; copies may be obtained from the Geographical Association, c/o the Park Branch Library, Duke Street, Sheffield 2.

Use of Films in the University of Cambridge

The fifth report of the Cambridge University Educational Film Council indicates that, besides regular film sessions in the Department of Geography, weekly sessions of Russian sound films are now provided for students in the Department of Slavonic Studies during all terms. Considerable use is also made of the film for teaching in the Department of Zoology. An interesting development during the year was a further investigation on the use of 'silent' films in education which was carried out in the Department of Engineering. Although more experimental confirmation is required, the evidence provided by this investigation seems to show that, first, when members of an audience have been given the opportunity of comparing 'silent' films shown with and without musical accompaniment, their opinion of what has been the effect of the music on their attention is in general a reliable index of its actual effect, measured by tests made after the showing of the films; secondly, that more students are aided by accompaniment to silent educational films than are hindered; and, thirdly, that those who are aided are those most receptive to the visual film medium. Among the research films which have been made is that of the Cambridge Jotenheim Expedition showing glacier formations, and others on the fur seal of the Pribilof Islands and on the sea-urchin's eggs. The report also contains a complete list of all the films made in connexion with teaching or research at Cambridge.

Current Trends of Physics in the United States

The September issue of the *Journal of Scientific Instruments* (28, No. 9; 1951) contains, in addition to original contributions and other regular features, a special article by Dr. J. C. Overbeck, of the Northwestern University, Evanston, Ill., and is the latest in the series of articles which he has contributed at intervals during the past twelve years on experimental physics in the United States. In his illustrated article, Dr. Overbeck surveys, by selecting several topics from the papers published in American physics journals, the significant trends in the method and technique of experimental physics in the United States during the past two years. The topics chosen include the germanium phototransistor and the germanium rectifier; two new types of mass spectrometer, the one using a time-of-flight method and the other velocity selection; a diaphragm type of pressure gauge for very rapid transient pressures; a novel method of increasing the safe power input of an X-ray tube by twenty to twenty-five times but still retaining the sharp focal spot; photographing sound waves; and an ingenious method of magnifying a crystal layer to provide an image of its atoms. Dr. Overbeck considers the period under review to be one of development rather than of profound new discoveries.

Thirteenth International Horticultural Congress, London

The thirteenth International Horticultural Congress will be held in London during September 8–15 under the auspices of the Royal Horticultural Society. Three general lectures will be given on each of the following subjects: environment, soils and nutrition, plant breeding, and growth and development. In addition, about a hundred and forty lectures will be given at the meetings of the seven specialized sections, which are as follows: fruit growing, vegetable growing, ornamental plant growing, plant breeding, environmental control, seeds, and tropical and subtropical horticulture. The various meetings will be held in the halls of the Royal Horticultural Society, Vincent Square and Greycoat Street, London, S.W.1, and at Church House, Dean's Yard, Westminster, London, S.W.1. Following the week of lectures, there will be tours and day excursions to research stations, gardens, nurseries, fruit- and seed-growing establishments, etc.; visits to places of historical interest will also be included. Other events that will take place during the Congress are as follows. The International Committee for Horticultural Congresses will meet on September 7 and 13; the International Committee on Horticultural Nomenclature and Registration will meet on September 7; a meeting of representatives of botanic gardens under the auspices of the International Botanic Gardens Commission will be held on September 13; and the Flower Show of the Royal Horticultural Society will take place during September 9–10. The membership fee for the Congress is 4 guineas. Further details can be obtained from the Secretary, Thirteenth International Horticultural Congress, Royal Horticultural Society, Vincent Square, London, S.W.1.

The Potsdam Geodetic Institute

FOLLOWING on the political changes in Germany resulting from the War, the Potsdam Geodetic Institute has renewed the publication of its work in a new series of *Veröffentlichungen*, of which six issues have been received, of dates 1949–51. They appear under the auspices of the Deutsche Akademie der Wissenschaften zu Berlin, of which the Geodetic Institute became in 1946 a dependent body, under the directorship of F. Mühlig. The Institute welcomes exchanges of its publications with those of other geodetic workers. The six issues now available deal partly with work begun before the War, as in the study (No. 2, F. Mühlig) of the 24-metre interference comparator, the construction of which was begun in 1937, and in No. 3 (K. Weiken), dealing with pendulum observations, 1934–43. Nos. 1 and 6, by K. Reicheneder, deal with the theory of errors and adjustment of networks in nadir triangulations; No. 4, by H. Haalck, is on gravity-disturbed fields and on the theory of the normal figure of the earth; and No. 5, by the late K. Friedrich and W. Jenne, discusses in much detail the solutions of systems of linear equations in which many coefficients are zero. The back covers of the later issues list some of the post-war publications of the Potsdam Geophysical Institute, prepared by R. Bock, F. Burmeister, F. Errulat, and W. Schumann; they deal entirely with geomagnetism.

Jodrell Bank Annals: A New Astronomical Journal

A NEW publication, to be known as the *Jodrell Bank Annals*, initiates Series 1 of the Astronomical Contributions from the University of Manchester (Vol. 1, No. 1, pp. 1–12; 1952). Through this medium a considerable amount of observational data will be made available to astronomers, especially in connexion with the continuous operation of the meteor, solar and galactic noise equipments at the Jodrell Bank Experimental Station. It is hoped, however, that the *Annals* will also contain, from time to time, contributions to theoretical astronomy from the University and its Mathematical Laboratory. The first publication, "Radio Echo Observations of the Daytime Meteor Streams in 1951", by G. S. Hawkins and Mary Almond, includes a certain amount of material that has previously appeared in *Mon. Not. Roy. Astro. Soc.* and also in *Nature*; but a few new features are worth attention. A new minor stream was detected near υ Piscium on May 12 and 13; but the radiant structure was diffuse. Although it is suggested that this stream may correspond to the Piscid streams observed in 1947 and 1948, the difference of 10° in the right ascension of the radiant renders the identification uncertain. The η Aquarid stream supplied meteors with velocities 63·7, 63·0 and 58·8 km./sec., respectively, as shown in Table 4; but meteors radiating from a radiant at R.A. 336°, Dec. 0°, with a period of Halley's Comet, should have a velocity of 70·4 km./sec. (velocities in all cases are geocentric), and the velocities indicated by the radio echo method correspond to a period of about ten years. This implies that the stream cannot be closely aligned with the orbit of Halley's Comet, nor could it be associated with the October Orionids. Some astronomers doubt very much the connexion of Halley's Comet with either stream—and in particular the Orionids—and hold that the apparent similarity in orbital elements is probably fortuitous. In *Mon. Not. Roy. Astro. Soc.*, 111, 37 (1951), it was shown by Mary Almond that the ζ Perseids and the night-time S. Arietids on October 12, radiant at R.A. 38°, Dec. 12°, were probably associated, and the work of 1951 has reaffirmed the connexion. We can confidently anticipate many interesting items in this new publication.

British Library of Political and Economic Science

THE annual report for 1950–51 of the British Library of Political and Economic Science (pp. 22; London School of Economics, 1951) refers to restrictions on expenditure necessitated by the heavy expenditure of the previous year and the increased cost of books and periodicals, but acquisitions during the year brought the total of bound volumes to 323,575 as against 315,185 in 1950, of which 11,281 were in the lending library and 3,891 in the Shaw library. Expenditure on treatises was £4,187, as against £5,377 in 1949–50, and on periodicals £5,524 as against £3,711; and 6,707 periodicals were currently received as against 6,291 in the previous year. Treatises issued, however, fell from 44,969 to 37,669; but works lent to other libraries increased from 516 to 761, while research readers' permits increased from 452 to 482. Progress has been made with the preparation of the three further volumes of the "London Bibliography of the Social Sciences" which will cover the intake of the Library during 1936–50. A special grant permitted the clearing-off of most of the arrears of binding which had accumulated since the War, but extensions to the fabric had again to be postponed. A list of publications by members of the Library staff is appended.

British Mammals

THE Trustees of the British Museum (Natural History) have again put naturalists in their debt by the production of "A List of British Mammals" (2s. net). This has been written by T. C. S. Morrison-Scott who, after an explanatory account of how the scientific names of animals are devised, describes the use of certain keys to the external characters and skulls of those species which might confuse the layman. Among the mammals described are the hedgehog, mole, seven species of shrew, twelve species of bat, the fox, pine marten and three species of stoat, the weasel, two species of polecat, badger, otter, Scottish wild cat, seven species of deer, three species of hare, the rabbit, two species of dormouse, eighteen species of field mouse, the black and brown rats, the house mouse, twenty-one voles and the coypu. Marine species include the grey and common seals and twenty-three species of whale, dolphin and porpoise. The descriptions are supplemented by a number of clear text-figures.

Medical Research Council Travelling Awards, 1952–53

THE Medical Research Council has announced the following travelling awards for the academic year 1952–53. *Rockefeller Travelling Fellowships in Medicine:* Dr. M. de Burgh Daly, lecturer in physiology, University College, London; Dr. J. E. Hotchin, member of the scientific staff, National Institute for Medical Research, London; Dr. E. L. McDonald, assistant to the professor of medicine, Middlesex Hospital, London; Dr. R. G. Mitchell, lecturer in child health, University of St. Andrews, Dundee; Dr. N. B. Myant, member of the scientific staff, Department of Clinical Research, University College Hospital Medical School, London; Dr. P. C. Reynell, graduate assistant, Nuffield Department of Clinical Medicine, Radcliffe Infirmary, Oxford. *Eli Lilly Travelling Fellowships in Medicine:* Dr. C. J. Earl, junior lecturer, Department of Chemical Pathology, Guy's Hospital Medical School, London; P. H. Schurr, senior registrar in neurosurgery, Radcliffe Infirmary, Oxford; Dr. R. G. White, Freedom research fellow, London Hospital; Dr. G. M. Wilson, senior lecturer in therapeutics, University of Sheffield, and assistant physician, Sheffield Royal Infirmary. *Dorothy Temple Cross Research Travelling Fellowships in Tuberculosis:* Dr. C. N. Iland, lecturer in bacteriology, University of Bristol; H. Platt, University research fellow in veterinary pathology, Department of Pathology, University of Liverpool. *Alexander Pigott Wernher Memorial Travelling Fellowships in Otology:* Dr. D. R. Haynes, Department of Oto-laryngology, Johannesburg General Hospital; Dr. R. F. Naunton, member of the scientific staff, Wernher Research Unit on Deafness, Institute of Laryngology and Otology, Royal National Throat, Nose and Ear Hospital, London. *French Exchange Scholarships in Medical Science* (in association with the Centre National de la Recherche Scientifique): Dr. J. D. Carr, British Empire Cancer Campaign grantee, Poultry Research Centre, Edinburgh; Dr. M. A. Epstein, assistant pathologist (research), Bland Sutton Institute, Middlesex Hospital, London.

Merck Fellowship of the National Research Council, Ottawa

THREE post-doctorate research fellowships, endowed by Merck and Co., Ltd., have been awarded by the National Research Council, Ottawa. The awards, which total 10,500 dollars and travel allowances, with an extra 500 dollars to each institution concerned in order to help pay for specialized equipment, have been made to the following for research as indicated: Dr. S. G. A. Alivisatos (University of Athens and McGill University), enzyme systems, at Bellevue Medical Center, New York City, under Dr. S. Ochoa; Dr. K. K. Carroll (Universities of New Brunswick, Toronto and Western Ontario), factors affecting the hatching of potato eelworms, at the University of Cambridge under Prof. A. R. Todd; and Dr. R. L. Kay (University of Toronto), properties of electrolytic solutions, at the Rockefeller Institute for Medical Research under Dr. D. MacInnes.

"Index of Zoologists"

THE Zoological Section of the International Union of Biological Sciences is engaged on the preparation of an "Index of Zoologists". This will give the addresses, ages and special interests of zoologists throughout the world. The work is well advanced and it is much hoped that it will be published before the International Zoological Congress in July 1953 at Copenhagen. Its completion is, however, delayed by the fact that many zoologists have failed to fill in and return the questionnaire postcard which they received. They are now requested by the Union to complete and return their cards to M. Marc André, 61 rue de Buffon, Paris 5^{e}. If the card has been lost, another can be supplied.

Announcements

THIS year the Australian and New Zealand Association for the Advancement of Science will meet in Sydney during August 20–27. The president will be Sir Douglas Berry Copland, vice-chancellor of the Australian National University at Canberra. The title of his address will be "Authority and Social Control in a Free Society".

MR. COLIN G. CLARK, recently Under-Secretary of State for Labour and Industry and financial adviser to the Treasury, Queensland, has been appointed director of the Institute for Research in Agricultural Economics at Oxford, in succession to Mr. A. W. Ashby, who is retiring under the age-limit provisions.

A DISCUSSION on "Biology as a Career" is being held in Birmingham on October 4 under the auspices of the Institute of Biology. Speakers will include W. P. Yapp, Prof. J. F. Danielli, B. G. Meara, Sir Harold Himsworth, Dr. H. J. Bunker, Dr. W. E. Ripper, G. A. C. Herklots and Sir William Slater. Further information can be obtained from the General Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

THE Division of Medicine and Public Health of the Rockefeller Foundation is providing bursaries for postgraduate study and research in public health engineering in universities in the United Kingdom, and for the next three years these will be administered by the Institution of Civil Engineers. Each bursary will be worth approximately £450 and will normally be tenable for one year, and candidates must hold a suitable engineering degree of a university within the British Commonwealth. Application forms (to be completed by August 31) and further information can be obtained from the Secretary of the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1.

A FELLOWSHIP in any branch of natural science and others in industrial research, virology and agriculture, each worth £A1,000, are being offered by the British Memorial Fund established in Victoria, Australia. The fellowships provide for ten months of study in Victoria and cover all travelling and living expenses during the period. Wives and children are welcomed; but no extra expenses can be paid to cover them. Applicants aged between 25 and 35 and of either sex are eligible, provided they are of British stock with ten years residence in the United Kingdom. Further details can be obtained from Sir John Lienhop, Victoria House, Strand, London, W.C.2, to whom applications should be made immediately.

BIOLOGICAL ACTIVITY OF COMPLEX IONS

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AND

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FOLLOWING the suggestion of Dwyer *et al.*[1], the biological activity of a number of complex ions has been examined. The toxicity of these compounds to mice, their bacteriostatic and bacteriocidal properties and their actions on enzymes have been studied.

Toxicity to mice. The compounds were dissolved in saline and given by intraperitoneal injection. Unless stated otherwise, the results are given in the table as the approximate minimum lethal dose. Owing to the difficulty of obtaining large amounts of the compounds, accurate L.D.50 values were not obtained. The figures are, however, sufficient to indicate the degree of toxicity.

ASYMMETRIC COMPLEX IONS*

Compound	Optical form and toxic dose
Tris-ethylenediamine cobalt III nitrate, $Co(en)_3(NO_3)_3$ (ref. 6)	(+), (−) and (±), 165 mgm./kgm.
Tris-1 : 10-phenanthroline ruthenium II perchlorate, $Ru(phenan)_3(ClO_4)_2$ (ref. 7)	(+), 9·2; (−), > 18·4 mgm./kgm.
Tris-1 : 10-phenanthroline nickel perchlorate, $Ni(phenan)_3(ClO_4)_2$ (ref. 8)	(+), 5·8; (−), > 11·6 mgm./kgm.
Tris-1 : 10-phenanthroline iron II perchlorate (ref. 9)	(±), 14·2 mgm./kgm.†
Tris-2 : 2′-dipyridyl osmium II perchlorate, $Os(dipy)_3(ClO_4)_2$ (ref. 10)	(+) and (−), between 13·5 and 14·8 mgm./kgm.
Tris-2 : 2′-dipyridyl ruthenium II iodide (ref. 11)	(+) and (−), between 15·7 and 16·8 mgm./kgm.
1 : 10-bis(salicylideneamino)-4 : 7-dithiadecane cobalt III iodide, Co(TET)I (ref. 12)	(+) and (−), between 85 and 95 mgm./kgm.
1 : 8-bis(salicylideneamino)-3 : 6-dithiaoctane cobalt III chloride, Co(EEE)Cl (ref. 13)	(+) and (−), between 210 and 220 mgm./kgm.

* (+) and (−) refer to sign of rotation in either the Na_D line or Hg_{5461} line.
† The active forms racemized rapidly at 37° C.

COMPLEX IONS

Compound	Toxic dose
Bis-2 : 2′ : 2″-terpyridylruthenium III perchlorate, $Ru(trpy)_2(ClO_4)_3$ (ref. 14)	> 3 mgm./kgm.
Bis-2 : 2′ : 2″-terpyridylruthenium II iodide, $Ru(trpy)_2I_2$	> 3 mgm./kgm.

NEUTRAL COMPLEXES

Compound	Optical form and toxic dose
Tris-acetylacetane cobalt III*	(±), > 75 mgm./kgm.
Tris-glycine cobalt III	(±), > 150 mgm./kgm.

* First dissolved in alcohol, then diluted with saline

As a rule, with the phenanthroline compounds the addition of the (−) form to the (+) form delayed the time of death slightly. The toxicity of the (+) and (−) forms was approximately additive.

The compounds $Ru(phenan)_3(ClO_4)_2$, $Os(dipy)_3(ClO_4)_2$ and $Ru(trpy)_2I_2$ were given *per os* to mice. The largest doses used, which were five times the toxic intraperitoneal dose, had no effect. The fæces of the mice showed the characteristic colours of the compounds, which appeared to have passed through the alimentary tract unchanged.

Toxic intraperitoneal doses of all of the compounds except the sexadentate chelate compounds, Co(TET)I, Co(EEE)Cl, and the uncharged complexes caused death in 10–15 min. About 1½ min. after dosing, breathing became laboured and then spasmodic. The hind limbs appeared paralysed and then tonicoclonic spasms occurred. Death appeared to be caused by respiratory failure. Atropine potentiated the toxic action of the (+) and (−) forms.

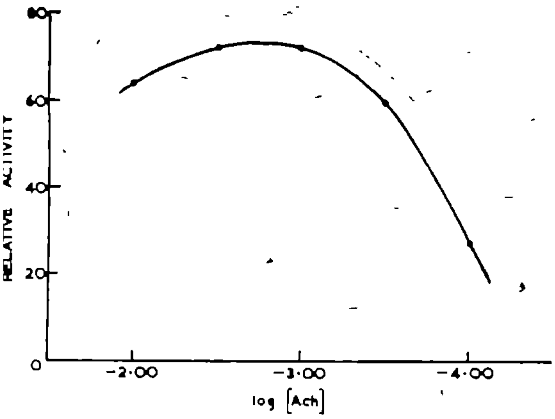
Action on enzymes. The toxic effects of the compounds on the mice suggested that the action of cholinesterase might have been affected, and this enzyme was therefore selected for examination. The enzyme was prepared from the erythrocytes of sheep by a modification of the method of Mendel and Rudney[2]. Activity was estimated manometrically in bicarbonate – carbon dioxide buffer. The compounds were in contact with the enzyme for about fifteen minutes during equilibration; after tipping in the substrate, inhibition was measured over a period of 30 min. It was found that the metal complexes of phenanthroline, dipyridyl and terpyridyl were potent inhibitors of cholinesterase. With a substrate of 0·06 *M* acetylcholine, $Ru(phenan)_3(ClO_4)_2$, 10^{-5} *M*, gave an inhibition of about 80 per cent. The difference between the (−) and (+) forms of the dipyridyl complex was pronounced. At 10^{-4} *M* the (−) form gave about 90 per cent inhibition. The (+) form at the same concentration gave about 20 per cent inhibition; at 10^{-3} *M* the inhibition reached about 75 per cent. The inhibition caused by all of these compounds seemed to be competitive (see graph). No appreciable inhibition was noted with $Co(en)_3(NO_3)_3$.

The use of (±) mixtures of $Ru(phenan)_3(ClO_4)_2$ did not appreciably affect the nature of the inhibition. It appeared that the action of the (−) and (+) forms was additive, and the (+) form did not appreciably antagonize the (−) form.

The action of the complexes on crystalline aldolase prepared by the method of Taylor and Green[3] was examined. Even at high concentrations no inhibition was noted.

Action on bacteria. Concentrated aqueous solutions of the optically active complex salts were sterilized by intermittent heating at 60° C. Appropriate amounts were added to sterile Wright's broth and their effects on the growth of *Escherichia coli*, *Staphylococcus hæmolyticus* and *Salmonella typhi-murium* were examined. With (+), (−) and (±) Co(TET)I, bacteriostatic and sometimes bacteriocidal action at 1/1,000 was noted against *E. coli* and *S. hæmolyticus*. In some instances, the growth of the Gram-positive organisms was inhibited at concentrations of 1/1,000 by (+), (−) and (±) $Ru(phenan)_3(ClO_4)_2$.

Discussion. The neutral complexes examined had no overall charge and had no pronounced biological



ctivity. The complex cations, most of which showed high biological activity, were chemically highly table, co-ordinately saturated, and had no specific ctive groups or centres. The ruthenium and osmium omplexes were not attacked by concentrated acids r alkalis. Dissociation of the complexes could be egarded as extremely small. It may be concluded rom the similarity of the effect in each series of ompounds that the biological activity was a function f the cation as a whole and not of the metallic atom.

From the concept of the "essential neutrality of toms" (Pauling[4]), it may be postulated that the onic charge is not centred in the metallic atoms, but s distributed fractionally over the ligands. The omplex cations thus carried a peripheral charge, hich was related to the total charge, to the electro-ositivity of the metal atom, the electrophyllic roperties of the ligands, and probably to their size. hey thus partake more of the nature of organic ompounds than of simple ions, but differ in that he charge is not localized and is greater in magnitude. Vith the exception of the Ru(trpy)$_2^{++}$ ion, they exist n enantiomeric forms in which the charge distribution eads to non-superimposable mirror-image electrical orms[1].

As a result of the nature of the metal/ligand bonds, harge separation may occur in neutral complexes, hich consequently carry a small peripheral charge[5].

It appears that the inhibition of cholinesterase ccurred by adsorption-electrical interaction on an ctive centre sufficiently close to the ester-splitting entre to inhibit by a steric effect. The absorption entre appeared to be associated with an optically ctive carbon atom which had an asymmetric field ue to the arrangement of four different dipoles. here was thus a general adsorption due largely to e cationic charge; and superimposed, a specific ffect due to differential coupling of the asymmetric elds.

Inhibition by the Ru(trpy)$_2^{++}$ ion, it appears, was ue to the charge alone; but the asymmetry of the elds was important in determining the degree of hibition by the (+) and (−) forms of the tris-: 2′-dipyridyl complexes. It is not clear what ctors influence the magnitude of the specific oupling. However, it is pertinent to point out that robably undue emphasis has been placed hitherto n the purely spatial considerations of optical ntipodes, properties which appear to be incidental o the electrical properties.

The toxicity of the complexes in mice would depend pon the rate of penetration to the site of action and o the specific inhibitory actions at that site. The rate of penetration would depend partly upon the lipid/water partition, and partly upon the nature and configuration of the charge of the complexes. The results suggest that the (+) forms penetrated more rapidly than the (−) forms. The specific action, probably due to the inhibition of cholinesterase in the central nervous system, was also dependent upon the nature and configuration of the charge, (−) forms being more effective than (+) forms.

We are indebted to Mr. G. Merritt, of the McMaster Laboratory, who carried out the bacteriological work, and to the Trustees of the Ian McMaster Bequest for a grant to cover the costs of this investigation.

[March 10.

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RADIO OBSERVATIONS OF THE SOLAR ECLIPSES OF SEPTEMBER 1, 1951, AND FEBRUARY 25, 1952

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AND
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THE radioastronomy research group working in the Physics Laboratory of the École Normale Supérieure in Paris organized an expedition to observe the annular solar eclipse on September 1, 1951. The totality zone crossed French West Africa and also the Niger near the Markala Dam (lat. 13° 42′ N., long. 6° 04′ W.), which had been chosen as the centre of observation.

The programme consisted of measurements on 9,350 Mc./s. (λ, 3·2 cm.) and 160 Mc./s. (λ, 1·78 m.). The aims were:

(*a*) On the centimetre wave-length: to compare total eclipse measurements made by Hagen, Haddock and Reber[1] in 1950 with annular eclipse observations; such a comparison may prove to be interesting for limb-brightening studies.

(*b*) On the metre wave-length: to study the dimensions of the radio-sun and the brightness distribution across the disk, taking advantage of the present low level of solar activity.

The meteorological conditions were favourable, the local conditions as to interference-level, mains-stability, auxiliary personnel and workshops were excellent and the solar situation was remarkably stable (very few prominences and two sunspots of slight importance).

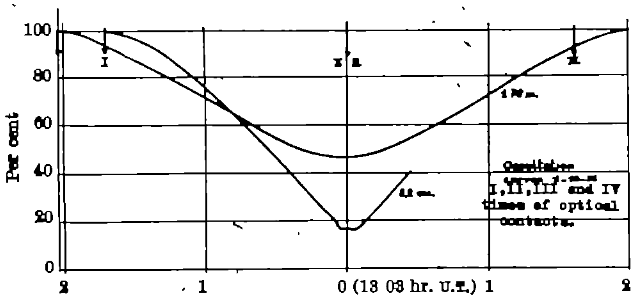

Fig. 1

The results obtained[2] were as follows (Fig. 1):

On the 3·2-cm. wave-length, errors of direction occurred which prevented us from using more than two-thirds of the eclipse duration. We observed that, at the time of eclipse maximum, 16 per cent of the whole radiation remained. This figure may be compared with those obtained by Hagen, Haddock and Reber, namely, 5·6 per cent for an eclipse of magnitude 1·018 against 0·975 in 1951. The disk fraction of area 8·6 per cent which was hidden in 1950 and could be seen in 1951 contributed 10–12 per cent to the total radiation. The theoretical figure is 12 per cent if limb brightening is assumed.

On the other hand, a disk of uniform brightness which would give the same 16 per cent remainder would have a radius of 1·07 that of the sun. The observed occultation curve always lies below the theoretical one computed for a disk of uniform brightness of radius 1·07 that of the sun. This also confirms the existence of limb brightening.

The occultation of a sunspot group is visible on the record. This allows us to see that the 3-cm. emitting area located near this group occupies the same position; its area is certainly smaller than twice the area of the perturbed zone.

On the 1·78-m. wave-length, the occultation curve obtained is the first published on a metre wave-length in a period of solar radio quietness. The relative accuracy achieved is 0·3 per cent. It can be observed that: (*a*) the decrease of the radio radiation begins 16 min. before the first optical contact. The apparent diameter of the radio-sun is 1·35 times larger than the optical apparent diameter; (*b*) at the contact times, 8·5 per cent of the total radiation is occulted; (*c*) at the time of maximum eclips
48 per cent of the total radiation remains.

From these results, we may deduce that th
solar radiation on 1·78 m. wave-length does nc
possess radial symmetry. If we study th
occultation curve for a disk with unifor
brightness distribution with a radius 1·35 tim
that of the sun, we find that 70 per cent
the total radiation must remain at maximu
eclipse. On the other hand, the energy receive
actually decreases much more rapidly ne
optical contacts than for any other model wit
radial symmetry, with uniform brightness
with limb or centre brightening.

The equatorial apparent diameter of the radio-su
on 1·78-m. wave-length is a great deal larger tha
the polar apparent diameter.

These results have been wholly confirmed by th
observation of the eclipse of February 25, 1952,
Marcoussis (near Paris) and Dakar (French We
Africa), where the apparatus used at Markala in 195
is now daily operated. Fig. 2 shows that, at the tim
of optical contacts, a decrease of 0–1 per cent wa
observed in Paris in 1952, 8·5 per cent in Makala i
1951 and 12–13 per cent in Dakar in 1952. Thes
figures confirm the above results. A tentative mod
of the radio-sun observed on a wave-length of 1·78 n
is also given in Fig. 2.

A detailed description of these experiments wi
shortly appear in the *Annales d'Astrophysique*. Th
description of the apparatus will appear in anothe
memoir.

We wish to acknowledge the help of Prof. Y
Rocard, director of this Laboratory, and to thank th
Service des Études et Recherches, French Nav
Department, the Bureau des Longitudes an
especially the staff of the Office du Niger establish
ments in Markala (French West Africa). [May 19.

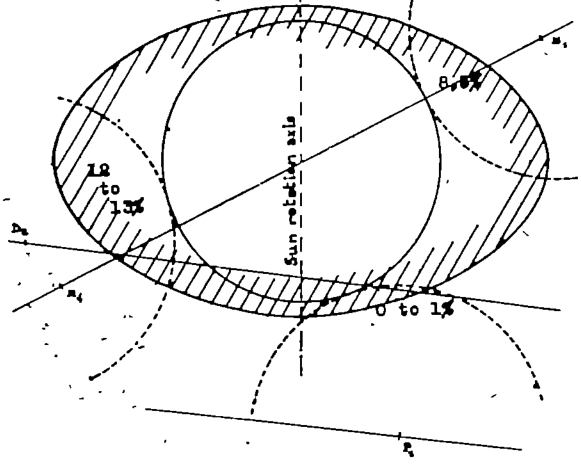

Fig. 2

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MEASUREMENT AND INTERPRETATION OF EYE-DOMINANCE

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SUCH expressions as 'the dominant eye' or 'th
master eye' are commonly used; but th
meaning attached to the terms varies considerabl
There is, further, no agreement as to the preci
significance and importance of such a conception
dominance in eyedness. At one extreme are thos
who agree with Gould[1] in believing that righ
handedness follows generally more perfect develop
ment of the right eye; or Parson[2], who stated tha
eyedness is one aspect of dominant sidedness and du
to greater activity of the cerebral hemisphere whic
governs the favoured side. There are also those wh
claim that there is no such thing as a unitary fact
of eye-dominance; that it is only evident under th
artificial conditions of a laboratory experiment, an
even there, probably an artefact.

When one considers what is meant by the actu
term eye-dominance, apart from its real signif

cance, here also there is considerable confusion. By the dominant eye can be meant either the eye with the greater visual acuity, that is, which can actually see better; or the preferred eye, which is not necessarily the same as the former. Matters are still further complicated by the fact that, whereas in handedness most important actions are carried out with one hand only and require a certain amount of skill, resulting in the choice of the same hand at each attempt, in eyedness, on the contrary, the normal method of using the eyes is as 'a pair of structures'. Thus dominance can either be considered when only one eye is being used, or in binocular vision, where in fixating or sighting one eye plays the leading part. All these points have to be borne in mind when constructing tests of eyedness or estimating the significance of such studies, especially where a claim is made that they reveal once and for all the dominant sidedness of the subjects.

In spite of the fact that binocular vision is the normal type, some investigators have used tests to determine the preferred eye for sighting where a deliberate choice of one eye is made. Examples of such tests are: sighting through a narrow tube, looking through a small hole, etc. The type of situation in everyday life when such a choice is made is in shooting with a rifle or using a microscope. Care requires to be taken in such tests to eliminate the effect of the dominant hand on the results. It appears that in instances where a high correlation was obtained between handedness and eyedness this was due to taking inadequate precautions to ensure that the preferred hand did not affect the results. When that precaution is taken, the correlation between handedness and eyedness is low. In early studies of eyedness, visual acuity was sometimes the only measure used. It has since been pointed out by several investigators that comparative visual acuity should not be confused with the dominant eye. Further, it has been shown by Gahagan[3] that in only 55 per cent of his cases was the better eye the preferred one.

It is not evident under normal conditions that one eye is dominant when both appear to be working. Some of the tests designed to determine the dominant eye in binocular vision are such that the subject has both eyes open, and is under the impression that he is using both; but the situation is such that it necessitates the use of only one. Examples of such tests are: sighting through a cone placed over both eyes, or through a small hole in a sheet of paper held at arm's length. If the subject looks directly at the experimenter, then the eye seen through the end of the cone or the hole in the paper is the dominant one. The advantage of using such a test is that the experimenter does not have to rely on the subject's report, which is obviously an advantage, especially in testing children. The use of such a simple technique means also that it has been possible to test children for eyedness at an early age, in fact as early as three years of age; and the eye preference then shown was found to be unchanged at the age of seven. Many more elaborate types of apparatus have been designed to measure eye dominance; but it appears that the simpler methods are as effective. Jasper and Raney[4], for example, utilized the 'phi phenomenon' as the basis for a test, while others have used retinal rivalry as a measure, by employing a stereoscope and presenting a different view to each eye, dominance being determined by the view which is kept longer in consciousness.

A warning which has been given by Crider[5] should be borne in mind. He carried out an investigation to discover the cause of the wide variation in figures found in different studies of eyedness, and claimed that this was due to the different criterion set up by different investigators. Consequently the data of no two investigators are comparable unless the number of sighting opportunities and the criterion are stated, and are in accord. This caution is particularly necessary when considering the figures given for indecisive eyedness.

Crossed laterality is the term used when a person's dominant eye and hand are not on the same side. Many have suggested that the ideal is for these to be in accord, claiming that this facilitates the co-ordination of skilled movements. Starting from the assumption that this is not only the ideal but also the normal, they have explained away cases of crossed laterality as being caused by change of handedness. A consideration of the facts reveals the inadequacy of this explanation. If, as is found, the percentages of right- and left-eyedness are 65 and 35 approximately, while those of handedness are about 94 and 6 respectively, then obviously a considerable number of right-handed people must be left-eyed. In short, the proportion of uncrossed to crossed laterals must be about 2 : 1. It seems absurd in any case to assume that all changed left-handers were left-eyed in the first instance; on the contrary, it would be more feasible to suggest that they may owe their success in making the necessary shift to the fact that they were already right-dominant in one respect, namely, eyedness. A third objection to this view, that crossed laterality results from changed handedness, is the fact that it does not suddenly appear after the children start school, but is also found in pre-school children. To have established that it may be normal to have the dominant hand and eye on opposite sides does not mean that one can dismiss the possibility that it may be advantageous to have them in accord, and that various difficulties may be encountered by those who are right-handed and left-eyed or left-handed and right-eyed. A number of writers have actually suggested that this does bring with it considerable educational difficulties, or even that left-eyedness may itself be an educational handicap. Further investigation is, however, needed on these points. A recent study[6] of the handedness of American top-flight baseball players showed that more than the expected number were left-handed, which leads one to consider the possible findings of an analysis of, say, ace dart players, archers, or crack shots with a rifle, in all of which sports hand–eye co-ordination is so important. It is possible that one would find among them a higher incidence of consistency with regard to hand and eye dominance, that is, more right-handed and right-eyed and left-handed and left-eyed than is found in a random sample of the population. This is an interesting idea, since it is usually said that a person's dominant eye cannot be changed. It would then reveal that the difficulties in learning to fire a rifle may not all be in connexion with handedness; in fact, these may be the least of the trouble. It might be advantageous for a left-eyed person to fire from the left shoulder, while a right-eyed person should fire from the right.

However, to leave the realms of speculation, it appears that dominance of one eye has been established roughly in the proportion of two right-eyed to each one left-eyed, and that it is found in its clearest form in binocular vision—that, in fact, true binocular vision in the sense of identical functioning of the two eyes does not exist. Walls[7] has recently suggested an explanation of eye-dominance by what he termed his theory of directional dominance, claiming that the record of the innervations to the muscles of one eye only are used for the construction of binocular percepts of visual direction. This does not mean that the other eye is unused, but merely implies a differentiation in function of the two eyes. Walls mentioned the fact that after practice the microscopist is able to keep both eyes open without distracting his attention from the slide. If he should, however, attempt to use the other eye, the non-dominant, he will find that the contents of the field of view of the dominant eye are seen superimposed on the instrumental field, and seem to interfere with good observation of the slide. It appears that the benefit of eye-dominance is that it clears the visual field by giving the right of way to the image of one eye, the dominant, making it appear more substantial than the other, which tends to be suppressed.

This survey of the commonest types of eyedness and some interpretation of the phenomenon reveals at least the range of factors considered important by different investigators, and also the necessity for caution in the acceptance of the findings based on such tests. In spite of this, it must be maintained that the dominant eye is a reality, though some of the statements on the subject have been rash, and many of the findings of dubious validity.

[May 16.

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RADIATION CHEMISTRY

THE Faraday Society held a general discussion on "Radiation Chemistry" in the University of Leeds during April 8–10. The meetings were well attended and there were many visitors from overseas—forty-four from fourteen different countries—including many well-known workers in this field, among whom was Prof. K. F. Bonhoeffer, president of the Deutsche Bunsen-Gesellschaft für physikalische Chemie. The president of the Society, Sir Charles Goodeve, took the chair on the first day; on subsequent days Profs. C. E. H. Bawn and H. J. Emeléus presided. The authors were allowed five minutes to make the salient points of their contributions, so that ample time was left for discussion.

Radiation chemistry—the study of the chemical effects of photons, electrons, or positive ions of an energy greater than 50 eV.—has made rapid progress during the past few years, mainly owing to our increased knowledge of the chemistry of free radicals and of molecular ions. Its relatively slow development compared with that of photochemistry is due to the greater complexity of the primary process: in photochemical reactions this is simple and involves the absorption of a quantum of radiation by a molecule; but the transfer of energy from short wave-length radiation or from bombarding particles is complex, and prediction of the mechanism or of the products is uncertain. The object of this discussion, the first to be held on the subject by the Faraday Society, was to review the present position, to attempt a synthesis of the differing points of view of physicists, chemists and biologists, and to suggest further lines of development.

The general introduction was given by Prof. F. S. Dainton (Leeds), who reviewed the present difficulties of the subject and directed attention to the more important problems which have to be solved. He emphasized the lack of knowledge of the nature of the primary process; the value of the energy (W) required for the formation of an ion pair (formed along or near the track of the bombarding particle) is not known for liquids, nor how it is related to the ionization potentials of molecules with which the impinging particle collides. The relation of the mean ion density to the energy, mass and atomic number of the particles is, however, known qualitatively at least, and forms the basis of hypotheses which relate the amount and nature of the reaction product with the mass and energy of the particle. Caution must be observed in applying to liquid systems conclusions based on the gaseous phase; but cases are known in which such extrapolations are legitimate. In polar media, however, the magnitudes of solvation energies and entropies are such as to invalidate the assumption of parallel behaviour in the liquid and the vapour, and they refer to equilibrium conditions not relevant in systems in which the charge transfer processes are very rapid. Prof. Dainton directed attention to some important questions which would be discussed at the meeting: the observed value of G_R, the fraction of the absorbed energy used in the formation of radicals, may be a function of the solute and may depend on other competing processes, and thus the maximum observed values are likely to be the more significant; differences in track density leading to variations in ionic yield may arise from quite small changes of energy—a point of considerable importance to radiobiologists; although the initial distribution of primary products is non-uniform, rate expressions based on uniform distribution may successfully account for the observed kinetic behaviour; the radiolysis of water produces species which may lead either to the oxidation or the reduction of certain solutes, and a considerable knowledge of the behaviour of the system under varying conditions is necessary before theoretical conclusions are made; the concept of protection and sensitization in biological systems may be of importance in simpler systems.

The first three papers were on the primary act. Prof. F. W. Spiers (Leeds) reviewed the processes of absorption of ionizing radiations in terms of the quantum energy, and discussed the relative importance of the photoelectric, Compton recoil and the pair-production processes in the absorption coefficient of water. (Data for water for some commonly used radiations were given.) The loss of energy by charged particles was discussed in terms of the stopping power of the medium given by the theory of Bethe and its modifications. The magnitude of the energy (W) required to produce an ion pair was discussed in relation to the type of particle, its speed and the properties of the absorbing medium, and finally some indication was given of the distribution of ion pairs along the track of the fast-moving particle. Prof. H. S. W. Massey (London) dealt with the nature of gaseous ions, and the formation of clusters by alkali metal ions with polar molecules and with rare gas atoms, and described recent work on the molecular ions of the rare gases. He directed attention to certain features of atomic and molecular negative ions and to metastable ionic states. The second part of his paper was concerned with the rates of reactions involving ions, their classification, and the different processes which may occur. Prof. J. L. Magee (Notre Dame) examined the mechanism of charge neutralization in reactions between positive and negative ions by means of potential energy curves and their crossing-points, and gave a theory of the probability of transition. He concluded that the reactants retain their constituent atoms and configurations, and that dissociation may follow, but not rearrangements involving both the ions; highly excited states are to be expected, and radicals should be common reaction products. In the discussion which followed, some consideration was given to the problem of light emission and its role (if any) in radiation chemistry.

The next group of papers were devoted to actinometry. Dr. N. Miller and J. Wilkinson (Edinburgh) compared and criticized a number of systems which have recently been proposed for chemical dosimetry. They discussed the characteristics of suitable reactions in aqueous media, and summarized the pertinent data for the oxidation of ferrous ions in air-saturated 0·8 *N* sulphuric acid solutions, the reduction of ceric ions in similar solutions, and the hydroxylation of benzene in air-saturated water. There is considerable lack of agreement, except for ferrous sulphate solutions at lower dose-rates. The results were presented of their exhaustive tests designed to examine the variables which might cause irreproducibility in this system with X- and with γ-rays. The system is also applicable to electron dosimetry, but not to that of heavy particles. Non-aqueous systems were also discussed. Prof. F. S. Dainton, in his introductory remarks, expressed the gratitude of the meeting to Dr. Miller and Mr. Wilkinson, and hoped that it would be generally agreed to use the aerated ferrous sulphate actinometer for X- and γ-rays with dose-rates less than 1,000 r./min. Prof. Milton Burton (Notre Dame) strongly supported this view, and stressed the desirability of recording the total amount of chemical change per unit of energy absorbed (for example, as the so-called *G*-value or radiation yield per 100 eV.) rather than the ionic yield. J. Wright (Harwell) described experiments on the pile irradiation of various chemical systems, designed so that they could be related to calorimetric measurements, which will ultimately be the basis of dosimetry for pile radiation chemistry. It was found that the ferrous sulphate system was suitable for short irradiations and gave information about the γ-radiation resulting from the decay of fission products. General discussion followed, devoted partly to a consideration of post-irradiation effects in the ferrous sulphate system.

Attention was then directed to the radiolysis of pure liquids. Prof. Burton and S. Gordon (Notre Dame) discussed the use of mass-spectrometric and radiation-chemical data on the same compounds for the interpretation of their mechanism of decomposition; the ions revealed by the former process are complementary to the radicals of the latter. The application of these methods to the radiolysis of benzene and heavy benzene (C_6D_6) shows that decomposition may occur either by bond rupture or by rearrangement; in a mixture the two compounds protect each other against radiation. A. Prevost-Bernas, A. Chapiro, C. Cousin, V. Landler and M. Magat (Paris) reviewed the possibilities and the limitations of two methods they have used for the determination of the number of free radicals formed in organic liquids by ionizing radiations, and gave estimates of the fraction of the energy used in free radical formation. They also discussed the mechanism of the production of free radicals in liquids irradiated in a pile, and the contributions of the different radiations present.

The radiolysis of water is important not only for its own sake but also because it is a factor in the study of the radiation chemistry of aqueous solutions. Dr. A. O. Allen (New York) discussed his mechanism of the decomposition of water, based on the very large amount of experimental work done in his laboratories during the past five years, according to which molecular hydrogen and hydrogen peroxide are formed simultaneously with the production of hydrogen atoms and hydroxyl radicals, the molecular yield increasing, and the radical yield decreasing, with the ionization density of the radiation. The reverse reaction, $H_2 + H_2O_2 \rightarrow 2H_2O$, which is initiated by free radicals, is favoured by dissolved hydrogen and retarded by dissolved oxygen or hydrogen peroxide. The molecular decomposition is ascribed to reactions occurring in very small regions —hot spots. Dr. Allen also discussed the conditions to be satisfied in experiments designed to determine the molecular (G_M) and radical (G_R) radiation yields in water, and gave provisional values for these quantities which were the subject of some discussion. Prof. P. Bonet-Maury (Paris) also discussed the formation of hydrogen peroxide and of hydrogen from pure water by radiations of different types, and the possible secondary reactions and equilibria which may occur.

The next group of papers was on the radiation chemistry of aqueous solutions. Dr. M. Haissinsky (Paris) considered the mechanism in dilute solutions in terms of the oxygenated radiolytic derivatives of water. Oxidation reactions preponderate; but reduction reactions are caused by hydroxyl radicals either directly, or indirectly by reaction with molecular hydrogen to give water and hydrogen atoms. It was suggested that hydrogen is produced chiefly by the process, $H_2O + e = H_2 + O^-$, which leads to the formation of two hydroxyl radicals and one molecule of hydrogen per ion pair. Dr. C. B. Amphlett (Harwell) described experiments in which the oxidation of ferrous ions by X- and γ-radiation was studied in dilute sulphuric acid solutions of different concentrations and in the presence and absence of complexing agents. The variation in the initial oxidation-yield with *p*H suggests that the primary act is more complex than is usually assumed. Values of the 'equivalent redox potential' of irradiated water with respect to the ferrous–ferric system were obtained. Dr. W. M. Garrison and Prof. G. K. Rollefson (Berkeley) described elegant tracer experiments on aqueous solutions containing ferrous ion and carbon-14 dioxide irradiated with high-energy helium atoms, and found that the principal products were ferric ion and hydrogen in the molar ratio two to one; formic acid and much smaller amounts of formaldehyde and oxalate were produced. A mechanism giving a rate law which agrees with the experimental data was proposed.

Papers mainly concerned with the decomposition of hydrogen peroxide followed. Dr. J. Weiss (Newcastle upon Tyne) discussed the photochemical decomposition in relation to that by ionizing radiations, and obtained rate expressions for the reactions occurring within, and between, the tracks. Dr. E. J. Hart and M. S. Matheson (Chicago) described experiments with continuous and intermittent γ-radiation on aqueous hydrogen peroxide solutions in paraffin-coated cells, in which they found that the decomposition yield depended on the square root of the hydrogen peroxide concentration and inversely on the square root of the dosage-rate. A novel feature of the mechanism proposed was that chain termination results from the termolecular reaction $2HO_2 \rightarrow H_2O_2 + O_2$, in which hydrogen peroxide is regarded as being a third body of exceptionally high efficiency. Dr. M. Ebert and J. W. Boag (London) reported experiments on the decomposition of water and hydrogen peroxide by electrons and X-rays, showing that with neutral water there is no dependence on the intensity of the radiation, but that in acid solution the equilibrium concentration of hydrogen peroxide produced by large doses depends on the intensity. The mechanism proposed received some confirmation by further work on hydrogen peroxide produced in neutral aerated water by 30 and 220 kV. X-rays and 1·2 MeV. electrons by these workers in collaboration with Dr. M. Lefort (Paris and Leeds), H. C. Sutton (Leeds) and M. Ebert and Tikvah Alper (Hammersmith) using different analytical techniques. Dr. T. J. Hardwick (Chalk River) showed that, in the indirect action of X- and γ-radiation on aqueous ferrous and ceric sulphates, the yield varies with the initial energy of the ionizing electrons, and that this effect may be explained on the basis of existing theories of the primary action of ionizing radiation on water. The probability of the recombination of hydrogen atoms and of hydroxyl radicals was calculated as a function of the instantaneous electron energy.

Dr. E. Collinson and Prof. Dainton (Leeds) showed that the kinetics of the polymerization of aqueous acrylonitrile solutions induced by X- and γ-rays are strongly different from photochemical or catalysed reactions, and are consistent with an inhomogeneous distribution of the radicals formed from water, while at higher dose-rates an increasing degree of homogeneity is indicated. The three types of radiation used produced the same results. In heavy water (D_2O) solution irradiation leads to the formation of deuterium atoms which participate in the polymerization. In the discussion it was suggested that the unusual kinetics might in part be due to the insolubility of polymer in monomer.

The remaining papers dealt with more complex systems: Dr. G. Stein (Jerusalem) described the reactions of certain dyes in aqueous and non-aqueous systems, drew comparisons with biological systems and then discussed the role of the hydroxyl radical, free electrons and molecular oxygen in the radiation chemistry of organic substrates. Tikvah Alper (Hammersmith) reported experiments on the indirect inactivation of bacteriophage by ionizing radiations, and gave survival curves under various conditions. Dr. W. M. Dale (Manchester) discussed the possible protective effect of a second solute which may act as a competitive acceptor of free radicals, and the use of this effect, which is specific, as a measure of the protective power of various solutes. Dr. C. B. Allsopp and J. Wilson (London) showed that the quantity of indole decomposed in aqueous solution by X-rays increases with increasing concentration of indole and with decreasing dosage-rate. The radiation and the photochemical decompositions follow similar courses. Dr. W. Minder and H. Heydrich (Berne) discussed the results of their experiments on the irradiation of halogenated hydrocarbons in organic solvents, which show that the formation of halogen acids depends on the dose, the concentration of the solution, the number of halogen atoms in the compound and the type of binding.

The meeting was very successful on both the scientific and social sides, and may fulfil the hope expressed by Sir Charles Goodeve at the guest-night dinner that it would stimulate the development of radiation chemistry as much as a previous discussion many years ago had that of the closely related subject of photochemistry. The papers, together with discussion on them submitted in writing to the secretary, will appear later as a separate publication of the Faraday Society.

J. W. Belton

SCIENTIFIC EDUCATION OF PHYSICISTS

THE pamphlet "The Scientific Education of Physicists"*, recently issued by the Institute of Physics, is a report prepared by the Education Committee of the Institute which should act as a useful guide, for students who wish to enter the profession of physics and for those who have the responsibility of advising or teaching such students, to the facilities available for the education and training of physicists.

The Institute recognizes only two qualifications as satisfying completely the academic requirements for election to corporate membership—an approved degree from a recognized university, and the Institute's own graduateship examination—although partial exemption from the graduateship examination may be claimed by those who have previously obtained the Higher National Certificate in applied physics. In addition to the suitable degree courses at university institutions, the report refers to the several technical colleges which provide advanced courses in physics, usually for the external degree of the University of London, but it warns the intending student that very often such technical colleges, with the exception of the London Polytechnics and a few of the main provincial colleges, have poor facilities for teaching physics and very rarely do their resources extend to an honours course in physics. Moreover, since he will find it extremely difficult to obtain adequate financial assistance at a technical college, for the student who wishes to continue and do post-graduate research, usually leading to the M.Sc. or Ph.D. degrees, it is almost essential that he should study at a university institution. However, many of the major technical, as well as university, institutions do run excellent part-time courses, series of lectures and summer schools on advanced topics in physics which practising physicists will find of great value.

The report emphasizes the importance to the science-student of an ability to express himself clearly, concisely and easily in English, both in speech and in writing. Recent discussion in the press has not settled whether the admitted prevalence of a low standard in English among physics students is due to lack of attention at the school or at higher levels; but in the report it is attributed mainly to individual negligence. The report concludes with appendixes giving factual data relating to the individual physics departments of all the universities and university lleges of Great Britain and Northern Ireland and those technical colleges recognized by the Institute. most universities are now revising their regula- ons, the information given in the report should be ated with some caution. It is always wise for the tending student to make early and direct appli- tion to the university institution or college con- rned and to obtain the most up-to-date information. would have been a good thing if some such dication had been added to the report.

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* The Scientific Education of Physicists. Pp. 32. (London: Institute of Physics, 1952.) 2s.

POSTERIOR PITUITARY GLAND

SYMPOSIUM AT CAMBRIDGE

A VERY informative session took place in the Physiological Laboratory, Cambridge, on June), when the Society for Endocrinology held a mposium on the posterior pituitary gland. This eeting was unique in the sense that so many of the eakers had made substantial contributions to our owledge concerning this gland, and that so much ore overall information is available for the posterior tuitary than any other endocrine gland.

The control of the secretion of the antidiuretic rmone was discussed from two different points of ew. Dr. P. A. Jewell and Prof. E. B. Verney gave account of their recent work dealing with the alization of the osmoreceptors. Intracarotid jection of hypertonic sodium chloride solution hibits water diuresis by causing release of the anti- uretic hormone. However, the exact site of the ceptor elements (osmoreceptors) stimulated by this pertonic solution is not known for certain. natomical investigation of the vascular bed of the ternal carotid artery showed that this vessel sup- ies the pituitary gland, the anterior hypothalamus cluding the greater part of the supraoptic and raventricular nuclei, as well as other parts of the osencephalon. Proof was given that the osmo- ceptors do not lie in the pars nervosa of the pituitary. e findings in an animal in which an internal carotid tery had been tied intradurally suggest that the ceptors lie in the prosencephalon. Dr. Mary Pick- rd emphasized that the supraoptic nerve cells, that ve rise to the majority of nerve fibres which supply e posterior pituitary, can be activated by different pes of stimuli, some arriving by nervous pathways, me being directly chemical, and some being physical physico-chemical. She described the release of tidiuretic hormone from the posterior pituitary and following injection of acetylcholine, nicotine, orphine and ferritin. Acetylcholine is rendered mporarily ineffective in this respect after appli- tion of di*iso*propylfluorophosphonate to the supra- tic nuclei. Intracarotid injection of adrenaline ven prior to an antidiuretic dose of acetylcholine gularly annuls the action of the latter. It is of uch interest that morphine is still effective in hibiting a high rate of urine flow if applied directly the supraoptic nerve cells, whether or not the olinesterase of the cells of the supraoptic nuclei ve been inactivated by di*iso*propylfluorophos- onate.

Prof. H. B. van Dyke, of the Department of armacology, College of Physicians and Surgeons, lumbia University, then dealt with the subject of sterior pituitary extracts. Ten years ago van Dyke, ow, Greep and Rothen[1] extracted a protein from e pars nervosa of the pituitary with the biological activities of both (antidiuretic – pressor and oxytocic) principles in about the same ratio as they are found in the gland. Its molecular weight was found to be about thirty thousand, and its biological activity was found to be low (1 unit = 61 μgm.). Although considerable evidence has been obtained that oxytocic and antidiuretic activities are present in constant ratios and that the protein is homogeneous, the possibility of adsorption of highly active principles on to an inert protein molecule has not been excluded. The highly purified principles recently isolated by du Vigneaud and his co-workers were discussed by Prof. van Dyke[2-5]. These principles have been isolated in a highly active form, 1 unit of the oxytocic principle being contained in 1·25 μgm. and 1 unit of the antidiuretic – vasopressor principle in 1·6 μgm. The amino-acid content of these two principles has been investigated, and it has been found that tyrosine, cystine, aspartic acid, glutamic acid, glycine and proline are common to both, whereas arginine and phenylalanine characterize the oxytocic principle and leucine and *iso*leucine characterize the antidiuretic – vasopressor principle. Using these principles, various workers have established that neither the contraction of the isolated rat uterus nor the ejection of milk by the lactating mammary gland is a specific test for the oxytocic principle, whereas the depressor response of the fowl's blood pressure appears to meet this requirement provided that contamination by antidiuretic – vasopressor principle is not excessive. The extremely sensitive antidiuretic test in the dog was found to be specific for the antidiuretic – vasopressor principle. It is not yet possible to decide from the published investigations whether the neurohypophysis secretes a large molecule containing both oxytocic and antidiuretic – vasopressor principles, or smaller molecules of highly active principles. The separate secretion of the latter has more teleological attraction.

In the next contribution, Prof. H. Heller dealt with the fate of the posterior pituitary (antidiuretic) hormone when secreted into the blood. Previous work had shown that antidiuretic extracts are rapidly inactivated by defibrinated blood, serum and liver homogenate. When injected intravenously the antidiuretic activity of posterior pituitary extracts disappears rapidly from the circulating blood, and antidiuretic activity appears in the urine. Recent unpublished experiments of Ginsburg and Heller have shown that the liver and kidney both play a part in the 'clearance' of the antidiuretic principle: it would seem that, in addition to excreting it, the kidney also removes it by another, as yet unknown, process. The question of the renal excretion of the antidiuretic principle, both of endogenous and of exogenous origin, was discussed in further detail.

B. A. Cross described the evidence underlying the present concept of a milk ejection reflex[6-8]. It can now be taken as established that the act of suckling stimulates a nervous reflex excitation of the posterior pituitary gland, and the secretion from this gland causes contraction of some element of the mammary gland and thus a positive ejection of milk from the mother to the young. Recent work using du Vigneaud's highly active oxytocic and antidiuretic extracts indicates that the posterior pituitary principle underlying milk ejection is the oxytocic principle and not a mixture of the two, as had been previously suggested. Mr. Cross also discussed unpublished work in which it was found that previous administration of adrenaline, or electrical stimulation of the posterior region of the hypothalamus with resultant sympathetic excitation, will inhibit the milk ejection reflex. Since the same procedures inhibit the milk ejection effect of posterior pituitary extract, it is likely that the effect of adrenaline is, at least in part, on the mammary gland itself. Dr. A. G. Lewis dealt with recent work on the secretion of the antidiuretic hormone in normal man. It is satisfying to know that many of the laboratory findings are being confirmed on the human. After eighteen hours of dehydration a normal subject had posterior pituitary hormone in the circulation with an antidiuretic activity equal to (approximately) 20 mU. of 'Pitressin'. It seems unlikely that the 5 mU./ml. of antidiuretic substance which have been detected by rat assay of human serum have any physiological action. Direct assay in the human subject has shown that human serum contains less than 0·1 mU./ml. after twelve hours of dehydration. Emotional stimuli, the intravenous infusion of acetylcholine, or of hypertonic saline, nicotine, morphine, anaesthesia and surgical operations and syncope may all produce large releases of the antidiuretic hormone in man.

The final speaker at the symposium, Dr. J. E. Cates, described the results of an investigation, in collaboration with Dr. C. Garrod, on fifteen patients with diabetes insipidus. 'Pitressin' tests separate the rare 'Pitressin'-resistant cases. Water deprivation gives results which vary in degree. Hickey and Hare's test with hypertonic saline may be nullified by an osmotic diuresis. Nicotine intravenously causes little or no antidiuresis when given in doses large enough to cause antidiuresis in normal subjects; larger doses usually cause some antidiuresis. The effect of nicotine in clinical diabetes insipidus supports the belief that nicotine stimulates the secretion of the antidiuretic hormone. The response to large doses suggests that the lesion to the supraopticohypophysial system is often not complete.

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LONG ASHTON RESEARCH STATION

REPORT FOR 1950

THE plant pathologist and the engineer tend to run their separate ways, sparing a modicum of liaison for each other, but rarely understanding the subject of plant pathological engineering as a whole. The annual report of the Agricultural and Horticultural Research Station, Long Ashton, Bristol[*], is perhaps most noteworthy for a determined attempt to consider the problems of the plant pathologist and engineer together. H. G. H. Kearns and N. G. Morgan publish an abridged specification of an experimental 'air-flow' small-volume drift sprayer and duster. This is designed to investigate the most efficient method of conveying very small drops of concentrated control materials to their disease targets, thus dispensing wit
large volumes of liquid, obtaining better penetratic
of the spray or dust cloud into foliage, and with
bringing great economy of the fungicide or insecticid
This material is fed into the blast from a fan deliverir
a large volume of air at low pressure.

New conceptions must not, however, be allowed
overshadow the solid worth of papers on more usu
subjects. Nutritional studies include investigatio
on zinc and copper deficiencies of crop plants (E.
Hewitt and E. W. Jones), work on iron metabolis
in plants by the same authors contributing separa
papers, and research on molybdenum and nitra
status in relation to yield and ascorbic acid levels
cauliflower (S. C. Agarwala; W. Plant). The weal
of detail and of interaction in all these results
summarized in the introduction to the report by t
director of the Station, Prof. T. Wallace (pp. 13–15
L. C. Luckwill and D. Woodcock have a prelimina
report on the nature of the hormone whic
occurs in the endosperm of developing apple see
It is, *inter alia*, acidic, heat stable, soluble in eth
and water, is destroyed by hydrolysis with stron
acid or alkali, and cannot be identical with indoly
acetic acid. A further report on pruning systems an
tree shape on yield and quality of apples is given b
R. M. Jarrett. Any pruning reduces yield; but norm
winter pruning improves quality. Allington and Cox
Orange Pippins cropped better as modified lead
trees; but Worcester Pearmain gave more produce
an open-centre tree. Continuing their studies of th
nutrition of the black currant, C. Bould and E. Catlo
find that yield varied as leaf nitrogen status, whic
decreased according to the following order of manuri
treatments: nitrogen plus phosphorus > sewag
sludge > nitrochalk plus compost > straw slud
compost > farmyard manure > no manure. D. J.
Nicholas and W. A. Forster consider the effects
copper, zinc, lead, cobalt, nickel and manganese i
excess on tomatoes and other crop plants. This is a
important study, for excesses of 'micro' element
figure in advisory work in addition to deficiencies
these elements.

Long-term work on spray materials superior t
lime-sulphur for the control of apple scab has bee
continued by R. J. W. Byrde and R. W. Marsh. The
found that glyoxalidine 341-*C* at 1 quart per 10
gallons equalled the standard lime-sulphur treatment
on Cox's Pippin, and was less phytotoxic. The ne
spray was also less damaging to foliage of Lane
Prince Albert and Stirling Castle than lime sulphu
A phthalimide preparation (*SR*-406) promises goo
fungicidal performance and freedom from phyt
toxicity.

F. W. Beech and S. W. Challinor discuss chang
in the pectin and nitrogen contents of apple juices
a first part of a larger study of maceration an
defecation in cider making. Fermentation of cide
can also be controlled by centrifuging; L.
Burroughs and S. W. Challinor consider the mecha
ism of this action in some detail. B. T. P. Bark
continues his investigation of cider yeast floras wit
a paper on that of Kingston Black ciders. Margar
E. Kieser and A. Pollard discuss the effect of fru
storage on the processing of apple juice, and, wit
C. F. Timberlake, the effect of manurial treatment o
the composition of black currants. Other short
papers are included in the report, which is edited b
R. W. Marsh, and numerous half-tone and lin
illustrations help to maintain its usual high standa
of production.

[*] University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1950. Pp. 217+13 plates. (Bristol: The University, 1951.)

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Heat Flow through the Floor of the Eastern North Pacific Ocean

THE flow of heat through the earth's crust has en measured many times at various continental ations, and is usually found to lie[1] within 50 per 1t of $1 \cdot 2 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$. Because of the sence of granitic rocks, with their relatively high dioactivity, in the crust under the oceans, it has en suggested that the heat flow through the deep- floor might be considerably smaller; but the ly data available from oceanic areas have been o measurements of the thermal gradient in deep- sediments reported by Pettersson from the edish *Albatross* expedition[2].

In 1949, Dr. E. C. Bullard spent the summer at Jolla in the preliminary development of an instru- nt for measuring temperature gradients in the sea or. During the following year, development of truments of the general type proposed by Dr. llard was continued under the direction of J. D. acs and J. M. Snodgrass, and in the summer of 50 a series of measurements was taken as part the work of the joint Scripps Institution of Oceano- phy – United States Navy Electronics Laboratory d-Pacific Expedition, on the Scripps research sel *Horizon*.

A hollow steel spear, 1·64 in. in outside diameter d 10 ft. long, was plunged vertically downward into bottom sediments and allowed to remain in place thirty to forty minutes. At its upper end the ar was attached to a heavy steel cylinder contain- a self-recording, self-balancing null potentio- ter which recorded continuously against time, to out 0·001° C., the difference in temperature be- een two thermal elements in the spear. The upper ment was situated 24·0 in. beneath the sea bottom, d the recording case, and the lower element 81·5 in. neath the upper element and 18·5 in. from the ar end. The thermal elements were connected rmally to the outside of the spear but were ulated electrically and protected from the outside drostatic pressure. We have satisfied ourselves m theory and experiment that the record of nperature difference against time obtained in this y can be extrapolated to give a value which responds within a few per cent to the undisturbed nperature gradient in the bottom sediment.

At each locality where the temperature gradient s measured, cores of the sediment were collected laboratory determination of the thermal con- ctivity; care was taken to preserve these samples as undisturbed a condition as possible and without ange in water content. The conductivity de- minations were made by D. W. Butler at the tional Physical Laboratory. Because of the high ter content of the sediments, the conductivities much lower than those in rocks and approach conductivity of sea water ($1 \cdot 3 \times 10^{-3}$ cal. sec.$^{-1}$.$^{-1}$ ° C.$^{-1}$).

The measured temperature gradients and thermal nductivities at six stations and the computed lues of the heat flow are given in the accompanying ole.

Latitude (North)	Longitude (West)	Depth of water (m.)	Temperature gradient (° C. m.$^{-1}$)	Conductivity (cal. sec.$^{-1}$ cm.$^{-1}$ ° C.$^{-1}$)	Heat flow (cal. cm.$^{-2}$ sec.$^{-1}$)
20° 48′	159° 42′	4,500	0·07	$1 \cdot 8 \times 10^{-3}$	$1 \cdot 3 \times 10^{-6}$
18° 18′	173° 23′	3,900	0·04	$2 \cdot 2 \times 10^{-3}$	$0 \cdot 9 \times 10^{-6}$
19° 28′	174° 35′	4,900	0·06	$2 \cdot 0 \times 10^{-3}$	$1 \cdot 2 \times 10^{-6}$
16° 45′	176° 24′	5,040	0·07	$1 \cdot 8 \times 10^{-3}$	$1 \cdot 3 \times 10^{-6}$
19° 02′	177° 19′	4,750	0·07	$1 \cdot 6 \times 10^{-3}$	$1 \cdot 1 \times 10^{-6}$
32° 35′	132° 30′	4,000	0·07	$1 \cdot 8 \times 10^{-3}$	$1 \cdot 3 \times 10^{-6}$

Although the number of measurements is small, it is noteworthy that at five of the six localities, covering a total distance of nearly three thousand miles, the computed heat flow lies within 10 per cent of the average value for the continents. From field evidence, it is likely that in the observation at long. 173° 23′ W. the spear did not penetrate completely into the sediment, and that consequently the recorded value for the temperature gradient at this locality is too low.

The heat flowing from the deep Pacific floor could represent at least in part a 'fossil' temperature gradient in the sediments, remaining from a time when the bottom-water temperature was higher than the present 1·60°. Short-period temperature fluctuations cannot be significant because observations indicate that deep-water temperatures in the North Pacific have remained constant within a few hundredths of a degree for the past twenty-five years. On the other hand, a markedly different climate five hundred to two thousand years ago might possibly have resulted in somewhat higher bottom-water temperatures in the tropics than those now prevailing. A bottom-water temperature of 4·5° one thousand years ago would account for half the observed gradient.

It might be supposed that the heat flowing from the deep-sea floor has been generated by processes within the sediments, such as biological activity, submarine weathering, radioactivity and compaction. Calculations show, however, that the total effect of these four processes cannot result in production of more than $0 \cdot 05 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$—about 4 per cent of the observed heat flow.

If the heat flowing from the sea floor does not originate within the sediments, it must come from the underlying rocks of the earth's crust and mantle. Seismic refraction measurements made by R. W. Raitt on the Mid-Pacific expedition show that the Mohorovičić discontinuity between the crust and the mantle lies within five to nine kilometres of the sea floor. If the material above this discontinuity is similar in content of radioactive substances to oceanic basalt, then only 15 per cent of the observed heat flow can originate in the crust. If we also assume that the heat is carried from the earth's interior by conduction, and that following Jeffreys[3] the thermal conductivity is 5×10^{-3} cal. cm.$^{-1}$ sec.$^{-1}$ ° C.$^{-1}$, only some 20 per cent of the total heat flow can be accounted for by cooling of the earth. The remaining 65 per cent could be supplied by disintegration of radioactive substances in the mantle. But the required content of radioactive materials is so high that, if the radioactivity is uniform with depth or decreases exponentially, the mantle below about 130 km. would melt within a time short compared to 3×10^{9} years. It is therefore necessary to assume either that radioactive materials are concentrated in the outer part of the mantle under the ocean, or that the heat is being transported outward by convection in the mantle. If a steady state of convection exists, more than sufficient heat would be generated in a mantle having a uniform potassium content equivalent to that of stony meteorites[4]. In either case, however, we have the paradox that if the mantle under the continents is similar to that under the ocean, then the heat flow from the continents should be much higher than the observed value because of the presence of highly radioactive rocks in the outer parts of the continental crust.

A heat flow of $1 \cdot 2 \times 10^{-6}$ cal. cm.$^{-2}$ sec.$^{-1}$ through the ocean floor should noticeably heat the bottom-water masses as they flow northward from the Antarctic. With a velocity of northward flow of the order of 0·1 cm. per sec., as suggested by Sverdrup, Johnson and Fleming[5], the temperature of a layer of bottom water 1 km. thick would increase by about one-tenth of a degree centigrade on its journey from the region of sinking in the Antarctic to the tropics. This amount of heating would be largely masked by mixing with high-temperature water from above. But with the much smaller velocity of northward flow suggested by some recent workers, there should be a much larger increase in the bottom-water temperature between the Antarctic and low latitudes. Such an increase is not observed. The possibility exists, therefore, that our measurements are not representative of the heat flow through the sea floor. Obviously many more measurements must be taken before reliable generalizations can be made.

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Arthur E. Maxwell

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La Jolla, California.
June 1.

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[1] Bullard, E. C., *Nature*, 156, 35 (1945).

[2] Petterson, H., *Nature*, 164, 468 (1949).

[3] Jeffreys, H., "The Earth", 85, 2nd edit. (1924).

[4] Birch, F., *J. Geophys. Research*, 56, 107 (1951).

[5] Sverdrup, Johnson and Fleming, "The Oceans", 754 (1946).

The preceding communication by Revelle and Maxwell gives a result which is completely unexpected, and demonstrates again how little we know of submarine geology. Their observations do, I believe, demonstrate that the heat flow is roughly the same under the oceans and continents. It seems most unlikely that this is a temporary condition dependent on recent large changes in the temperature of the bottom water, for this is largely determined by the existence of ice in the Arctic and Antarctic. The ice cannot have melted since the last ice age, because the water from it would drown the greater part of the continents. It seems almost certain that the heat found by Revelle and Maxwell must be generated by radioactivity in the rocks beneath the oceans, and therefore that the total amount of radioactivity beneath unit area of continent and ocean is the same when summed down to a depth of a few hundred kilometres (heat generated deeper down has not had time to escape). This would be very surprising if the continents were formed from a primitive sialic layer not present under the oceans, and are underlain by material which is the same under continents and oceans. It would, however, be natural if the continents are continuously expanding by a process of differentiation in which radioactive material is concentrated vertically[1]. The rocks beneath the oceans would then have the same total amount of radioactivity as those beneath the continents, but spre through a greater range of depth; this would gi the same heat flow as beneath the continents, b higher temperatures at depth.

As is pointed out by Revelle and Maxwell, so upward concentration is necessary to avoid melti under the oceans. Calculation suggests that the radioactivity were spread through a depth 150 km., no impossibly high temperatures wou be produced. A possible interpretation of t results therefore appears to be that when t earth solidified most of the radioactivity was co centrated in the upper 150 km. of the mantle; und the oceans this distribution still exists, but und the continents a further concentration has occurr into the top 10 or 20 km. On this view it would expected that the oceanic ultra-basic rocks wou contain more radioactive material than th continental ones. There are few reliable measur ments; but those that do exist do not show such difference. This matter should be further investigate

Other explanations can be suggested. It migh for example, be supposed that at some not too remo time a convection current rose under the Pacific an brought hot material near the surface, or that th horizontal limb of a convection current had tran ported material from beneath the continents t the central Pacific. Such suggestions are pu speculation, and there is no other evidence in the favour.

The difficulties may be connected with that reconciling the oceanic seismic and gravity result The gravity results suggest that the material beneat the Mohorovičić discontinuity may not be quite th same beneath the continents and oceans in spi of the close agreement in seismic velocities. Som discussion of these matters is given in a book[2] to published shortly.

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National Physical Laboratory,
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June 18.

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[1] Wilson, J. T., *Trans. Roy. Soc. Canad.*, 43, 157 (1949).

[2] Bullard, E. C., in "The Solar System", 2, chap. 3, edit. by G. P. Kui (Chicago Univ. Press).

Use of a Gamma-Ray Pinhole Camera for *In vivo* Studies

The pinhole camera method of taking gamm radioautographs, though it has been described in th literature[1], has had very little use because of th long exposure times which are necessary even whe the most sensitive radiographic films are used. A intensifying screen for use with the pinhole camer has now been developed which has made it possib to reduce the exposure time considerably. The scree consists of a large, flat crystal of thallium-activate sodium iodide. The gamma-rays produce scintillatio in the crystal which in turn affect the photograph plate. This method has made it possible to take a *in vivo* gamma-ray pinhole radioautograph of tumour containing 20 millicuries of iodine-131.

A drawing of the pinhole camera and intensifyi screen is shown in Fig. 1. A gamma-ray from th object being photographed goes through the pinho and travels in a straight line until it enters th sodium iodide crystal, where it may produce a Compton or photoelectric recoil. The recoil electron trave about a millimetre or less in the crystal. The lig

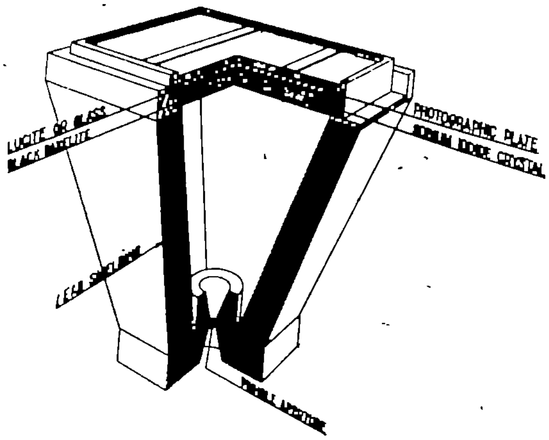


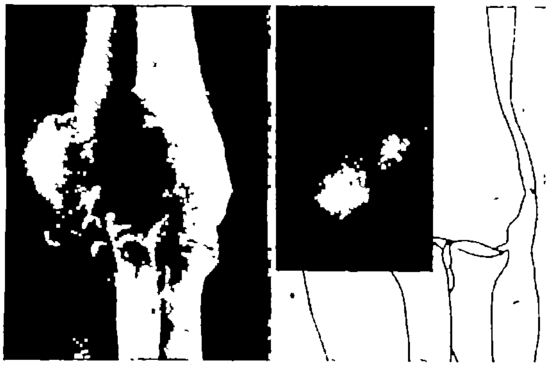
Fig. 1

roduced along the path of the recoil is emitted sotropically. The spreading of the light over the hotographic plate and the consequent loss of definition are limited both by inverse square law attenuation and by total reflexion from the glass-to-air oundary between the crystal and photographic plate. he angle of total reflexion is about 35°. The light eflected from the glass surface passes back through he crystal and is absorbed by the black 'Bakelite' ontainer.

There is a considerable loss in definition due to preading of the light from the thick intensifying creen, even though it is limited as described above. n ordinary radiographic work this would not be ermissible; but due to the relatively poor definition btained from the pinhole camera, the additional loss n definition is relatively unimportant. In order to get ood optical contact between the crystal and the glass window, and also to protect the crystal from the ffects of moist air, it is contained in a bath of Monsanto Chemical Co. 'Aroclor No. 1248'.

The camera was tested by taking autoradiographs f bottles of iodine-131 solution. It was found that concentration of about 1 mC./cm.² and an exposure ime of 1 hr. were sufficient to give a faint but sable image of the source. This is about twenty imes less exposure time than is necessary if Kodak No-Screen film is used with the lead-foil intensifying creens customarily used for gamma-ray radiographs.

The exposure times given above are for the following conditions. The pinhole size was 1/8 in.; the inhole-to-intensifying screen distance 7½ in.; the ntensifying screen was a crystal of thallium-activated sodium iodide crystal 2 in. × 4 in. × 5/16 in. thick, obtained from the Harshaw Chemical Co., 1945 East 97th Street, Cleveland 6, Ohio; the photographic plate was a Kodak type 103a—0 spectroscopic plate slightly overdeveloped in *D*-19 developer.



(*a*) X-ray radiograph. (*b*) Pinhole autoradiograph

Fig. 2. Metastasis of thyroid tumour at elbow

As mentioned before, the camera has been used for taking an *in vivo* gamma-ray autoradiograph of a tumour containing iodine-131. The tumour was a metastasis of a thyroid carcinoma. It was close to the skin, had a volume of 90 ml.[1] and an area of about 20 sq. cm. The picture was taken 24 hr. after a therapeutic dose of 100 mC. iodine-131 was administered to the patient. It was determined independently that 20 mC. lodged in the tumour. A one-hour exposure was taken and the resulting picture is shown in Fig. 2*b*. The general outline of the area which took up the iodine-131 is shown, together with the fact that it is concentrated in two main areas. An X-ray radiograph of the tumour taken from the same point of view is shown in Fig. 2*a*.

I wish to acknowledge consultation with Dr. C. A. Tobias and also the assistance of Drs. Frank Pierce and Enrique Strajman in supplying information about the patient. This work was performed under the auspices of the Atomic Energy Commission, Contract W-7405-eng.-48.

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May 1.

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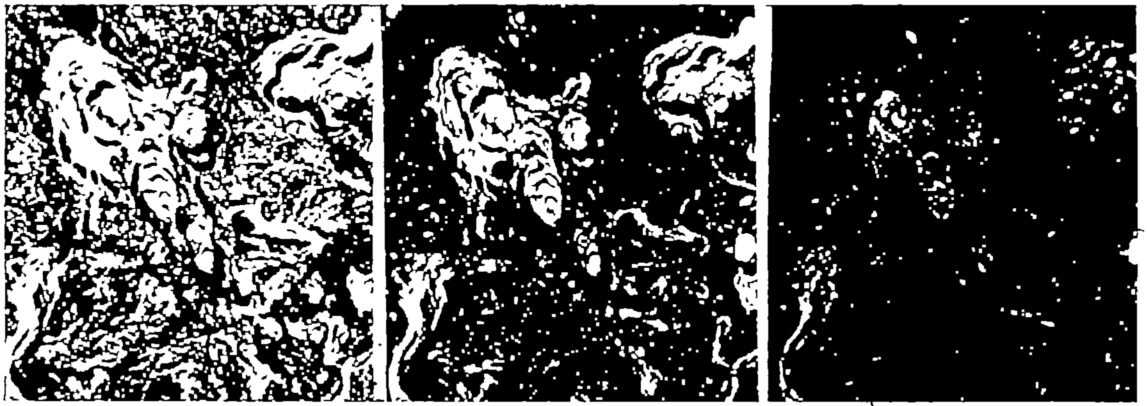
Microradiography with Alpha-Rays

ALPHA-PARTICLES are very strongly absorbed even by thin layers of materials. Their path through matter is almost exactly a straight line, and their effect on a photographic emulsion is very strong. These properties seem to be well suited for microradiographic mass determinations. Since such methods promise to be of value in several research fields, such as biology, medicine, mineralogy and metallurgy, experiments have been undertaken to determine the potentialities and optimal conditions for alpha-microradiography. The main advantage of using alpha-particles as compared with soft X-rays[1] would be the much simpler apparatus needed and the relative independence of the absorption on the composition of the object.

From purely geometrical considerations it is evident that to obtain high picture-resolution the alpha-particles must be collimated to normal incidence upon the object. Further, the object must be placed as near as possible to the photographic emulsion, and the grain-size of the emulsion should be small enough to allow the necessary enlargement. The collimation is most simply accomplished as in other types of radiography; the source of alpha-rays is placed at a distance from the object, which is large compared with the size of the source and the object.

When arranging for optimal mass resolution, that is, good contrast between areas differing in mass per unit area, the special mechanism of alpha-absorption must be borne in mind. The alpha-particles, being fast helium ions, are gradually slowed down


(1) (2) (3)

Alpha-microradiographs of a section 10 microns thick of cancer of the skin forming keratin (× 50.) The photographic density increases with decreasing mass per unit area

Source: 3·5 millicuries polonium-210, diameter 2 mm.; distance, source to object, 130 mm.; film, Lippmann emulsion 84·890 1 *M*; number of incident particles per square micron, 40

Energy of the alpha-particles entering the object corresponds to ranges of: (1) 0·6 cm.; (2) 1·1 cm.; (3) 1·6 cm. (in air at a pressure of 760 mm. mercury and a temperature of 15° C.)

through interaction with the electrons in the absorber. The number of elementary processes in this slowing down is sufficiently large to give a relatively low statistical variation (straggling) in the total range. This variation is only a few per cent of the total range, and is well represented by a Gaussian distribution.

An alpha-particle which has passed through a thin part of the object differs from one that has passed through a thicker part in that its residual range is greater, and it will thus penetrate deeper into the photographic emulsion. If the residual range of the alpha-particles after passing through the object is large compared with the straggling, the number of alpha-particles hitting unit area of the film is constant. The contrast is then solely dependent on the variation of photographic density with residual range. For normal incidence, it seems probable that this variation should be small except at small residual ranges. To obtain good contrast, the energy of the alpha-particles should thus be chosen so that they are almost completely stopped by the object. In this case, however, the straggling will be an important factor in the contrast produced, since a lower number of the alpha-particles will reach the film under thick areas than under thin areas. One would thus anticipate that the photographic density will vary with the thickness in a rather limited region of mass per unit area. On the other hand, the contrast should be very good.

The microradiographs chosen to illustrate this discussion were taken on the same object, the number of incident particles per unit area and the geometrical arrangement being held constant. The energy of the particles entering the object was varied by changing the air pressure in the space between source and object.

It is seen that in the thicker areas of the object the picture is white without contrast, and in the thinner areas the picture is uniformly black. In the intermediate regions the mass distribution can be measured by photometric comparison with the blackness under reference absorbers. The pictures show that by increasing the energy of the impinging particles the measurable region is moved towards thicker regions. By taking a sufficient number of radiographs with alpha-particles of varying energy, all the areas can be accurately measured. It is evident that all areas can be measured in one radiograph by using thin enough sections or an alpha-particle source emitting particles of a wide variety of energies. This means, however, sacrificing some of the mass-resolving power.

By using particles of homogeneous energy under oblique incidence, a large interval of linear dependence of photographic density on mass per unit area should be obtained. This, on the other hand, means sacrificing some of the resolution of the picture.

A more comprehensive publication concerning alpha-microradiography will be published elsewhere.

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Diffraction Microscopy with X-Rays

In a recent communication, A. V. Baez[1] predicts the practical resolution obtainable by diffraction microscopy using X-rays. His prediction is based on the required conditions for making the hologram. Similar derivations were described by us at the International Conference on Electron Microscopy in Paris, September 1950, though unfortunately we are still awaiting publication of the proceedings of this conference. Our derivation relates to the application of the method to electron irradiation where lenses can be used for producing intense coherent sources or to magnify the diffraction image (hologram). Our results are immediately applicable to the X-ray case and lead to the same conclusions as reached by Baez.

The predictions made by Baez that a resolution approaching 10^{-8} cm. could be obtained by the use of a point source or a grainless film are somewhat misleading since neither case is a physical possibility. In practice, the resolution is determined by both the size of source and the resolution of the photographic plate. Conditions can be arranged so that the resolution obtained is approximately equal to half the size of the source or resolution of the plate, whichever is the smaller. This, in fact, represents no worthwhile nprovement in resolution over that which can be btained by direct methods, for a point projection licroscope will give a resolution equal to the size f source, and shadow microscopy (object in contact ith photographic plate) will give a resolution equal) that of the plate. The theory shows an apparent ain in resolution of 2 ×. There is some doubt, howver, whether this is a real gain or whether it is lost s a result of the use of coherent illumination; for xample, to resolve two coherent Airy patterns, twice he separation required for incoherent radiation is ecessary.

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ssociated Electrical Industries, Ltd.,
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June 19.

[1] Baez, A. V., *Nature*, 169, 963 (1952).

Surface Oxide Films in Intermetallic Contacts

Bowden and Hughes[1] have shown that removal f surface oxide films can endow metals with very igh coefficients of friction. To examine to what xtent these films, when present, prevent metallic ontact, electrical resistance measurements have een made on the loaded junction between crossed ylinders (½ in. in diameter) of various metals, their xes being perpendicular. The apparatus was designed o minimize vibration. The metallic constriction esistances have been calculated from theoretical onsiderations which have been discussed by Holm[2] nd plotted against the applied normal loads. Experimental curves for gold and silver between 10 gm. nd 10 kgm. agreed closely with the calculations. High resistances obtained with other metals indicated the presence of poorly conducting films in the contacts. Some of the curves could be explained quantitatively by assuming the films to be uniform and stable.

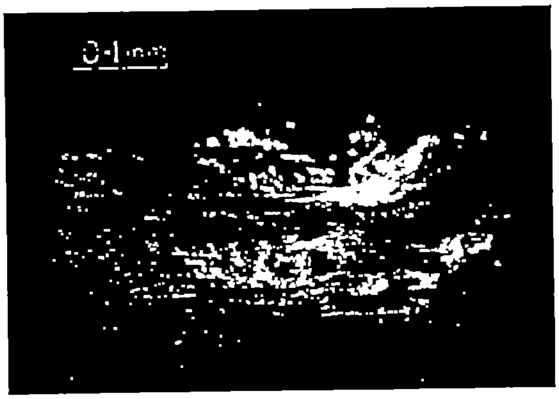

Fig. 2. Damage to stainless-steel cylinder; displacement increases from left to right

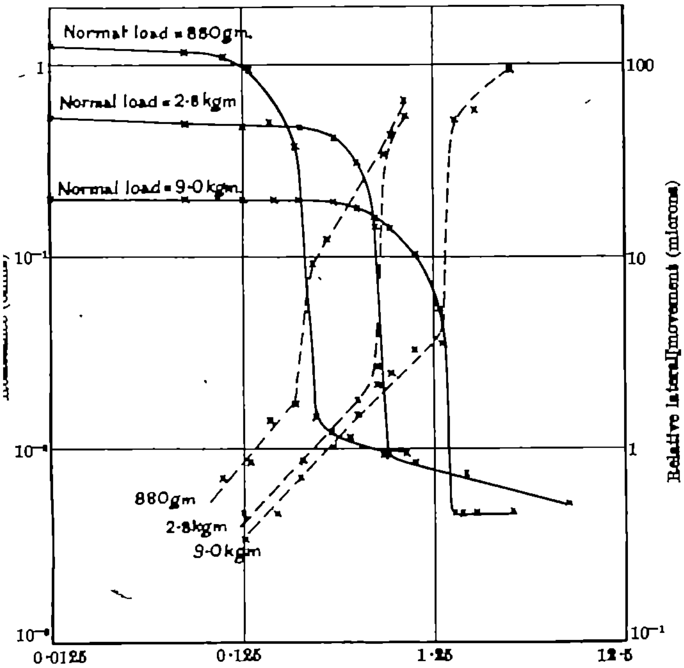

Fig. 1. Resistance *vs.* tangential force curves for stainless steel crossed cylinder contacts under various normal loads: ———, resistance; – – – –, lateral movement

With electropolished stainless steel and copper, the resistance remained high under loads up to 10 kgm. Fig. 1 shows the effect of applying an increasing lateral force (in the axial direction) to one of the normally loaded cylinders. The broken curves show the relative lateral displacement of the cylinders, measured by an optical lever device. Initially, the resistance was unaffected, and the small displacement could be attributed to strain in the cylinders and mountings. At a certain critical force, there was a fall in resistance accompanied by a sudden displacement. This force was much smaller than the usual friction force; but the resistance to motion increased rapidly with further displacement. The curves shown are for stainless steel; but those for copper are similar, except that the movement at the critical force is less sudden.

Microscopic examination showed that when the critical force was just exceeded, the damage to the contact surfaces was slight; greater lateral displacement rapidly increased the damage. With stainless steel, the damage formed a number of distinct tracks which later developed into torn patches (Fig. 2); but with copper the whole contact area became torn.

It has already been shown[3], using the radioactive method, that sliding enormously increases the transfer between metals in contact. The experiments described above show that the films on some metal surfaces are not penetrated under normal loading; a small lateral force is necessary to form metallic contacts. Subsequent lateral movement then raises the friction by increasing the area of intermetallic contact.

With cylinders lubricated by a thick layer of stearic acid, perceptible sliding began under a small force which did not increase very rapidly with displacement. The coefficient of friction could not be measured accurately, but was of the order of 0·01. Visible damage to the contact surface was confined to a few thin scratches. Fluctuations in resistance which accompanied any change in lateral displacement suggested that, when metallic contact was made, it was usually broken again by the lubricant. This supports the suggestion[4] that an important function of a lubricant is to prevent the growth of any small welds which may form.

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Aldermaston, Berks. Feb. 5.

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Contrasting Methods of Transmission of Animal Viruses by Mosquitoes

RECENT investigations[1] of the mechanism of the transmission of myxomatosis of rabbits by mosquitoes have brought to our attention certain clear-cut differences between the transmission by mosquitoes of those diseases in which a 'biological cycle' occurs in the insect vector, and those in which carriage is purely mechanical. Among the animal viruses, it is only in fowlpox[2,3] and myxomatosis[1,4] that mosquito transmission has been conclusively shown to be mechanical in nature. In all the other mosquito-transmitted virus diseases that have been adequately studied (dengue, yellow fever, the viral encephalitides, and Rift Valley fever), there is a 'biological cycle' in the mosquito. Certain implications of these contrasting modes of transmission are summarized in the accompanying table.

	'Mechanical'	'Biological'
Source of virus	skin lesions	bloodstream
Specificity of mosquito-vector	nil	high
Interrupted feeding	positive	negative
Extrinsic incubation period (latent period)	none	present
Arthropod transmission the only natural mechanism	no	yes
Multiplication of virus in mosquito	no	yes

Mechanical transfer by mosquitoes may be expected to occur in any disease in which a high skin concentration of a relatively resistant virus occurs. It is not inconceivable that the 'airborne smallpox' reported around fever hospitals[5] was sometimes mechanically transmitted by mosquitoes, and cowpox may be spread thus among cows, as well as by the milker's hands. Similarly, swinepox may well be transferred from place to place by some more mobile mechanical vector than the hog louse[6]. Mechanical transmission is not incompatible with prolonged infectivity of the mosquito. Brody[3] obtained positive results with fowlpox at intervals up to forty-one days, and we found[1] that myxomatosis could be transmitted as long as twenty-five days after the infective feed.

If there is a viræmia but no deposition of virus in the skin, mechanical transmission by mosquitoes occurs only under exceptional conditions[7]. The data of Philip[8] and St. John *et al.*[9] appear to prove that the feeding mechanism of the mosquito is such that regurgitation does not occur. The opportunity for virus in the blood to contaminate the mouthparts appears to be slight, for in many diseases the virus is associated with the cellular elements of the blood, rather than circulating freely in the plasma[10,11].

Biting insects which are voracious 'pool feeders' may, on the other hand, be more likely to transfer virus present in the circulation, and this may be the explanation of the mechanical transmission of equine infectious anæmia by tabanid flies and *Stomoxy calcitrans*, but not by mosquitoes[12].

Appreciation of the features of mechanical and biological transmission of animal viruses shown in the table may help in elucidating the epidemiology of some of those diseases in which the role of insect vectors is not yet clear.

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M. F. DAY

Division of Entomology,
Commonwealth Scientific and
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Canberra. Feb. 1.

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Non-random Distribution of Multiple Mitotic Crossing-over among Nuclei of Heterozygous Diploid *Aspergillus*

SOMATIC, or mitotic, crossing-over[1] occurs in nuclei of the mycelium of the homothallic ascomycete *Aspergillus nidulans*[2,3], made diploid and heterozygous for known markers by means of a new technique[4]. The asexual *Aspergillus niger* has now been found to behave in a similar manner; that is, diploids heterozygous for known markers give mitotic recombinants homozygous for one or more of these markers but usually still heterozygous for the others, and therefore undergoing further mitotic recombination. Detailed analysis of mitotic recombinants in *A. nidulans* further shows that mitotic crossing-over is not distributed at random between the nuclei of the mycelium but tends to be concentrated in a small proportion of them. The kind of evidence on which this conclusion is based is exemplified in the following paragraphs.

A diploid was used, having green conidia and no growth-factor requirement, of genotype

$$\frac{W \;\; ad_1 \;\; y}{w \;\; AD_1 \;\; Y} \;\; \frac{LYS}{lys} .$$

(W/w, coloured versus white conidia; AD_1/ad_1, independence of, versus requirement for, adenine; Y/y, green versus yellow conidia—these three loc linked in this order and with map distances of more than 50 cMo between w and ad_1, and about 7 cMo between ad_1 and y, w epistatic to Y/y. LYS/lys independence of, versus requirement for, lysine, non-linked to the others.) In the chromosome carrying e three linked genes the centromere is located tween *w* and ad_1.

On the theory of mitotic crossing-over[1], one expects at recombinants homozygous at one locus should usually homozygous also at other closely linked ci, especially if distal, but not usually at loci on e other arm of the same chromosome or on different romosomes. From a diploid of the genotype given ove, one would therefore expect that the homozygous recombinants should be mainly homozygous for i_1, which is proximal but only 7 cMo away, and the mozygous *w* mainly prototrophs, that is, still terozygous for ad_1 and for *lys*. In fact, recombina-on giving homozygosis for both *w* and ad_1 requires o disparate exchanges, one in each arm, and mozygosis for both *y* (usually with ad_1) and *lys*, for both *w* and *lys*, requires two exchanges, one each of two chromosomes.

The results of testing strains from individual een conidia, or from individual mosaic spots of llow or white colour, are as follows :

	Requiring :				Total tested
	adenine	lysine	both	neither	
Green	0	0	0	234	234
White	4	1	1	46	52
Yellow	13	0	2	1	16

he expectation that because of linkage most of e homozygous *y* should also be homozygous for i_1 is fulfilled (15 out of 16). That homozygosis for i_1 or for *lys* alone occurs rarely is shown by the ct that none of the 234 green shows it. That mozygosis for *w* or for *y* alone occurs rarely can seen by inspection of growing colonies of the iploid, where rarely are more than twenty recombin-nt mosaic patches or single heads found in a whole etri dish. A very crude estimate of homozygosis r ad_1 gives its occurrence as about once every mitotic divisions. Yet among the 52 homo-ygotes for *w*, 5 are also homozygous for ad_1, nd among the 68 homozygotes for *w* or/and *y*, 4 are lso homozygous for *lys*. Thus homozygosis at two more loci on different chromosome arms is far too equent to be accounted for by chance coincidence more than one exchange per nucleus.

Results with *Aspergillus niger* point in the same rection. In this species, however, while genetic alysis and experimental 'breeding' *sui generis* can ow be carried out with the present technique, we nnot cross-check the results of this analysis with ose of standard genetic analysis because of the bsence of a sexual cycle.

Incidentally, our work shows that mitotic crossing-ver occurs regularly if diploid nuclei are formed in ecies with an exclusively or mainly haploid life-cle. We see now that Sansome[4] was probably cor-ct when she suggested mitotic crossing-over as the use of certain results in her work on *Penicillium*. his raises the question of whether or not crossing-ver might be a general feature of chromosome nthesis. As diploid life-cycles evolved, it would ave become confined mainly to meiosis by the nergence of special mechanisms preventing it in matic cells.

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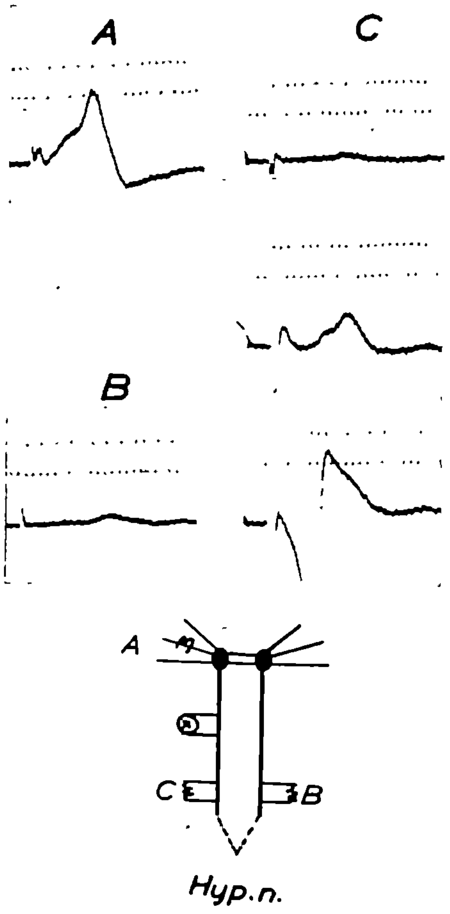
Excitation of Ganglion Cells in the Inferior Mesenteric Ganglion by Collaterals

WHEN the hypogastric nerve is stimulated with a current which is subthreshold for the postganglionic *C* fibres but sufficiently strong to stimulate the delta and *B* fibres, a number of cells in the inferior mesenteric ganglion are excited, and an impulse coming from the ganglion can be recorded in the hypogastric nerve. An impulse is also recorded on stimulation of the contralateral hypogastric nerve[1] (see diagram). If in a curarized preparation a conditioning tetanus is given preganglionically, a test shock to the post-ganglionic hypogastric nerve afterwards excites a larger number of ganglion cells. Now post-tetanic potentiation, also in the curarized ganglion, is exclusively localized to the stimulated fibres. Therefore these ganglion cells must have been excited through collaterals. This reflex persisted, when the afferent fibres, after bilateral excision of the spinal ganglions, Th 11—L VI, had been denervated. It was absent after sections and degeneration of the ventral roots of the same segments. Consequently, these collaterals are given off from efferent fibres which traverse the ganglion, and have their trophic centre in the spinal cord.

This is a confirmation of the tentative conclusion drawn by Langley and Anderson[1] concerning the pathway for the Sokownin crossed bladder reflex[2].



Stimulating electrodes on. (*A*) 2nd preganglionic nerve; (*B*) contralateral hypogastric nerve; (*C*) ipsilateral hypogastric nerve. increasing strength of stimulation. 500 c./s.

If the hypogastric nerve is stimulated with a current strong enough to excite *C* fibres, it was regularly found that a synaptically relayed impulse can be recorded in the colonic nerve and occasionally also in another branch of the hypogastric nerve. In some experiments on the curarized ganglion, these reflexes were potentiated after preganglionic tetanization with a current supra-threshold for *C* fibres. Therefore also *C* fibres which traverse the ganglion can give off collaterals capable of exciting the ganglion cells.

After bilateral denervation of the preganglionic nerves, a reflex in the colonic nerve can still be recorded on stimulation of the hypogastric nerve at *C* fibre strength. This finding is consistent with the anatomical and physiological data presented by Kuntz and Saccomanno[3].

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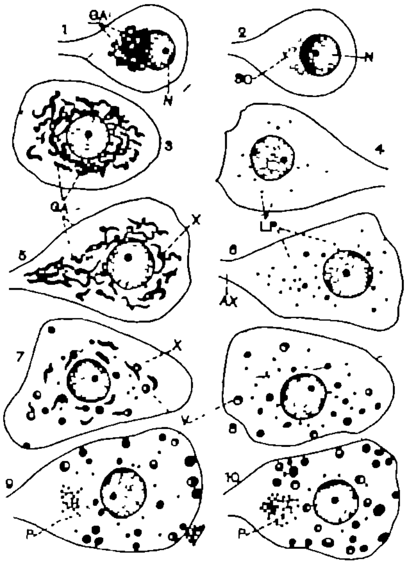
Senility Changes in the Spinal Ganglion Neurones of the Toad, *Bufo regularis*

In a paper on fat, Ciaccio has figured various neurones, some of the toad, containing large spherical hollow bodies, which stain by Sudan III in formalin-fixed postchromed material.

Toads of different ages have been examined by various methods, among which the Kolatchew–Nassonow has provided a good series. The Golgi apparatus of the late tadpoles and the young toad is a canalicular reticulum which is polarized in th tadpoles (Fig. 1). In young toads few granules ar visibly attached to the osmiophile reticulum (Fig. 3 As the full-grown toad ages, it is possible to follo the break-up of the canals to form a variable numbe of large spherical and sub-spherical bodies show in the initial stage in Fig. 5. One such vesicle being formed at *X*, by the widening of the canal int a vesicle, and the thickening of one side. In Fig. the process of metamorphosis has become greatl advanced in the old toad, the Golgi reticulum havin nearly disappeared. In the senile condition (Fig. 9) th Golgi apparatus has completely degenerated into number of very large osmiophile vesicles (*v*), whic are more concentrated at the cell periphery. Thes osmiophile vesicles stain clearly in Sudan black in Regaud postchromed material, whereas the Golg reticulum does not so stain. It is clear, therefore that in old toads the Golgi material of the spina ganglion neurones is transformed into lipid. Beside the above-mentioned vesicles, pigment granules ar secreted by the Golgi apparatus; these granules ar situated in the cell body and finally migrate to th axon hillock region. The mitochondria in the spina ganglion neurones are granular. A further accoun of the material is being published elsewhere.



Semi-diagrammatic figures · Left-hand figures from Kolatchew–Nassonow preparations, right-hand figures from Regaud-postchromed Sudan black preparations. Figs. 1–2, tadpole. Figs. 3–4, young toad. Figs 5–6, full-grown toad. Figs. 7–8, old toad. Figs. 9–10, senile toad. *AX*, axon; *GA*, Golgi apparatus; *LP* (Figs. 4 and 6), ordinary lipid granules (Golgi secretion), xylol-soluble; *N*, nucleus; *P* (Figs. 7–10), pigment granules; *SC*, sudanophile cloud, the area *SC* being non-granular, but slightly sudanophile; *V*, osmiophile and sudanophile vesicles

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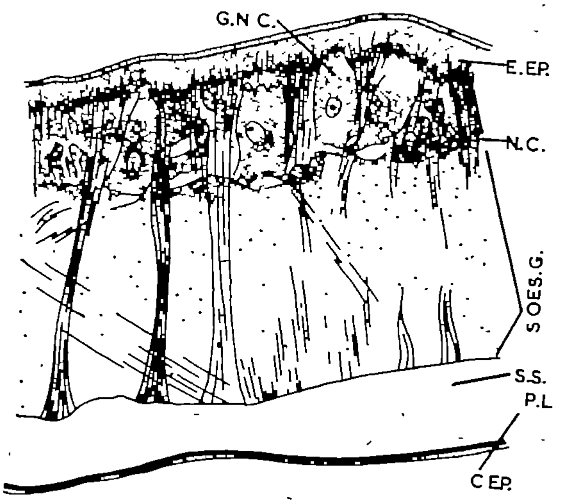
Giant Nerve Cells in *Lingula*

Elongated invertebrate animals which effect quic muscular contractions, either as a means of rapi withdrawal and escape like some Annelida[1] an Enteropneusta[2], or for the purpose of making sudde darts through the water like the macrurous Crustacea and the squids and cuttlefishes[4], have been show to possess giant nerve cells and fibres.

Fifty years ago, Morse[5] observed that the tw closely allied genera of ecardine Brachiopoda, *Lingul* and *Glottidia*, with long stalks by which they ar attached to the bottoms of their tubes in sand o mud, withdraw into their tubes with a quick jerk o an interruption of the light which falls upon them "The available descriptions of the nervous syste in the Brachiopoda give us a picture of the arrange ment in a few species but they do not supply in an point the modern demands. . . . About the for and nature of the nerve fibres we know only tha the fibre mass is a net-work of fine fibrillæ and tha the nerve cells like most cells of the Brachiopod are very small and therefore difficult to investigate."

However, working with fresh material fixed i Bouin's fluid, sectioned in paraffin and stained wit hæmatoxylin and eosin, I have found a small numbe of giant nerve cells in the suboesophageal ganglio of *Lingula* (see diagram). I hope, by the use of mor specific stains for nerve tissue, to be able to trac



Vertical section through the suboesophageal ganglion of *Lingula*. *C.EP.*, coelomic epithelium; *E.EP.*, epidermal epithelium; *G.N.C.*, giant nerve cell; *N.C.*, nerve cell; *P.L.*, pigment layer; *S.OES.G.*, suboesophageal ganglion; *S.S.*, supporting substance. (× *c.* 250)

he processes of these cells to the muscles of the stalk nd so to provide an explanation of the jerk noted by orse.

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Lactic Oxidases of *Mycobacterium tuberculosis avium*

WE have previously discovered that the cell-free reparation of *Mycobacterium tuberculosis avium* akeo strain) catalyses the oxidation of lactate. ecently, we have confirmed that this preparation ontains two distinct lactic oxidases, and made clear e respective characteristic properties. One of these nzymes is a new type of lactate oxidative enzyme.

Enzyme activity was determined by measuring the xygen consumption manometrically in Warburg pparatus. Lactate, the substrate, was determined anometrically with ceric sulphate. The product, a olatile acid, was steam-distilled and titrated. yruvate, the other product, was determined by the sulphite-binding method of Clift and Cook and by e ceric sulphate method.

Mycobacterium tuberculosis avium, strain Takeo, as grown on the glycerol broth media. From the ompact mass of harvested bacteria, the crude cell-free nzyme preparation was obtained by alternating eezing and thawing. This preparation was able to xidize lactate with no addition. The addition of ethylene blue, however, increased by 30–50 per ent the consumption of oxygen. When the extract as heated for 10 min. at 50° C., the effect of methyle blue was not changed appreciably. Dialysis gainst water at 0° C. for 12 hr. had no effect on the xidation of lactate in the absence of methylene blue; ut in the presence of methylene blue the effect of is dye was abolished (Table 1).

Table 1. EFFECT OF HEATING AND DIALYSIS ON LACTIC OXIDATION BY THE CRUDE ENZYME PREPARATION

Enzyme preparation	Oxygen uptake (c mm.) per 60 min.	
	Without methylene blue	With methylene blue
Crude extract	101	210
Heated 10 min. at 50° C.	0	125
Dialysed 12 hr. at 0° C.	109	94

Warburg's vessels contain 2·0 ml. of enzyme preparation, 0 3 ml. of 0·2 *M* phosphate buffer (*p*H 6·2), and 0·2 ml of 3 *M* DL-lactate.

These phenomena indicate that the preparation includes two distinct lactic oxidases: one is heat-labile, stable in dialysis, and reacts directly with molecular oxygen, whereas the other is relatively heat-stable, labile in dialysis and active only in the presence of methylene blue. For convenience, we named the former 'lactic oxidase I' and the latter 'lactic oxidase II'.

The crude preparation (Q_{O_2} (per mgm. dry weight) = 15) was brought to *p*H 3·8 with acetic acid and the precipitate was dried in a desiccator *in vacuo* at room temperature. The dried precipitate was suspended in phosphate buffer. The extracted residue was removed by centrifugation, and ammonium sulphate was added to the supernatant solution (Q_{O_2} = 150), bringing the solution to saturation. Repeating the precipitation by acetic acid and ammonium sulphate alternately, the purified lactic oxidase I (Q_{O_2} = 450) was obtained. In the course of purification, lactic oxidase II was destroyed completely.

Lactic oxidase I. The purified lactic oxidase I oxidizes aerobically DL-lactate with no addition. Neither methylene blue, thionine, nor the cytochrome c and cytochrome oxidase system has any effect. The Michaelis–Menten constant is 5×10^{-2} mole per litre, using DL-lactate as the substrate. The optimum *p*H is about 6·2. Neither cyanide, azide nor 8-hydroxyquinoline has any inhibiting effect; but silver nitrate and copper sulphate both inhibit the reaction almost completely at a concentration of 3×10^{-4} mole per litre. This enzyme has no readily dissociable cofactor. Various coenzymes, for example, diphosphopyridine nucleotide, adenosine triphosphate, flavine mononucleotide and magnesium ions, were found to have no effect on the enzyme activity. However, flavine adenine dinucleotide often stimulated the catalysed reaction slightly.

Anticipating that the coenzyme of this enzyme might be flavine adenine dinucleotide, we heated preparations of various degrees of purification at 85° C. for 15 min., and the clear supernatant fluids were added to a mixture consisting of the apoprotein of pig kidney D-amino-acid oxidase and DL-alanine; the content of flavine adenine dinucleotide was measured by determining the oxidation-rate of DL-alanine. The oxidation-rate of alanine due to these preparations increased remarkably with the increasing degree of purification. It was presumed, therefore, that the prosthetic group of this enzyme is flavine adenine dinucleotide.

Oxygen consumed, and volatile acid and carbon dioxide produced, are all found to be one mole per mole lactate. The reaction catalysed by this enzyme can therefore be expressed by:

$$CH_3CHOH—COOH + O_2 \rightarrow CH_3COOH + CO_2 + H_2O.$$

This enzyme does not attack pyruvate, whether cocarboxylase is present or not, and also lactate oxida-

Table 2. CHARACTERISTIC PROPERTIES OF LACTIC OXIDASES

	Lactic oxidase I	Lactic oxidase II
Method of extraction	Alternate freezing and thawing	Autolysis from acetone powder
Heated at 50° C. for 10 min.	Labile	Stable
Dialysis	Stable	Labile
Precipitated with acetic acid	Stable	Labile
With molecular oxygen	Reacts directly	Reacts in the presence of carrier
With methylene blue or cytochrome *c*	Not affected	Affected; the enzyme requires them as carriers
Prosthetic group or co-factor	Flavine adenine dinucleotide	Diphosphopyridine nucleotide
Reaction product	Acetate	Pyruvate

tion is not inhibited by pyruvate. It appears, therefore, that this enzyme catalyses the oxidation of lactate to acetate and carbon dioxide with no intervention from pyruvate.

The addition of alcohol, azide, cyanide, hydrogen peroxide and active catalase prepared from beef liver, respectively, has no effect on the rate of reaction, and the addition of alcohol with strong liver catalase has no effect on the total amount of oxygen consumed and carbon dioxide produced. Consequently, we consider that the possibility of the formation of hydrogen peroxide is ruled out.

Lactic oxidase II. A larger amount of lactic oxidase II is contained in the acetone-powder extract than in the extract which is obtained by alternate freezing and thawing. Although we have not succeeded in purifying this enzyme, the activation by methylene blue, the cytochrome *c* and cytochrome oxidase system, and diphosphopyridine nucleotide was demonstrated with the acetone-powder extract. In the presence of methylene blue, pyruvate was detected as the reaction product. The reaction catalysed will be perhaps as follows:

$$CH_3CHOH\text{—}COOH + \tfrac{1}{2}O_2 \rightarrow CH_3COCOOH + H_2O.$$

The characteristic properties of the two distinct lactic oxidases are summarized in Table 2. As shown in the table, lactic oxidase I is a new type of lactate-oxidizing enzyme differing from the lactic dehydrogenases of animal tissues, yeast, *E. coli*, *Gonococcus* and higher plants. Lactic oxidase II is similar to the animal enzyme.

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Growth of Rat Ovary in Tissue Culture

THERE are few reports of rat tissue cultures producing growth comparable to that from other mammalian species or from chick explants. Martinovitch[1], working with rat pituitary and rat ovary in watch-glass cultures, was able to keep the tissues alive *in vitro* for a considerable length of time; but cell outgrowth was comparatively slight. Abercrombie and Harkness[2] cultured regenerating rat liver. Fibroblasts or bile duct epithelium rarely grew from normal liver cultures, but appeared sporadically in cultures of regenerating material, the outgrowth varying with the state of liver regeneration. Only lymphocytes and granulocytes occurred in cultures regularly and in similar numbers regardless of the state of regeneration. The only case of rat pituitary tissue producing vigorous growth *in vitro* is that reported by Haymaker and Anderson[3].

In the present experiments it has been found that extensive epithelial growth can be obtained in slide cultures of rat ovary if the explants are kept in a fluid medium for 24 hr. before being placed in the slide cultures.

As a result of preliminary cultures, it was decided that rats 27–31 days old and approximately 60 gm. in weight were the optimum age from which tissues should be taken. Histological sections showed that in such ovaries follicular tissue was at a maximum.

Whole ovaries were removed from the rats and washed in Simm's solution containing 10 per cent rat serum. From each ovary, the larger follicles were gently squeezed, and then from the remaining piece of ovary ten to fifteen explants 1–2 mm. in diameter were cut. The expressed follicles, together with the larger ovarian explants, were transferred to an embryological watch-glass containing 2 c.c. of culture medium, which consisted of 50 per cent rat serum, 50 per cent rat embryo extract and streptomycin in the final concentration 0·0002 per cent. The watch-glasses were covered with large coverslips, sealed and incubated for 24 hr. at 37° C.

This 'preincubated' tissue was now cultured by the slide method. Explants were moored to the coverslip in a thin rat plasma-extract clot; a drop of fluid culture medium similar to that used for 'preincubation' was added and a meniscus drop culture finally prepared. Control cultures were prepared using fresh rat ovary in fresh medium. All cultures were incubated at 37° C.

After 24–48 hr. incubation, on an average, 75 per cent of the cultures of 'preincubated' tissue showed growth; after a further 24 hr. epithelial sheets of cells were prominent. By renewing the fluid medium, cultures could be kept healthy for up to seven days, the final width of the growth varying from 2 to 4 mm. On an average, 40 per cent of the control cultures grew and produced epithelium, but to a lesser extent than the experimental cultures.

The reasons for growth promotion and the beneficial properties of 'preincubation' are as yet undetermined. Rat tissue may be sensitive to injury, and injured cells fall from the explants, thus leaving healthy cells for culture. In transferring the explants to a fresh medium before culturing by the slide method, products of cell damage may be washed off. Slight separation of cells may occur during 'preincubation'. The effects of different culture media, and of duration and temperature of 'preincubation', require further study. The effect of 'preincubation' on the subsequent growth *in vitro* of other rat tissues should also be investigated since the optimum conditions for one tissue are not necessarily those required by other tissues.

This work was carried out during a short visit to the National Institute for Medical Research, London, and I wish to thank Sir Charles Harington and Dr. A. S. Parkes for making my visit possible. I am also indebted to Dr. A. U. Smith for many helpful suggestions, and for her stimulating interest in the work.

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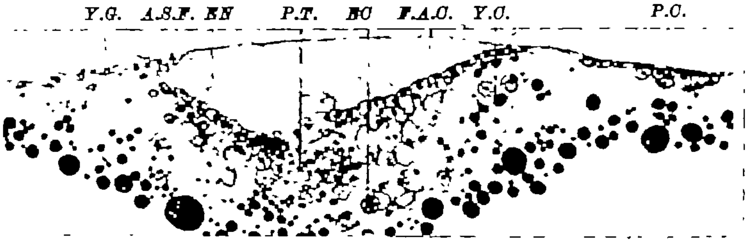
evelopment of the Embryonic Coverings in the Scorpion, *Buthus quinquestriatus* (H.E.)

DURING the period of proliferation of the embryonic ık of the scorpion (*Buthus quinquestriatus* (H.E.)), amnio-serosal fold appears at the anterior peri- ery (Fig. 1). The posterior margin of the embryonic ık up to this stage does not show any trace of ıher the serosa or the amnion. This is contrary the findings of Kowalevsky and Schulgin[1], who ımed that the amnio-serosal fold, in *Androctonus ıatus*, arises simultaneously around the whole ırgin of the embryonic disk.

As development proceeds, the anterior amnio- rosal fold extends gradually backwards above the ture amniotic cavity (Fig. 2) and, at the same time, ong the margin of the germinal disk.

Also during the extension of the fold, the outer riphery of the upper layer extends beyond the rminal disk, just below the vitelline membrane, ıle that of the lower one is kept attached to the ıstoderm, which can be referred to, now, as the ıoderm.

At a later stage, the amnio-serosal fold continues development around the whole margin of the rminal disk and its edges fuse with each other to m two embryonic coverings, namely, the serosa d the amnion.



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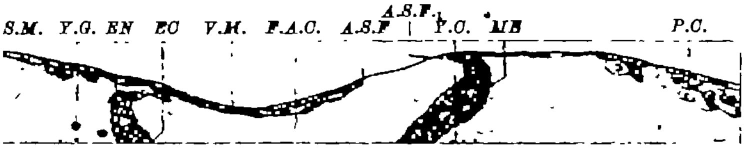

(2)

. 1. *Buthus quinquestriatus.* A longitudinal section in the embryonic disk of an early stage showing the anterior origin of the amnio-serosal fold. (× 225)

2. *Buthus quinquestriatus.* A longitudinal section in the side of an embryonic disk of a more advanced stage showing the extension of the amnio-serosal fold. (× 225)

.F., amnio-serosal fold; *A.S.F.₁*, marginal extension of the amnio-serosal fold; *EC*, oderm; *EN*, endoderm; *F.A.C.*, future amniotic cavity; *ME*, mesoderm; *P.C.*, primitive ıulus; *P.T.*, primary thickening; *V.M.*, vitelline membrane; *Y.C.*, yolk-cell; *Y.G.*, yolk granules; *S.M.*, serosa

The above description differs from those given by urie[2] in *Euscorpius italicus* and Brauer[3] in *Euscor- us carpathicus.* According to Laurie, the serosa velops, independently, before the amnion around edges of the blastoderm as a single layer of cells, ıich becomes reflected dorsally and grows gradually til its edges meet and fuse in the middle, just below vitelline membrane. The same author mentioned ıt the amnion appears from the edge of the blasto- rm shortly afterwards as a single layer of cells low the serous membrane. He further stated that serous membrane, at that moment, loses all con- xion with the blastoderm and then grows gradually around the yolk. The description given by Brauer is very near to that of Laurie.

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Seasonal Change in the Humidity Reaction of the Common Earwig, *Forficula auricularia*

IN an investigation on physiological and ecological problems in *Forficula auricularia*, van Heerdt[1] found that well-fed, non-desiccated earwigs showed no humidity preference in the alternative chamber; but if previously desiccated, the earwigs became distinctly hygropositive. Whenever *Forficula* is found in dry places, its presence there is, according to van Heerdt, to be ascribed to thigmotaxis. Experiments begun in the winter of 1946–47 gave results closely resembling those of van Heerdt. In the summer of 1949, however, when the experiments were continued, the earwigs (both specimens taken directly from very dry natural conditions, and specimens kept in moist air even for weeks) showed a clear and strong preference for the drier side of the alternative chamber. Two-hour experiments were carried out in the day-time, but in darkness with the exception of short intervals for counting. With a choice between 100–34, 100–97, 100–99·5, 97–87, 77–34, 34–20 and 34–0 per cent relative humidity, the drier humidity was consistently preferred by the summer earwigs. Desiccation, however, caused even the summer earwigs to choose the moist air. These same specimens, well-fed and kept in a moist atmosphere all the time, so that the effect of desiccation was excluded, were investigated in the following winter. It appeared that the animals no longer showed the dry reaction, but tended now to prefer 100 to 34 per cent relative humidity. The experiments were repeated in the summer of 1950 and winter of 1950–51, with results similar to those obtained in the earlier years.

The accompanying table shows the difference in reaction in summer and winter, the intensity of reaction being expressed as the excess percentage, $\frac{100\,(W - D)}{N}$, on the moister side, where W represents the number on the moister side (100 per cent relative humidity), D the number on the drier side (34 per cent relative humidity), and N the total number of insects; + means reaction towards moist, and − means reaction towards dry. These experiments were carried out in the light.

	Time in minutes						No. of position records
	1–5	6–10	11–15	16–20	21–25	26–30	
Intensity of reaction during July–August	−49	−55	−53	−57	−67	−72	900
Intensity of reaction in January	+19	+37	+41	+64	+69	+66	1,800

These results are in full accordance with the ecology of the species. It is well known[2] that in the autumn earwigs burrow into the soil for hibernation and egg-laying, the fresh soil in the burrows keeping the air constantly humid. In view of this the disappearance of the strong dry reaction of the summer earwigs in the winter is quite understandable. These results, however, still need confirmation with earwigs taken directly for experiment from their burrows in the soil in the winter.

These investigations on the humidity sense in *Forficula* will be continued, and the results will be published fully elsewhere.

My thanks are due to Prof. J. E. Harris for help and facilities in the Zoological Department, University of Bristol.

VILHO PERTTUNEN

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(Present address:
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Feb. 15.

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Maximum Molecular Weight of Insulin

CURRENT investigations on the molecular weights of enzymic digests of insulin prompted the redetermination of the sedimentation and diffusion constants of the untreated crystalline protein. This work has given results which differ considerably from the previously published figures for this substance[1].

In phosphate buffer, *p*H 7·4, the mean of seven determinations in the Spinco ultracentrifuge gave $s_{20,w} = 3 \cdot 12 \pm 0 \cdot 02$ (S.D.) Svedberg units. This value was independent of concentration in the range 0·4–0·8 per cent, of temperature in the range 17–26° C., and of ionic strength in the range 0·10–0·30. The experimental details of operation of the ultracentrifuge were as previously described[2,3]. Diffusion coefficients were determined with the Gouy diffusiometer[4], the use of which with proteins has recently been discussed[5]. At *p*H 7·4, and ionic strength 0·10, the results shown in the accompanying table were obtained.

The diffusion coefficients given are the means of two, or more generally four, determinations, and are expressed in units of 10^{-7} cm.^{2} sec.$^{-1}$. They we independent of temperature in the range 14–30°

DIFFUSION COEFFICIENTS OF INSULIN AT *p*H 7·4

Concentration (per cent)	$D_{20,w}$	Concentration (per cent)	$D_{20,w}$
0·181	9·57	0·300	8·50
0·196	9·03	0·328	8·23
0·238	8·74	0·380	8·23
0·257	8·91	0·482	8·34
0·266	8·77	0·684	8·28

The values were calculated from the movement the outermost interference minimum in the expe mental record, which gives a D_A average; calculati of D_m for the most concentrated solution by t method of Ogston[5] gave 8·16 for this quantity. T diffusion behaviour, therefore, approximates to t ideal at this concentration.

This work provides qualitative confirmation f the dissociation phenomena reported from osmot measurements by Gutfreund[6], for concentratio lower than about 0·3 per cent, but gives a differe value for the molecular weight in the stability rang Thus, using the values $s = 3 \cdot 12$, $D = 8 \cdot 2$, applicati of the Svedberg equation gives $M = 34{,}800$ f $\bar{v} = 0 \cdot 735$ (see Pedersen[1]), or 36,700 on the older valu $\bar{v} = 0 \cdot 749$. Gutfreund[6] obtained $M = 48{,}000$ und these conditions.

The value of 35,000–36,000 refers to the maximu molecular weight of insulin as it exists in soluti (investigations at *p*H 7·0 and 7·2 gave similar result and so is in satisfactory agreement with the X-r determination[8] of the molecular weight in the sol state, namely, 36,000.

At *p*H 8·0, lower values of the sedimentation co stant and higher values of the diffusion coefficie have been obtained; details of these and oth results will be included in a full account of this wor to be published shortly elsewhere.

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May 23.

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[2] Charlwood, P. A., *Biochem. J.*, 51, 113 (1952).

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A Synergistic Interaction between 3-Indolylacetonitrile and 3-Indolylacetic Acid

EXPERIMENTS carried out with 3-indolylacetonitril recently isolated by Jones, Henbest, Smith a Bentley[1] from brussels sprouts, have indicated th the substance may function either as a plant grow regulator or can be converted within the plant to substance with growth-regulating properties.

Some experiments carried out in this Departmen with a pure sample of the 3-indolylacetonitrile, kind supplied by Prof. E. R. H. Jones of Manchester, we designed to substantiate a further explanation f the activities shown by this compound.

Jones *et al.* have stated that in the *Avena* straigh growth test the nitrile is more active than t corresponding 3-indolylacetic acid and have sho that a 10-mgm./l. solution of the nitrile in the presen of *Avena* coleoptiles may produce, in twenty-fo urs, an acid with an activity equivalent to a con- tration of less than 0·1 mgm./l. of 3-indolylacetic d. If the nitrile was broken down to the acid by plant, it is clear from the results quoted by these rkers that up to 50 per cent of the elongation due the nitrile at 10 mgm./l. could be ascribed to the version of the nitrile to 3-indolylacetic acid. veral possible explanations have been proposed by se workers to account for the greater activity wn by the nitrile in this test. First, the nitrile elf may be active, and the resultant elongation is summation of the effects of the nitrile and the d. Secondly, the plant cells may be more permeable the nitrile than the acid and this, coupled with breakdown of nitrile within the cells, might lead a higher internal concentration of acid than that ained if the tissue was immersed in the acid alone the same concentration. There would appear to be further possible explanation. The nitrile could inactive, but might act as a synergist to 3-indolyl- tic acid present naturally within the plant tissue formed by the breakdown of the nitrile. Thus, the ta of Jones *et al.* could be interpreted as follows. to 50 per cent of the activity of a 10-mgm./l. ution of nitrile could be due to conversion to the d, while the remaining activity could be attributed a synergist effect of the nitrile upon the 3-indolyl- tic acid.

In the standard Went pea curvature test[2] Jones *al.* found that the nitrile was inactive at concentra- ns below 20 p.p.m., indicating that any breakdown 3-indolylacetic acid which may have occurred at se concentrations was too small to be detected by assay. The rigorous proof of synergism between o active compounds is often difficult, but such interaction can be more readily demonstrated if of the compounds concerned is inactive. For se reasons experiments were carried out with pea sue in preference to *Avena* tissue to determine ether, in fact, the nitrile could act as a synergist applied 3-indolylacetic acid.

DEGREE OF CURVATURE OF SPLIT PEA EPICOTYLS
(Went standard test)
rvatures shown as mean number of degrees, ± standard error)

3-Indolylacetic acid concentration—p.p m.	3-Indolylacetonitrile concentration—p.p.m.		
xperiment 1	0	20	
0	0	0	
0·1	2 ± 1	57 ± 11	
1 0	108 ± 10	157 ± 9	
2·5	120 ± 5	159 ± 12	
xperiment 2	0	5	50
0	0	0	25 ± 6
0·1	2 ± 1	7 ± 4	81 ± 11
0·5	34 ± 5	38 ± 8	136 ± 12
1·0	65 ± 7	95 ± 10	127 ± 12

The results for two experiments are given in the le. In concentrations up to 20 p.p.m. the nitrile luced no positive curvatures. At each concentration 3-indolylacetic acid, the addition of 20 p.p.m. of nitrile resulted in an increase in curvature which statistically significant. With 5 p.p.m. of the rile, the increase is small and non-significant, but still positive. At 50 p.p.m. the nitrile itself ex- its some activity but the curvature produced is s than that given by 0·5 p.p.m. of 3-indolylacetic d alone. When, however, 50 p.p.m. of the nitrile combined with 0·5 p.p.m. of the acid, the curvature tained is significantly greater than that produced 1·0 p.p.m. of 3-indolylacetic acid. Thus the evidence for synergism between these compounds in pea tissue seems clear, and it is therefore suggested that the synergistic or hemiauxin activity of the nitrile in the presence of 3-indolylacetic acid is a further factor for consideration in assessing the growth-regulating activity shown by this new plant product.

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June 24.

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Hydrogen Transfer by Thiols

THE thermal decomposition of α,α'-azoethylbenzene in inert solvents at 125° C. leads, apart from a quantitative production of nitrogen, to methylbenzyl radicals which combine to meso and racemic 2,3-diphenylbutane. Disproportionation of the radicals does not occur since ethylbenzene could not be detected (1).

$$C_6H_5(CH_3)CH{-}N{=}N{-}HC(CH_3)C_6H_5 \rightarrow N_2 + 2\,C_6H_5(CH_3)\dot{C}H \qquad (1)$$

However, in the presence of a twice molar proportion of a thiol such as *n*-octane-1-thiol or thiophenol, dehydrogenation to phenyl methyl ketazine takes place, the amount of nitrogen evolved in the course of the reaction dropping to about 58 per cent (2, 3). Part of the methylbenzyl radicals formed is hydrogenated to ethylbenzene, the balance giving 2,3-diphenylbutane or other products. Apparently, thiyl radicals are more reactive than methylbenzyl radicals, since they are capable of abstracting a hydrogen atom from the azo compound, eventually converting it into the ketazine.

$$C_6H_5(CH_3)\dot{C}H + R\mathrm{SH} \rightarrow C_6H_5(CH_3)CH_2 + R\mathrm{S}\cdot \qquad (2)$$

$$2\,R\mathrm{S}\cdot + C_6H_5(CH_3)CH{-}N{=}N{-}HC(CH_3)C_6H_5 \rightarrow 2\,R\mathrm{SH} + C_6H_5(CH_3)C{=}N{-}N{=}C(CH_3)C_6H_5 \qquad (3)$$

Active hydrogen donors like 9,10-dihydroanthracene, which scarcely react with methylbenzyl radicals, are readily dehydrogenated to compounds like 9,9′,10,10′-tetrahydrodianthranyl-9,9′, in the presence of thiols (4, 5).

$$R\mathrm{S}\cdot + \mathrm{H}D \text{ (hydrogen donor)} \rightarrow R\mathrm{SH} + D\cdot \qquad (4)$$

$$2\,D\cdot \rightarrow D_2$$

Hydrogen donor and azo compound will compete for the thiyl radicals, the amount of nitrogen evolved being a measure of the reactivity of the former. In the system α,α'-azoethylbenzene (1 mole), *n*-octane-1-thiol (2 moles) and 9,10-dihydroanthracene (1 mole), the amount of nitrogen evolved is increased to 98 per cent again.

It was found that only one mole of thiol disappears for every four moles of ethylbenzene formed, thus showing that the thiol acts as a hydrogen transfer agent.

Other aliphatic azo compounds, for example, 2,2′-azo-*iso*butyronitrile, can also be used for the dehydrogenation of active hydrogen donors when thiols are present.

In view of the ready formation of thiyl radicals from thiols even by relatively inert radicals—as is evident from the extremely high chain-transfer constants in vinyl polymerization[1]—the above high reactivity of RS radicals with respect to dehydrogenation would seem surprising. Thus, the heat of reaction of (6) should be equal to the sum of the heat effects of (2) and (4), although (6) would appear to be very much slower.

$$C_6H_5(CH_3)\dot{C}H + HD \rightarrow C_6H_5(CH_3)CH_2 + D \qquad (6)$$

However, a close parallel between heats of reaction and activation energies can be expected only in the case of closely analogous reactions, that is, reactions involving the same reacting functional groups. Thus, it may well be that in the reactions (7) and (8) the relationship between activation energy and heat of reaction is quite different from that in hydrogen abstractions involving only hydrocarbons and hydrocarbon radicals.

$$R_1\cdot + R_2SH \rightarrow R_1H + R_2S\cdot \qquad (7)$$

$$R_2S\cdot + R_3H \rightarrow R_2SH + R_3\cdot \qquad (8)$$

Furthermore, it seems conceivable that the fast rate of (4) as compared with that of (6) is merely due to a higher concentration of the RS radicals as compared with that of the methylbenzyl radicals. On the other hand, such a difference should be caused by a faster rate of dimerization of the methylbenzyl radicals as compared to that of the RS radicals, which seems somewhat unlikely.

The above results suggest that the activation energies of reactions of type (7) and (8) are rather low. In consequence, these reactions might well be reversible even at room temperature. As a result, they may play an important part in biochemical oxidation and reduction processes.

A detailed account of this work will be published in the near future. Our thanks are due to the management of the Bataafsche Petroleum Maatschappij for permission to publish this communication.

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Jan. 16.

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Thiol Catalysis of the Homolytic Decomposition of Aldehydes

The homolytic decarbonylation of aliphatic aldehydes regularly occurs at elevated temperatures in the vapour phase[1]. We have studied this reaction with a number of aliphatic aldehydes in the liquid phase at 90°–120° C., using the $Me_2\dot{C}—CO_2Me$ free radical (produced by the thermal decomposition of dimethyl-2 : 2′-azo-*iso*butyrate) as the initiating catalyst, and have found that only about 5 per cent of these radicals are effective as dehydrogenators (1).

$$Me_2\dot{C}—CO_2Me + R—CHO \rightarrow Me_2CH—CO_2Me + R—\dot{C}O \qquad (1)$$

Only a short reaction chain (2–3) can be concerned in the liberation of carbon monoxide, and this is probably terminated by (4).

$$R—CO\cdot \rightarrow R\cdot + CO$$ (

$$R\cdot + R—CHO \rightarrow R—H + R—CO\cdot$$ (

$$R—CO\cdot + Me_2\dot{C}—CO_2Me \rightarrow R—CO—CMe_2—CO_2Me$$ (

Even when the molar proportions of aldehyde
azo ester are as low as 5 : 1, the amount of carb
monoxide evolved was never more than that of t
nitrogen formed from the azo-compound : the ave
age extent of aldehyde decomposition was less th
8 per cent, and benzaldehyde gave no carb
monoxide. Carbon tetrachloride, with which R—C
radicals react easily, was a very effective inhibit
of the chain process (2–3).

Our results accord with those of Winstein a
Seubold[2], who effectively decarbonylated β-phen
*iso*valeraldehyde at 130° using *t*-butyl peroxide
the radical-producing catalyst, but reported th
benzoyl peroxide at 80° initiated very little actio
By using the more active $CH_3\cdot$ radicals from acet
peroxide at 65°, Kharasch, Urry and Kuderna[3] hav
however, reported up to 20 per cent decarbonylati
of aldehydes even in the presence of olefins. Fro
the small extent of the decarbonylation at modera
temperatures, it can be inferred from all these observ
tions that some at least of the reactions (1–
must require a significant amount of activati
energy.

When, a few months ago, Drs. Kooijman and Bick
of the Koninklijke/Shell Laboratorium, Amsterda
kindly informed us that thiyl radicals, Alk—S·, we
more effective dehydrogenators of 9 : 10-dihydr
anthracene than were α-methyl-benzyl radicals[4],
investigated the effect of adding a little benz
mercaptan to mixtures of aliphatic aldehydes a
azo-compounds and obtained quite striking resul
The addition of as little as 0·5 mol. per cent of t
thiol to our mixtures increased the extent of aldehy
decomposition, as measured by carbon monoxi
evolution, to 80–90 per cent for α-branched aldehyd
such as 2-ethyl-hexanal, and to a lesser but st
marked extent with *n*-aldehydes. Hence the cha
sequence :

$$Me_2C—CO_2Me + Tol—S—H \rightarrow Me_2CH—CO_2Me + Tol—S\cdot$$ (

$$Tol—S\cdot + R—CHO \rightarrow Tol—S—H + R—CO\cdot$$ (

then (2) followed by

$$R\cdot + Tol—S—H \rightarrow R—H + Tol—S\cdot$$ (

must be much more effective than the reaction cha
(1–4) above, and, in particular, (6) and (7) must
more effective than (1) and (3).

If current bond-strength values are taken for C—
and S—H links, then (5) and (7) should be exother
and (6) decidedly endothermic, whereas (1) and
should be nearly thermoneutral, though it is possi
to explain the exothermicity of reactions (1), (3) a
(6) by ascribing large resonance stabilization to t
R—CO· free radical. The resonance concept d
not, however, account for the greater ease of occ
rence of the chain (5–7), and, as our Dutch collea
have pointed out[4], it would seem that in our reacti
too, the activation energy required for attaining t
transition state

$$R_1—S \ldots H \ldots CR_3$$

may be less than for the hydrogen transfer betw
hydrocarbon radicals

$$R'_3C \ldots H \ldots CR_3.$$

The scope of this thiol-catalysed decarbonylation f aldehydes is now under investigation, and details ill be submitted for publication in the near future. t is also proposed to search for other instances of ehydrogenation by thiyl radicals, R—S·, since the entative speculation made by one of us some years go[4] that thiol-containing enzymes may act by prooting homolytic dehydrogenation may now prove o be capable of exemplification with simpler organic olecules.

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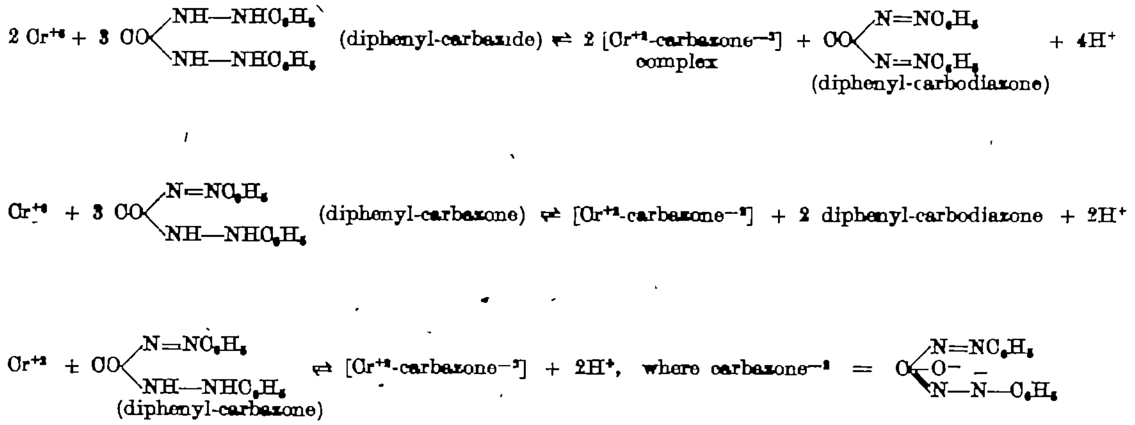
Jan. 21.

See Steacie, E. W. R., "Atomic and Free Radical Reactions" (1946).
J. Amer. Chem. Soc., 69, 2917 (1947).
J. Org. Chem., 14, 248 (1949).
See preceding communication.
Waters, "The Chemistry of Free Radicals", 257, 283 (1946).

Mechanism of the Reaction between Dichromate and Diphenylcarbazide

THE colour reaction between dichromate and dihenylcarbazide in acid medium is the basis of the est method yet devised for the detection and colorietric estimation of small amounts of chromium. ccording to Cazeneuve[1], the intense colour is unoubtedly due to an organo-metallic chromium omplex. Attempts were made by Moulin[2] to isolate he compound but without any success. Thus the echanism of the reaction has remained unknown.



$$2\,Cr^{+6} + 3\,CO\begin{matrix}\diagup NH{-}NHC_6H_5\\ \diagdown NH{-}NHC_6H_5\end{matrix}\ \text{(diphenyl-carbazide)} \rightleftharpoons 2\,[Cr^{+2}\text{-carbazone}^{-2}]\ \underset{}{\text{complex}} + CO\begin{matrix}\diagup N{=}NC_6H_5\\ \diagdown N{=}NC_6H_5\end{matrix} + 4H^+$$

(diphenyl-carbodiazone)

$$Cr^{+6} + 3\,CO\begin{matrix}\diagup N{=}NC_6H_5\\ \diagdown NH{-}NHC_6H_5\end{matrix}\ \text{(diphenyl-carbazone)} \rightleftharpoons [Cr^{+2}\text{-carbazone}^{-2}] + 2\ \text{diphenyl-carbodiazone} + 2H^+$$

$$Cr^{+2} + CO\begin{matrix}\diagup N{=}NC_6H_5\\ \diagdown NH{-}NHC_6H_5\end{matrix} \rightleftharpoons [Cr^{+2}\text{-carbazone}^{-2}] + 2H^+,\ \text{where carbazone}^{-2} = C\begin{matrix}\diagup N{=}NC_6H_5\\ -O^-\\ \diagdown N{-}N{-}C_6H_5\end{matrix}$$

(diphenyl-carbazone)

In the present work, attempts have been made to lucidate the mechanism of the reaction from different hysico-chemical points of view. It has been noted hat, for the reaction to occur, the chromium must e in the hexavalent state. This leads to the conlusion that it must be a redox reaction, and possibly lso coupled with complex formation. Chromium n the tervalent state fails to react with either iphenylcarbazide or its oxidation product diphenylarbazone, but hexavalent chromium reacts with oth, producing the same colour reaction. However, hromium in the bivalent state reacts with diphenylarbazone to produce the same colour reaction, but ils to react with freshly prepared carbazide which free from carbazone. Excess of chromous ion or xcess of dichromate ion destroys the colour, probably owing to the reduction of carbazone to the carbazide in the first case and oxidation of the carbazide to its higher oxidation product carbadiazine, or even further, in the latter case. The spectral curves of three different systems, namely, chromate–carbazide, chromate–carbazone and chromous–carbazone are found to be identical, having an absorption maximum at 540 mμ.

A quantitative study of the reaction from spectrophotometric measurements was made by the method of Job[3]. For mixtures of chromate–carbazide and working with equimolecular solutions, the maximum reaction was found to correspond to a ratio of chromate to carbazide of 2 : 3. For the chromate–carbazone reaction this ratio was 1 : 3 and for chromous–carbazone mixtures it was found to be 1 : 1.

These observations can be explained by the accompanying reactions.

Transport measurements on concentrated solutions of mixtures of chromate and carbazide showed the compound to be of a non-electrolytic type. This is also in conformity with the above formulation of the compound as an inner metallic chromium complex.

That the compound formed contains chromium in the bivalent state is corroborated by magnetochemical methods. Magnetic susceptibility measurements were made with solutions of chromate–carbazide mixtures in which the ratio of chromate to carbazide was 2 : 3 (corresponding to the maximum composition in Job's method, where as a first approximation it can be considered that the complete conversion of chromate to the chromous complex has occurred). The solution was found to be paramagnetic, and calculation gave a susceptibility of 4·5 Bohr magnetrons for the moment of chromium, which is undoubtedly due to bivalent chromium.

Details of the mechanism of the reaction and its kinetics will be published elsewhere.

My thanks are due to Prof. P. B. Sarkar for his interest and kind encouragement, and to Dr. B. C. Haldar for his helpful suggestions during the progress of the work.

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Jan. 21.

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[3] Job, P., C.R. Acad. Sci., Paris, 180, 928 (1925).

FORTHCOMING EVENTS

Wednesday, August 6—Friday, August 8

FARADAY SOCIETY (in the Department of Zoology, The University, Cambridge)—General Discussion on "The Physical Chemistry of Proteins".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT STATISTICIAN (preferably holding a degree in economics with statistics) in the Department of the Commercial Manager—The Secretary, East Midlands Gas Board, Beverley House, University Street, Leicester (August 12).

STATISTICIANS in the Department of Census and Statistics, Ceylon—The Office of the High Commissioner for Ceylon in London, 13 Hyde Park Gardens, London, W.2 (August 13).

LECTURER IN AGRICULTURAL CHEMISTRY (with an honours degree, or its equivalent, and considerable general experience with special experience in animal nutrition)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (August 16).

RESEARCH DEMONSTRATOR IN MATHEMATICS—The Registrar, The University, Sheffield (August 16).

ASSISTANT WATER ENGINEER—The Managing Director and Engineer, Lowestoft Water and Gas Company, 163 High Street, Lowestoft (August 20).

RESEARCH ASSISTANT IN PSYCHOLOGY—The Secretary, The University, 38 North Bailey, Durham (August 20).

LECTURER, Grade II (graduate, with a first-class certificate of competency under the Coal Mines Act) IN MINING (Coal), and a LECTURER, Grade II (with a good honours degree, and practical experience in coal preparation) IN COAL TREATMENT—The Secretary, The University, Birmingham 3 (August 23).

RESEARCH ASSISTANTS for work with a small team engaged in research, IN THE DEPARTMENT OF MINING, on the chemical constitution of coal, and a RESEARCH FELLOW IN COAL TREATMENT—The Secretary, The University, Birmingham 3 (August 23).

RESEARCH OFFICER IN THE PLANT AND SOILS LABORATORY, Brisbane, for research on the nutrient requirements of subtropical plants with special reference to pasture legumes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Ref. No. 3922 (August 23).

ZOOLOGIST (with a first- or second-class honours degree in zoology) for research on the ecology of streams, rivers or lakes—The Director, Freshwater Biological Association, The Ferry House, Far Sawrey, Ambleside, Westmorland (August 31).

ASSISTANT LECTURER IN PHYSICAL CHEMISTRY—The Secretary, University College, Earlsfort Terrace, Dublin (September 1).

BIOCHEMIST (with research experience) to work on problems connected with tissue metabolism and the metabolism of cancer-producing substances—The Secretary, Institute of Cancer Research, Royal Cancer Hospital, Fulham Road, London, S.W.3 (September 1).

DIRECTOR OF THE IMPERIAL INSTITUTE—The Secretary, Ministry of Education (Establishments General), Curzon Street, London, W.1 (September 1)

ASSISTANT TEACHER (Grade B) IN ZOOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (September 5)

CHEMICAL ENGINEER or CHEMIST, with experience in the design and operation of pilot plants used for obtaining process data, and familiar with instrumentation for automatic control of such plant (Ref. TT/505), a SCIENTIST II—PHYSICIST (with a good honours degree), for laboratory investigations on the briquetting of coal and allied materials (Ref TT/506), SCIENTIST III—PHYSICISTS and ORGANIC CHEMISTS (with a good honours degree), for laboratory investigations on the briquetting of coal and allied materials (Ref. TT/507); a SCIENTIST III, with University or other recognized training in mineral engineering or coal preparation to second-class honours standard (Ref. TT/508); and SCIENTIFIC TECHNOLOGISTS (Grade I), as mechanical and electrical technologists for design, construction and operation of pilot plant connected with the briquetting of coal (Ref. TT/509); at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (September 10)

ASSISTANT LECTURER IN ARCHÆOLOGY—The Registrar, University College, Cathays Park, Cardiff (September 13).

CHAIR OF CIVIL ENGINEERING in the University of Western Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

SENIOR RESEARCH FELLOW IN THE DEPARTMENT OF STATISTICS in the Research School of Social Sciences, Australian National University, Canberra—The Administrative Officer in the U.K., Australian National University, 27 Russell Square, London, W.C.1 (September 15).

PHYSICAL CHEMIST, or ORGANIC CHEMIST with special experience of spectroscopy and electrochemistry, as Research Fellow in the Department of Medical Chemistry in the John Curtin School of Medical Research—The Administrative Officer in the U.K., Australian National University, 27 Russell Square, London, W.C.1 (October 31)

ASSISTANT LECTURER (Grade B) IN METALLURGY—The Principal, North Staffordshire Technical College, Stoke-on-Trent

BURSARIES (2) IN THE CHEMISTRY DEPARTMENT of the Imperial College of Science and Technology for research on (*a*) the constitution of molten silicates using viscosity techniques, and (*b*) the fundamental aspects of the sorption of hydrogen by iron—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1

BURSARIES (2) IN THE NUFFIELD RESEARCH GROUP IN EXTRACTIO METALLURGY at the Royal School of Mines, for research on the physica chemistry of high-temperature equilibria involving (*a*) molten silicate and (*b*) molten iron—The Personnel Officer, British Iron and Ste Research Association, 11 Park Lane, London, W.1.

DEMONSTRATOR IN MICRO-BIOLOGY, a DEMONSTRATOR IN AGR CULTURAL CHEMISTRY, and a RESEARCH ASSISTANT IN AGRICULTURA CHEMISTRY, at the School of Agriculture, Sutton Bonington—Th Registrar, The University, Nottingham.

DIRECTOR OF THE BRITISH NON-FERROUS METALS FEDERATION—Peat, Marwick, Mitchell and Co, Lombard House, Great Charl Street, Birmingham 3, endorsed 'Federation Selection Committee'.

EMPIRE RHEUMATISM COUNCIL FELLOWSHIPS—The General Secr tary, Empire Rheumatism Council, Tavistock House (N), Tavisto Square, London, W.C.1.

LECTURER IN PHYSICS—Prof W. H. Watson, Head of the Depar ment of Physics, University of Toronto, Toronto, Canada.

LECTURER or ASSISTANT LECTURER IN THE DEPARTMENT OF AER NAUTICAL ENGINEERING—The Secretary and Registrar, The Universit, Southampton.

RESEARCH ASSISTANT (with a knowledge of electronics and mecha ical physics and, preferably, some research experience) for the develo ment and use of borehole gravimeter—The Department of Geode and Geophysics, Downing Place, Cambridge.

SCIENTIFIC OFFICER (graduate in chemical engineering or fu technology; some practical engineering experience is desirable) f research and development work on coal burning equipment for g turbines—The Assistant Secretary (Ref. A.18), British Coal Utilizatio Research Association, Randalls Road, Leatherhead, Surrey.

SCIENTIFIC OFFICERS (2, honours graduates in physics or enginee ing) IN THE PHYSICS DEPARTMENT, for work on problems in the fiel of (*a*) heat transfer and (*b*) particle mechanics, which includes t properties and behaviour of dust particles—The Assistant Secretar British Coal Utilization Research Association (Ref. A.10), Randal Road, Leatherhead, Surrey.

SOIL SURVEYOR in the Research Division of the Ministry of Agr culture, Sudan—The Sudan Agent in London, Wellington Hous Buckingham Gate, London, S.W.1, quoting 'Soil Surveyor 423'.

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(*not included in the monthly Books Supplement*)

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SCIENTIFIC FREEDOM AND SECURITY

THE Stevenson Lecture which Dr. J. B. Conant delivered at the London School of Economics and Political Science on March 17 has now been published* under the title "Anglo-American Relations in the Atomic Age". It is important both for some suggestions for co-operation which deserve close consideration by the man of science as well as by the administrator and politician, and as a contribution to Anglo-American understanding. Dr Conant recognizes that Great Britain can help the United States to preserve the conditions of academic integrity and freedom upon which scientific advance largely depends—but only if we attempt to understand conditions in the United States. Equally he recognizes the need for the same attempt at understanding on the part of the United States in regard to what appear to be weaknesses in British security measures and policy.

If Dr. Conant's lecture contributed solely to sufficient understanding to restrain scolding on either side and stimulate counsel instead, he would earn the thanks of men of science generally. His lecture should equally stimulate constructive thought about the real issues—the thinking that is an essential preliminary to the working out of any means of giving effect to the practical suggestions he makes. We are left in no doubt as to the practical difficulties with which international co-operation in such matters as nuclear energy bristles, particularly through the natural reluctance of any nation to enlarge its security risk by divulging secrets of such transcendent importance even to its allies. That difficulty would remain, even if so many scientists everywhere were not genuinely opposed to any restriction of the traditional freedom of publicity in science and if none had communist sympathies.

The heart of Dr. Conant's address lies, in fact in its frank discussion of some of the factors which at present adversely affect Anglo-American relations and of the means by which those factors may be overcome. He does not claim to be unbiased in this discussion, for at the outset he admits that, to his mind, good Anglo-American relations were never more important nor more difficult to achieve than at present. Accurate information and informed interpretation, however, are the right counter to the efforts of those who from private or subversive motives seek to sow discord between the English-speaking nations, and in this address Dr. Conant's sympathies with Great Britain have manifestly not prevented him from approaching his subject on rational lines, or from seeing it in the wider perspective.

Most men of science are only too well aware of the extent to which the position of science in international relations has deteriorated over the past hundred or even fifty years. Not so many appreciate the extent to which, as Dr. Conant also reminds us in this lecture, statesmen and politicians are handicapped from applying the obvious rational measures which a situation demands, through the political pressure exerted by sectional groups looking at only one aspect of the situation. That is true of Great Britain and other countries as well as of the United States.

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* Anglo-American Relations in the Atomic Age. By Dr. James B. Conant. (Delivered on 17 March 1952 at the London School of Economics and Political Science.) Pp. 42. (London: Oxford University Press, 1952.) 5s. net.

The position is the more dangerous in view of the new situation created by the advent of nuclear weapons. Dr. Conant points out that we are now dealing with the consequences of a new social phenomenon. Until the advent of nuclear weapons, developments in defensive or offensive weapons depended on the special application of the publicly known facts and principles of physics and chemistry. Any new scientific knowledge involved had no revolutionary consequences for the advance of science. The flowering of the whole field of nuclear physics, on the contrary, depended on the expenditure of a large sum of public money, justified in the first instance in terms of the destructive power of a weapon required in a desperate global struggle. Inevitably nuclear physics, thus born of a war-time necessity, was marked from its birth with the secrecy which was anathema to nineteenth-century men of science.

The advance of one whole area of science was thus equated with national security; and Dr. Conant insists that the assumption that science knows no frontier is automatically cancelled and we must face the consequences. We must distinguish sharply between the special position of nuclear science and that of the other fields of physics and chemistry. This is the first step towards preventing the spread of undue secrecy and thereby assisting the progress of science and promoting the welfare of the international community of science.

It is but fair to point out that Government policy in Britain, and probably in the United States also, has on the whole sought to recognize this distinction, however imperfect administration of the policy at times may have been. Another factor to which Dr. Conant directs attention has at times been an embarrassment—the extent to which success in nuclear physics has become a matter of national and political pride. That alone could well account for some of the cruder manifestations of the spirit which has found expression, for example, in the Committee on Un-American Activities or even in some of the investigations under the Loyalty Programme of the United States Government. Dr. Conant does not attempt to justify hysteria, but he appeals for an attempt to understand it; and his lecture gives a welcome reminder that in the universities and elsewhere there has been a much firmer stand against infringements of academic and personal freedom in the United States than could often be gathered from the press.

In this situation Dr. Conant believes that it is impossible to-day, or at any time in the foreseeable future, to have a frank, rational, searching discussion of the industrial uses of nuclear energy. There is no point now in discussing whether the decisions on security regulations in the early days were wise or unwise; but Dr. Conant's own opinion is that misunderstandings and bad feelings between the governments of Canada, Great Britain and the United States might have been avoided by greater frankness at the outset. He thought in 1943, and still thinks, that a treaty should have been drawn up between the three nations dealing with everything even distantly related to nuclear energy.

The chief suggestion he now makes is that an attempt should be made to strike the balance between the demands of security and the demands of justice by a joint commission of the United States and of Great Britain. Such a commission might have to sit behind heavily barred doors; but there is something to be said for Dr. Conant's view that not only is a wise solution more likely to be reached in this way but also that the way would be prepared for a rea partnership in this technical area, comparable with that represented in military matters by the Combined Chiefs of Staff during the Second World War. Even if such a Commission failed to surmount the difficulty in regard to the free exchange of information on nuclear energy noted at the outset, it could scarcely fail to facilitate understanding and co-operation. As Dr. Conant rightly says, the important issue is the future conduct of scientific men, of academic men and of government officials. The more the framework within which these men operate in one country approximates to the framework in which they work in the other, the smoother will be the path of co-operation; and the more nearly that framework is determined on principles which respect the professional loyalties and ideals in which those men are trained, irrespective of nationality, the greater the likelihood of such frameworks being similar. It may not be possible even so to eliminate secrecy or government monopoly; but it should be possible to ensure that they are limited to the minimum consistent with security, and that the area in which the scientific man can work with honest reporting, ful discussion, no political interference and full liberty of investigation is as wide as possible.

In this lecture Dr. Conant dealt primarily with the question of Anglo-American relations and co-operation in relation to this problem of securing a sane balance between freedom and security. It is plain enough that he is aware that co-operation and understanding are also demanded not only across such national frontiers and within the ranks of scientific men themselves, but also between different professional groups—between the scientific man and the administrator, whether Civil servant or academic and between those again and the military authorities and statesmen or politicians. With this aspect indeed, Dr. Conant dealt at some length in a subsequent speech at a luncheon given in his honour in London by the Pilgrims.

The first barrier to be broken down is that between the scientific men of the free nations, and especially between those of Canada, Great Britain and the United States. The grand academic alliance to promote greater understanding between scholars and administrators in the universities of the United States and English-speaking countries of the Commonwealth which he suggested to the Pilgrims could contribute powerfully to that end, as well as place a furthe massive stone in the foundations of good Anglo merican relations. Scientific men to-day depend ery largely on administrative understanding for their eedom of communication and contact with their llows in other lands. It is a matter of governmental r departmental regulation and constraint, and not lways financial restriction, that has frequently revented the free exchange either of information or f visits, and it is well that a man of Dr. Conant's anding should direct attention to the importance f much freer movement of individuals between orth America and Great Britain.

Neither country has been free from examples of liberal restraint on the movement of individual cientific workers, and this plea for closer co-operation etween the administrator and scholar on both sides f the Atlantic has already received a warm welcome. t is already known that a strong American delegation to be invited to the Congress of Universities of he Commonwealth next year in Cambridge ; but the ffective discussion of Dr. Conant's proposal there ill involve much detailed preparatory work, and he careful consideration of administrative as well as inancial obstacles to movement. Recent untoward ncidents like those in which Dr. L. Pauling and Prof. attimore have been concerned may serve a useful urpose in this connexion by indicating some of the rrors to be avoided.

In this connexion it should be noted that Dr. Pauling has now been given a passport to enable him o visit Great Britain and France, and that the Council of the American Association for the Advancement of Science has already expressed its concern over the manner in which measures like the McCarran Act are being administered to prohibit American citizens from going abroad, and citizens of other nations from visiting the United States to interchange knowledge of science which does not affect secrecy. At its meeting in Philadelphia last December, the Council strongly urged a review and modification of the administrative procedures under the McCarran Act so as to modify injustices and the damage to American prestige. It has recently been announced that, because of the delays and embarrassments which foreign men of science experience in attempting to obtain even temporary admission to the United States, the International Congress of Psychology, which was to have been held in New York in 1954, will now be held in Montreal, Canada, where procedures for granting visas appear to be more flexible and realistic. In making this announcement, the American Psychological Association expressed its support of the resolution of the American Association for the Advancement of Science ; the executive secretary of the Association has said that the real objection of scientific men to the McCarran law is that it uses an axe in dealing with a problem that needs a razor-sharp approach.

Meanwhile, Dr. Conant's speech has encouraged all those concerned with educational exchange between the United States and Great Britain, to the value of which the reports of at least two of the 'productivity teams' have recently testified. The Director of Extra Mural Studies at the University of Birmingham estimates that whereas some 1,500 students from the United States have attended summer schools in Britain during recent years, it is doubtful whether as many as a dozen British students have been able to get to comparable schools in the United States in the same period. For this disproportion the dollar exchange position is largely responsible ; but the security regulations of the United States and the visa hurdles which Dr. Conant condemned have also been major obstacles, and there are other minor ones in the questionnaires which applicants for travel grants under the Fulbright Fund are required to complete.

Informal discussion and keen thinking on the part of scientific men as well as of scholars generally and university and Civil service administrators could do much to assist the formulation of practical proposals which the approval of such a congress as that to be held at Cambridge next year would go far to promoting adoption by both governments and universities. It is essential that such discussion and inquiry should proceed with all vigour, even if it may not be necessary to set up a special commission to deal with the whole subject. The Atomic Scientists' Associations in Great Britain and in the United States could well help in this matter, and already the Present Question Conference at Oxford last August* on "Freedom and Responsibility" has assisted in bringing out some of the issues underlying co-operation in this field, while the forthcoming conference on "Conflicts of Loyalties" should further clarify thought.

What has to be realized is that such a matter as the academic alliance which Dr. Conant suggests is not a matter for the universities alone, quite apart from the way in which implementation of any such project may depend upon government action to remove restrictions on movement or even upon government financial support. It is linked up with what is possibly an even more fundamental issue, namely, that of facilitating effective public discussion. Dr. Conant himself referred to the dangerous consequences of the present position, which virtually deprives the public of the accurate and authentic information without which a sound judgment of public policy in this field is impossible, and this is the issue to which, above all, immediate attention is imperative.

Unless that problem is handled wisely, public support is unlikely to be forthcoming for any measures of Anglo-American co-operation in the academic field, still less for any modification of the relations between atomic scientists and the State. Re-examination of institutions and organizations in Britain is imperative even if, as Sir John Cockcroft said at the Present Question Conference, for the moment a working solution has been found which preserves a reasonable degree of freedom for scientific work in nuclear physics. These arrangements need, however, to be scrutinized in a wide context and against the background of the ideas and principles on which a democratic society is based.

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* Question : a Journal. Edited by H. Westmann. Vol. 4, No. 2 : Freedom and Responsibility.' By Prof. H. D. Lewis, H. J. Blackham, Dr. J. Bronowski and Wells Coates. (Published for the Present Question Conference, Ltd.) Pp. 105–216. (London : Hammond, Hammond and Co., Ltd., 1952.) 2s. 6d.

Dr. J. Bronowski's address to the Seventh Present Question Conference brought out very clearly both the dangers of the present situation and the implications for the scientific man. Vindicating, like Sir John Cockcroft before him, the scientist from the charge of irresponsibility in his scientific work, Dr. Bronowski insists that the great responsibility of the scientific man to-day is to become a teacher to the whole community, and to help his fellow men to understand clearly the implications of the forces which science has released and the changes science is bringing about. Only so is there any hope of society acquiring the wisdom which is required for it to regain control over events, and to choose those directions which tend to good and turn from those that do not. Dr. Conant's addresses should inspire an even wider circle of scientific men and other scholars to turn to the imaginative and constructive thinking out of which will emerge the new institutions of Anglo-American co-operation, whether in science, in the universities or in world affairs generally.

ENTOMOLOGY AND CITRUS FRUIT PRODUCTION

Citrus Entomology in the Middle East

With Special References to Egypt, Iran, Irak, Palestine, Syria, Turkey. By F. S. Bodenheimer. Pp. xii+663. ('s-Gravenhage: Dr. W. Junk, 1951.) n.p.

PROF. F. S. BODENHEIMER'S work is a very thorough compilation of almost all that has been published in the literature, since it covers all the living organisms of the animal kingdom which are related to the now almost universally important problem of citrus fruit production. The part played by insects being by far the most predominant, the author gives an exhaustive account of the results of investigations on the insect pests in the countries surrounding the eastern Mediterranean. In chapters on flies (Diptera), scale insects and thrips, Prof. Bodenheimer fully discusses the ecology of each major pest, selecting not only good and concise descriptions of the species but using also the most recently adopted nomenclature—with keys for the identification of the major groups, as well as of the species. The geographical distribution, a list of the host plants, the seasonal history, the correlation of the development of the insect to temperature and humidity (illustrated by ecoclimograms), threshold of development, thermal constant and the number of generations are given for every important species. Reproduction and productivity, differences between summer and winter eggs, sexual fluctuations, biology of nutrition, fluctuation of populations as a result of change in the nutritional properties of the soil, and numerous other details are discussed and illustrated by a large number of useful tables and graphs. The natural enemies, parasites and predators are studied and supported by judicious conclusions as regards their varying importance based on their biology.

It is to be regretted that Prof. Bodenheimer's book has been considerably retarded owing to the Second World War, for during the past few years the measures of control, particularly those dealing with the most disastrous species of scale insects, have undergone many improvements.

It is unfortunate and regrettable, also, that the list of the most important literature at the end of each chapter does not extend beyond 1946, when the text (Prof. Bodenheimer in his introduction admits that the manuscript of the book was sent to Amsterdam during the early part of the War) is said to have been entirely revised. Moreover, earlier papers such as the valuable piece of research by Dr. A. D. Hanna, on *Ceratitis capitata* Wied. (*Bull. Soc. Fouad I d'Entom.*, 22 (1938), 31 (1947) and 32 (1948)), are not mentioned in the bibliography. The completion of the work in this respect would have considerably enhanced the value of the book. In my opinion, it would have been preferable to combine the bibliography of each chapter at the end of the volume, and an alphabetical index of the names of insects dealt with should have been added.

In spite of these remarks, Prof. Bodenheimer's "Citrus Entomology" is an authoritative and indispensable book, being written with a breadth of view only to be acquired by a truly scientific outlook. I recommend it not only to agricultural research institutes and citrus farmers but also to entomologists the world over.

H. C. EFFLATOUN

PARASITES AND PARASITISM

Parasitic Animals

By Dr. Geoffrey Lapage. (Cambridge Library of Modern Science.) Pp. xxi+351+8 plates. (Cambridge: At the University Press, 1951.) 21s. net.

THIS is not intended to be a text-book of parasitology, but it does contain a considerable amount of factual information concerning a number of forms, mostly those affecting man or domesticated animals. It could only have been written by one who had, like Dr. G. Lapage, devoted years to the study of parasites and parasitism with its manifold practical and theoretical implications. It may be regarded as almost an ecological study of highly specialized animals living in remarkable environments and a discussion of the general principles underlying the relationship. The author makes a plea, that in considering the many aspects of the subject, the student should try to overcome the prejudice resulting from a knowledge of the diseases, pain and loss caused by parasites and should turn to the beauty of the remarkable adaptations they illustrate.

From the method of approach, the arrangement of the contents can be neither that of systematic zoology nor of medical practice. Dr. Lapage has, with success and as the result of the exercise of much thought and ingenuity, produced a logical sequence in the method of presentation. The methods of contact between parasite and host and the ways in which the parasite reaches its resting place are arranged and discussed in a series of examples of increasing complexity. Similarly, the descriptions of life-histories of parasites are not only divided into chapters according to whether one or more than one host is involved, but also within each chapter the life-histories are arranged in series beginning with the most simple and passing by steps to the more and more complex. With this factual material for reference, the author considers the effect of the parasitic mode of life, first upon the parasite itself and secondly upon the host. This naturally leads on to more general questions such as tissue reactions and immunity, and other aspects of the host–parasite elationship. There are but few slips in the book; ut some readers will doubtless consider that the liscussion starting on p. 14 as to whether the fœtus f the mammal is to be regarded as a parasite involves tretching the meaning of the word parasite beyond egitimate biological limits. Indeed, it runs against he grouping of animal associations set out on p. 2, vhere parasites are placed in associations of animals belonging to "different zoological species".

This, however, is a minor point in a most interesting, readable and very useful book. It will appeal o specialists and general zoologists alike, and certainly should be read by all students whose courses nclude a consideration of animal parasitism. Even he lay reader will be able to follow its clear style vithout too much difficulty and find in it much that s of interest and thought-provoking.

ELECTRICAL BREAKDOWN OF SOLIDS

Dielectric Breakdown of Solids

By S. Whitehead. (Monographs on the Physics and Chemistry of Materials.) Pp. xv+272+18 plates. Oxford: Clarendon Press; London: Oxford University Press, 1951.) 25s. net.

ONE may often read of the need for greater interest, in Britain, in the applied sciences and for a more widespread appreciation of their value in education and in industry. Indeed, it is sometimes almost possible to detect, even in authoritative articles, the reiterated outline of a standard complaint. There is, however, little doubt that more attention should be paid, primarily in universities, o applied physics, for example, and the well-known Oxford series of "Monographs on the Physics and Chemistry of Materials" is contributing notably to that end.

The present book, by Dr. S. Whitehead, director of research of the Electrical Research Association, is one of the latest additions to the aforementioned eries, and covers as fully as possible in 272 pages he important subject of electrical breakdown in olids. This is apparently the only modern book of ts kind and follows an earlier one written by the ame author some twenty years ago.

The purpose of the book is to review recent fundamental work in a form suitable for physicists working n university, government or industrial laboratories. t will probably be little used at the present time by undergraduate students in most universities; but esearch students and graduates in general, working on the solid state, will find it of great value.

The author is an outstanding authority on his ubject and, with his colleagues in the Electrical Research Association, has been responsible for many dvances, especially in the study of the effects of mall voids in solid insulation. It is therefore not urprising to find in the book a masterly, but necesarily condensed, treatment of the subject. The hapters deal with intrinsic breakdown, including a ull treatment of the theory of breakdown in simple rystals, which is one of the most fundamental parts f the book; thermal breakdown; breakdown aused by discharges, external or internal to the solid dielectric; electrochemical deterioration; and, finally, dielectric breakdown in technical practice. It is, perhaps, surprising that more space was not evoted to surface sparkover, in view of its great technical importance, even though this is not strictly a problem in breakdown of solids and is controlled greatly by the nature of the electrodes, which diminishes its attraction as a basic general problem. The description of the effects of internal discharges in dielectrics is particularly comprehensive. It seems unfortunate that, having achieved the impossible once, Dr. Whitehead should not have achieved it again by including even one or two chapters on breakdown in liquids.

The book has exceptional value in many respects, but perhaps especially in directing attention repeatedly to the lack of experimental data obtained in controlled and simplified conditions. This applies even to the relatively simple case of electrical breakdown in ionic crystals, and to the study of thin films, where the work of a very few investigators stands out. It is remarkable, as Dr. Whitehead's book so clearly shows, that such an important subject as the electrical breakdown of solids has attracted, with a few notable exceptions, such a small number of research workers. This excellent work should do much to stimulate others.

STATISTICS AND THE CHEMIST

Statistical Methods for Chemists

By W. J. Youden. (Wiley Publications in Statistics.) Pp. x+126. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 24s. net.

IN this short book, chemists are shown not only how to use statistical analysis but also why to use it and how to plan investigations so that numerical observations will be made to the best advantage. Dr. W. J. Youden writes as one of the few chemists who have studied and practised modern techniques of statistics: his book is full of the wisdom that comes from long experience of his subject-matter.

The book is elementary and well suited for a reader without previous knowledge of statistics. Theory and proofs are almost entirely absent, yet the logical basis of the methods discussed is always clear. The first chapter displays the need for proper statistical treatment of chemical data by showing—a favourite theme of mine—that often the man who refuses to use statistics is in reality using inefficient statistical methods when better ones are readily available. Subsequent chapters relate to the various concepts that enter into analysis of variance, regression analysis, and experimental design, together with short sections on sampling. In the main, the presentation is of the kind familiar in texts of biological statistics; but it takes on a distinctive character because the illustrations are drawn from chemical investigations. Dr. Youden rightly insists that a proper understanding of the functions of statistics in chemistry can be attained only by study of practical problems; he therefore puts before his readers a fine and varied selection of experimental data, largely from pieces of research with which he has been personally concerned. Especially valuable are the explanations of experimental designs and their uses. Dr. Youden gives an excellent introduction to incomplete blocks and complete and incomplete replications of factorial schemes; but the emphasis is on general principles rather than details of interpretation, and the chemist concerned with elaborate experiments would probably need further guidance from another book.

Perhaps the most surprising point is the complete absence of any discussion of discrete variation: neither χ^2 nor the binomial distribution is mentioned. The discussion of sampling is rather inadequate, and no mention is made of quality control, a branch of applied statistics that would seem to be of special interest to chemists. The very brief chapter on regression would be improved by some recognition of the existence of multiple regression methods. Such flaws are inevitable in so short a book, but a study of what Dr. Youden has said should encourage many chemists not only to put his simpler procedures to immediate use but also to read more widely in other text-books of applied statistics. D. J. Finney

SURVEY OF CANCER IN LONDON DURING 1938-39

British Empire Cancer Campaign

A Survey of Cancer in London: Report of the Clinical Cancer Research Committee. By Dr. W. L. Harnett. Pp. vi+834. (London: British Empire Cancer Campaign, 1952.) 45*s*.

Between 1936 and 1938 the Clinical Cancer Research Committee of the British Empire Cancer Campaign designed thirty-one detailed case-sheets, applicable to patients suffering from cancer in the various regions of the body, which were distributed to all the voluntary and London County Council hospitals and most of the special hospitals in the County of London. 15,200 patients were registered from April 1938 to September 1939, and the data on their case-sheets coded by Colonel W. L. Harnett, the full-time medical secretary and registrar to the Committee. A five-year follow-up was carried out, and only four hundred cases could not be traced. The primary design was to secure accurate information on the efficacy of the various methods of treatment available; but, in addition, much data on other aspects of clinical cancer were obtained. Analyses on half the material were published in the Annual Reports of the British Empire Cancer Campaign. This survey gives the revised findings, both summarized and detailed, in the whole series of patients.

There were sufficient cases for detailed analyses in thirty-four out of the forty-three sites of registered malignancy. Each site is analysed under about thirty headings, which, in addition to types of therapy and follow-up, include age distribution, occupation and social class, relevant past history, first symptoms, delay in treatment, findings on examination, clinical stages, actuarial estimation of survival after treatment, biopsy reports and causes of death. The number of cases in the commoner cancers is large—breast, 2,152; stomach, 1,405; rectum, 1,390; skin, 1,080; lung, 1,024; colon, 892; cervix uteri, 859; bladder, 423; pharynx, 385; prostate, 383—and their analyses are thereby of great significance.

Comparison of different treatments summarized from the whole data favours radical surgery combined with radiotherapy over radical surgery, while the latter was better than radiotherapy alone. However, the results varied according to the site, stage, age and selection of the patients. In cancer of the breast, for example, post-radical mastectomy irradiation slightly improved the long-term results in clinical stage III*b* but not in any other stage. Again and again throughout the survey, the already long-established fact is accentuated by the tables that early cases of cancer do well with any orthodox treatment but that, once the lymph nodes are involved, the number of five-year survivors is considerably reduced, whatever the treatment. The totals of all sites variously treated, analysed according to stages, showed a five-year survival-rate of 38·7 per cent in stage I, 20·0 in stage II, 13·2 in stage III and 1·5 in stage IV. About one-third of all cases proved to be clinical stage I on admission to hospital.

The interval from first symptom to medical consultation varied greatly with the site. It was less than three months in 53·1 per cent of the 12,277 records in which the data were available, and more than six months in 20·8 per cent. Of the 12,125 patients who consulted a medical practitioner, 68 per cent were referred to hospital at once. The five-year survival-rate for all methods of treatment was 19·22 per cent of the 14,182 patients with primary cancer. In his introduction to the "Survey", Sir Heneage Ogilvie says that this figure would have been raised to 38·7 per cent had all patients come to hospital while the disease was still in stage I. This is an indirect plea for earlier diagnosis and treatment, laudable but perhaps over-optimistic with regard to the benefit which might ensue, since rapidly growing and spreading tumours constitute a fair proportion of most groups of malignancies. It is a pity that the Research Committee did not look into this matter by an attempt to correlate the stage with the length of history. Such a correlation might establish how many advanced cancers are in that state because of prolonged delay in diagnosis and how many are due to the presence of a rapidly spreading tumour. In a number of sites the survival-rate has been correlated with duration of symptoms and, interestingly enough, rarely shows any statistically significant difference between patients who came under treatment within the first six months and those who delayed longer.

Analyses of social class agree with the Registrar-General's conclusions from mortality figures that the poorer groups are more liable to cancer of the tonsil, pharynx, lip, mouth, tongue, œsophagus and skin. The significance of the findings in the patients' relevant past history, such as incidence of unsatisfactory dental conditions, heavy smoking or excessive alcohol consumption in relation to cancer of the mouth, pharynx and larynx; pre-existing goitre with cancer of the thyroid; gall stones with cancer of the gall bladder and a number of other conditions cannot be judged because of the absence of data on their incidence in a control non-cancerous population selected at the same time. A previous history of tuberculosis, pneumonia and influenza was recorded in the cancer of lung series; it was unfortunate that smoking habits were not recorded in these patients.

This survey is an example of a research approach which is likely to prove every whit as important as the laboratory one, and which, if the right questions are asked, might be even more fruitful. As it stands, we see the state of cancer at the hospitals of Greater London in the year preceding the outbreak of the Second World War, preserved for posterity—a base-line for studies on changing incidence, diagnosis, clinical manifestations and treatment. Everyone interested in malignant disease will be deeply indebted to the British Empire Cancer Campaign for its production of this unique and monumental survey of cancer in London. I. Doniach

THE OAK RIDGE 86-INCH CYCLOTRON

By Dr. ROBERT S. LIVINGSTON
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THE construction of an 86-in. high-current proton cyclotron of the fixed-frequency type was started at Oak Ridge in August 1949. Design and fabrication of the machine was completed by the staff of the Oak Ridge National Laboratory with the assistance of other personnel and facilities of the Carbide and Carbon Chemicals Co. in almost exactly one year. On November 11, 1950, the first beam was obtained. The cyclotron now produces an internal beam in excess of one milliampere of protons at 24 MeV. At this energy the relativistic increase in mass is 2·6 per cent.

The maximum particle energy which a fixed-frequency cyclotron can produce is a function, of course, of the available dee voltage. When proper account is taken of the rate and shape of magnetic field fall-off, ion 'phase grouping', relativistic mass increase, and electric and magnetic focusing, the threshold voltage for any given energy can be calculated reliably[1].

The major specifications of the 86-in. cyclotron are as follows: diameter of pole face, 86 in.; maximum beam radius, 33 in; magnetic field strength, 9,000 oersteds; resonance frequency, 13·4 megacycles per sec.; peak dee-to-dee potential, 300 kV. min., 500 kV. max.; dee-to-dee gap, 4 in.; dee width, 8 in.

The cyclotron is unique in that the orientation of the magnetic field is at right angles to that in conventional machines (Fig. 1). The dees are suspended vertically and can be lowered into the vacuum tank by a crane. The magnet, vacuum system, oscillator and testing console are in a room 28 ft. × 34 ft. This room is entirely surrounded by a shielding wall of ordinary concrete 5 ft. thick. Three walls are solid and the fourth is of blocks laid without mortar. The overhead portion of the shielding is composed of removable blocks which provide convenient access when modifications are required. An operating console, 400 ft. away from the cyclotron, provides for additional protection from radiation while the machine is operating at high level.

The U-shaped magnet yoke for the cyclotron is 40 in. × 62 in. in cross-section and weighs 250 tons. The vacuum system consists of three 20-in. oil-diffusion pumps, each equipped with an 8-in. booster pump, exhausting to a common header and backed by a 15-h.p. mechanical pump. The total pumping speed of the system is 15,000 litres per sec. at 0·03 micron.

The oscillator is of the grounded-grid self-excited type using a single Federal 134 tube. This tube is rated at 400-kW. input and 150-kW. plate dissipation. Several systems were investigated for overcoming the well-known 'ion loading' phenomenon, which makes it very difficult to obtain satisfactory starting conditions with the self-excited oscillator.

A dee-bias system using a negative 1,000-V. potential on the dees is the most successful method tried for control of ion loading. In investigation of other methods, the use of a pre-exciter oscillator was tested, and a charged-grid system made of copper tubes was suspended between the dees and the ground plane. It was found that the biasing system produces

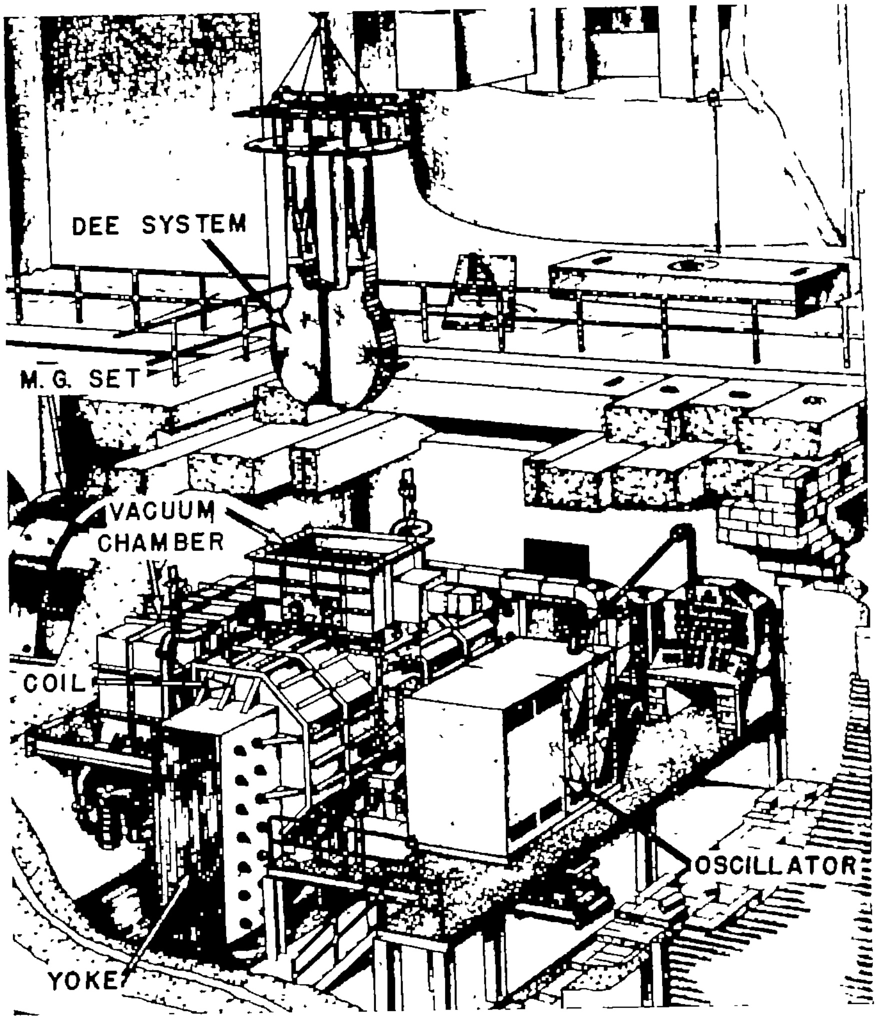

Fig. 1. Artist's sketch of the 86-in. cyclotron installation showing motor-generator, vacuum system, magnet, dee assembly, oscillator cabinet, and shielding

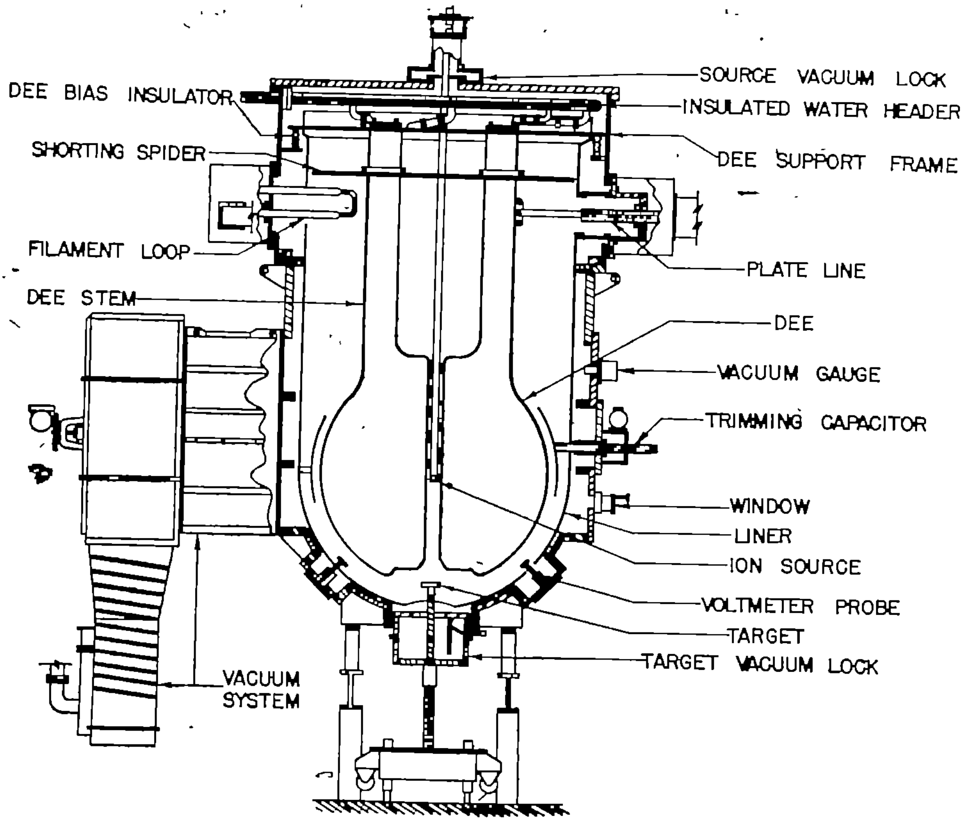

Fig. 2. Diagram of the resonant dee system. The ion source and the target are inserted through vacuum locks, from above and below respectively

the most dependable operation and permits a much higher dee voltage than the grid system. At present the voltage ranges between 280 kV. and 400 kV. dee to dee. Highly stable oscillator operation is achieved, and it is of interest to note that the oscillator may be turned on safely at full power.

The resonant system of the cyclotron is illustrated in Fig. 2. The copper-plated stainless steel framework which supports the dees rests upon, and is insulated by, four stand-off type cylinders of Alsimag 222 (American Lava Co.). A 500 μμF. capacitance is inserted in series with the plate transmission line, at the tube end, to prevent shorting of the D.C. bias. It was not found necessary to add any condensers between the 'r.f.-shorting-spider' and the liner; but great care is taken to balance the capacity of the dees exactly in order to minimize the 'unbalanced' current which flows between the dees and the liner. Heavy silver-plated copper clamps, with water cooling, successfully carry the very large radio-frequency currents (~ 5,000 amp.) at the voltage node of the resonant quarter-wave dee system.

In this cyclotron it was desired to use large circulating currents without making the dees intensely radioactive. To accomplish this, the dees are completely lined with a layer of graphite, so that any stray protons are prevented from impinging directly on the copper. The leading edges of the dees are also of graphite. It was gratifying to observe that after one million μampere-hours of operation, the dees could be approached quite safely within a few hours for carrying out alterations. It has been observed that the limiting activities near the cyclotron, exclusive of the targets, are those due to silver-110 (270 days) and iron-59 (43 days), both of which are induced by neutrons. In the fabrication of future dees, an attempt will be made to eliminate silver (from brazing alloys) completely.

A simplified technique has been worked out for the fabrication of components of the resonant radio-frequency system, where large amounts of heat due to either the radio-frequency heating or to impingement of the beam must be removed. This has proved highly satisfactory for such structures as the dees and liner. Water tubes of 0·875-in. outside diameter, flattened to increase the area of contact, are furnace-brazed to sheets of copper 0·090–0·125 in. in thickness. 'Heliarc' welding is used in joining sheets where high conductivity is desired, and vacuum-tight construction is not required. Continuous lengths of tubing are used wherever feasible.

In order to establish the energy of the beam by a measurement not dependent on the geometry of the cyclotron, three different methods have been used. The first of these consists of the bombardment of stacks of thin foils such that the depth of activity may be traced for a particular reaction. The best results by this method have been obtained with copper foils. The reactions used were ^{63}Cu(p,n)^{63}Zn and ^{63}Cu(p,2n)^{62}Zn, having extrapolated activation thresholds of 4·5 and 14·5 MeV., respectively. Some work has also been done with carbon foils by tracing the activation as a function of depth for the ^{12}C(p,pn)^{11}C reaction, which has an extrapolated threshold of 18·7 MeV. In the second method, the energy has been measured by allowing the beam to impinge upon a photographic plate after passing through a stepped aluminium absorber. The third nethod is by the use of a 'burn-out target' consisting f a series of separated lead foils placed across the path f the beam. The curvature of the 'burn-out' pattern roduced by the circulating beam and the known ntensity of the magnetic field give a maximum value f the energy.

These methods of measurement are all in subtantial agreement and indicate that the energy of he beam can be as much as perhaps 10 per cent ugher or lower than that calculated from the cycloron geometry. The variations in energy are dependent rimarily on the position of the ion source.

A particular problem with this cyclotron is the esign of internal targets and the facilities for nstalling and removing these targets from the yclotron. The target-mounting assembly is perlanently arranged on a stainless steel carriage. Hydraulic cylinders are incorporated in the carriage or actuating the target dolly by remote control and or holding the target face-plate against the vacuum ock. The carriage contains a separate motor-driven crew mechanism for raising or lowering the target o the desired radius. For rotating targets, provision as also been made for an auxiliary motor drive.

While many types of targets have been designed, wo are described to illustrate the types of arrangenents which have proved practical. In the first type, he beam passes through a 0·015-in. aluminium window and into the target directly behind the window. Cooling water circulates in contact with the arget, which is held in place by a spring clip. This a convenient system for irradiating metallic targets hen only a few microampere-hours are needed. eams greater than 100 μamp. have been used withut damage to the aluminium windows.

When larger irradiations are desired, it has been ound convenient to place a target at a small angle the incident beam (2–5°) and to make the target s large as possible. Aluminium targets 6 in. × 10 in. ave safely withstood more than 30 kW. of beam, easured calorimetrically. It should be noted that is necessary to have high-velocity water flowing in ne cooling circuit in such a target in order to obtain ifficient heat transfer. The induced activities at rge beam currents are extremely high. A zinc target ombarded for an hour at 400 μamp. gives 50 R./hr. 1 m. On a beryllium target, one neutron is released r approximately every fifty incident protons. To cilitate quick and easy removal of such 'hot' rgets, an arrangement has been designed such that quarter turn of a lever permits removal of the rget with a pair of long tongs or with remotely perated handling equipment.

ohen, B. L., "Fixed Frequency Cyclotron Theory", April 4, 1951, *AECD*-[illegible]01.

ARIABLE STARS AND GALACTIC STRUCTURE*

By CECILIA PAYNE-GAPOSCHKIN

THE intrinsic variable stars are the stars whose changes of brightness, temperature and spectrum e the results of physical changes of a single object, contrast to the geometrical variables, which show e effects of periodic eclipses of a close stellar pair. trinsic variables may be roughly divided between the pulsating variables (which undergo periodic or quasi-periodic changes governed by their physical properties) and explosive variables (which undergo changes that are more nearly explosions, and are, at the most, cyclic in nature).

Variable Stars

The pulsating variables embrace the classical Cepheids (periods of a day to fifty days or more); the *RR* Lyræ stars (periods less than a day), the yellow semi-regular variables (including the *W* Virginis stars, the *RV* Tauri stars, and the stars such as *SX* Herculis, with periods that range from about twenty to more than a hundred days), and the long-period variables with large ranges, and periods from rather less than a hundred to almost a thousand days. These divisions are not arbitrary, but are borne out by the physical nature of the stars in each group, as well as by their distribution and motion. Although all seem to undergo some type of pulsation, little progress has been made in understanding the details, or in analysing the complex interrelationships that exist between brightness, temperature, spectrum and radial motion of the surface.

The explosive variables include the supernovæ, the classical novæ, recurrent novæ, and dwarf novæ (*U* Geminorum and *Z* Camelopardalis stars). They are listed in descending order of maximal brightness; with the exception of the supernovæ, their outbursts are probably cyclic, those that reach the smallest luminosity at maximum having the shortest cycles. For these stars also, the abrupt changes of brightness, and the associated complex changes of spectrum, temperature and surface velocity are at present understood only in the most general way.

The intrinsic variables, despite the difficult physical problems that they present, can be studied fruitfully from another point of view. All are stars above the average in luminosity, and for each class the absolute magnitudes are fairly well determined. Therefore they can be located within the galaxy when correct allowance has been made for obscuration (a problem at present only approximately soluble), and the structure of the galactic system can be studied by their means better than in any other way.

Galactic Structure

The distribution of any group of stars within a galaxy may be regarded as the instantaneous result of the motions of the stars concerned. We shall find that the intrinsic variables fall into definite groups, not only on the basis of physical behaviour and of distribution, but also of motion. They form part of the general picture of the complex structure of our galaxy, which we may regard as the outcome of the motion of stars, nebulosity, and dust, in orbits of a variety of sizes, shapes and inclinations about the centre of the system.

A spiral galaxy, such as we may suppose our own system to be, has a complex structure. The main part of the light comes from a somewhat flattened spheroidal mass of stars, which also contains most of the mass. The spiral arms, superficially conspicuous in spirals such as Messier 31 in Andromeda, contribute perhaps ten per cent of the light, and are confined to a comparatively thin central layer, which also contains the dust and gas. This picture, which has emerged from the study of the nearer spiral galaxies, seems to be applicable to our own system, though in the latter the structure is more difficult to trace; this is because the sun happens to lie at present almost in the central plane, so that we encounter the full obscuring effect of the layer of dust.

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* Synopsis of three lectures given in the University of London on y 5, 7 and 8.

Stellar Populations

Within our own galaxy, the motions of the stars give a clue to the structure of which they form part. Stars characteristic of arms move in nearly circular orbits of low inclination; stars of the substratum may move in orbits of high inclination, and also of high eccentricity. Therefore their motion relative to the sun (which shares the motion of stars associated with the arms) may be considerable, and they embrace the 'high-velocity stars', first recognized by Oort. In the notation first suggested by Baade, the stars characteristic of the arms are known as 'population I', those of the substratum as 'population II'. Extreme specimens of population I are the galactic (sometimes called the open) clusters: they are confined to the galactic plane and move in nearly circular orbits. Extreme examples of population II are the globular clusters, which form a nearly spherical system about the galactic centre, and the large dispersion in their radial velocities places them among the high-velocity objects.

The galactic and globular clusters show a profound difference of population. The brightest stars of galactic clusters are the bluest—often blue super-giants of great luminosity—and their members run downwards along the main sequence; such clusters may, however, contain a few red giants. The brightest stars of globular clusters are the reddest, and are never as bright as the brightest blue stars of such galactic clusters as the Double Cluster in Perseus and the Pleiades.

The main population of the globular clusters runs from red to blue towards lower luminosity, and appears (from recent work at Mount Wilson) to converge with the main sequence for stars not much different in brightness from the sun. Globular clusters contain some bluer stars, which tend to form a branch of the colour-luminosity array near absolute magnitude zero; this branch embraces a variety of colours. The *RR* Lyræ stars, which are very numerous in many (though by no means in all) globular clusters, lie on this branch. These two population-patterns are characteristic respectively of stellar populations I and II. It is tempting to see in them a contrast which results from difference of origin, age or history.

Characteristics of Variable Stars

In order to relate the distribution and motion of a group of stars to the structure of our galaxy, we need to know their distances, and therefore their absolute magnitudes. This information is available for five main groups of intrinsic variables.

The *classical Cepheids* are distinguished by concurrent changes of brightness and radial velocity, by the relation between period and minimal spectrum, and by the progression of form of light curve with period (the Hertzsprung relation). They form a distinctive, but probably not a homogeneous, group, for none of the three relations mentioned is unique. The absolute magnitudes tend to be greatest for the Cepheids of longest period (the period-luminosity law, established by Miss Leavitt in the Magellanic Clouds, and assumed to be valid for all classical Cepheids). The Magellanic material establishes the scale of the period-luminosity curve; but the zero point must be established from the motions of comparatively few nearby galactic Cepheids, as has been done by R. E. Wilson. The absolute photographic magnitudes of classical Cepheids, which are thus functions of period, lie between − 1, for the shortest periods, to about − 4·5, for the longest. Classical Cepheids include the most luminous of intrinsic variables.

The luminosities of the *long-period variables* must be derived entirely from the motions of galactic members of the group. They are found by Merrill and R. E. Wilson to range from about + 1 for the longest periods to about − 2 for the shortest. The relation is less simple than for the classical Cepheids, since the long-period variables of shortest period tend to be high-velocity stars, and the velocities appear to bridge the gap separating populations II and I between the shortest and the longest periods. Studies of luminosity that are based on proper motions require modification for high-velocity stars, and therefore the luminosities of individual long-period variables cannot be confidently inferred from period alone. These variables cannot, moreover, be shown to consist of two distinct groups, for the gradation of motion (and distribution) is continuous, and there seems to be no relation between motion and such physical properties as can be inferred from spectra. Our knowledge of the distribution and motions of the long-period variables is thus necessarily less definite than for the classical Cepheids.

The *red semi-regular variables*, with very few exceptions, share the motion that is typical of population I; their absolute magnitudes are shown, by the studies of R. H. Wilson, Joy and Keenan, to be in the neighbourhood of 0 or − 1, except for the readily recognizable super-giants, such as Antares and *AD* Persei.

The luminosities of the *yellow semi-regular variables*, which include the *W* Virginis stars, the *RV* Tauri stars, and such stars as *SX* Herculis, have been established by Joy's studies of variables in globular clusters; they range from −1 to −3. These stars are distinctive in light curve and in spectrum; in particular, the *W* Virginis stars can be readily distinguished from classical Cepheids of similar period by their striking departure from the Hertzsprung relation.

The *RR Lyræ stars*, distinctive in period and in form of light curve, have been shown by a number of investigators to have an absolute magnitude near zero. They are, moreover, all sensibly of the same luminosity. As they are high-velocity stars, the absolute magnitudes of the galactic members, on which the determination necessarily depends as present, must be evaluated on the basis of radia velocity only.

Distribution of Variable Stars

Although only a fraction of the total of galacti variable stars has been discovered, their apparen distribution, in conjunction with our knowledge o their luminosities, and approximate corrections fo obscuration, permits us to draw certain conclusions about true distribution. From the fragmentary material available, it is only legitimate to arrange the distributional parameters in order. *Horisonta gradient* expresses the rate at which stars of a given type increase in numbers along a galactic radius from the centre outward. *Vertical gradient* expresses the rate at which they fall off above and below the galactic plane.

The horizontal gradient is greatest for the *RR* yræ stars, and almost as large for the long-period ariables of shortest period. For variable stars of ther types it is too indefinite to be evaluated. The ertical gradient is smallest for the globular clusters xtreme population II); then follow, in order, the *R* Lyræ stars, the *W* Virginis stars, the *RV* Tauri tars, the long-period variables of short period, the ng-period variables of long period, the semi-regular d stars, the classical Cepheids, and finally the alactic clusters (extreme population I). From this follows that the globular clusters form the most pherical subsystem of the galaxy, and the succeeding bjects constitute more and more flattened subystems, until we reach the classical Cepheids and alactic clusters, which are practically confined to a hin layer near the galactic plane.

The novæ appear to form a system which is otably concentrated towards the galactic centre, eing not so closely confined to the galactic plane as he classical Cepheids, but more flattened than the ystem of *RR* Lyræ stars. The planetary nebulæ have een shown by Minkowski to be concentrated in the irection of the galactic centre, but, until their istances are measured, neither the horizontal nor he vertical gradient can be evaluated. Their distribution suggests that of the novæ.

Motions of Variable Stars

The motions of the various types of intrinsic ariables are even less completely known than the istributions. The Bottlinger diagram (despite its rude implication of Keplerian motion, and the evere limitations imposed by selection) provides a ethod of arranging the motions in definite order. Vhen the observed motions of variable stars are nserted in a Bottlinger diagram, one can determine ne distributions of eccentricity and semi-major axis f the instantaneous orbits. In order of decreasing edian eccentricity, we find the *RR* Lyræ stars, the ng-period variables of short period, the red semiegular variables, the long-period variables of long eriod, and finally the Cepheids with essentially rcular orbits. The median semi-major axes do not iffer sensibly except for the *RR* Lyræ stars, which ave the smallest.

If we accept the crude assumption of Keplerian otion (probably approximately valid in our own parsely populated neighbourhood), we can calculate ne average perigalactic distances for the stars of arious types: the smallest are those of the *RR* yræ stars, followed in order by the long-period ariables of short period, the red semi-regular ariables, the long-period variables of long period, nd the classical Cepheids. Unfortunately, our nowledge of the motions of the yellow semi-regular ariables is at present too scanty for application ere; they do, however, contain a considerable roportion of high-velocity stars (as shown by Joy's udy of radial velocities), and would probably fall etween the *RR* Lyræ stars and the long-period ariables of short period.

Galactic Structure and Variable Stars

The distribution of variable stars shows a conuous graduation from the nearly spherical subystem of the *RR* Lyræ stars (which approaches that the globular clusters in form, if not in extent) to ne highly flattened system of the classical Cepheids (which approaches that of the galactic clusters). The galactic clusters themselves contain a considerable proportion of the highly luminous hot stars, the more so if we include in our conception the looser associations of hot stars which have long been known to be concentrated in the galactic plane. Variable stars, then, strengthen the conception of a galaxy built of a number of concentric subsystems, flattened to various extents.

When we seek among the variable stars for evidences of structure within the central layer of the galaxy, which contains dust, gas and high-luminosity hot stars, we are on less sure ground. Recent studies by W. W. Morgan have suggested the feasibility of tracing actual spiral structure within the central layer by means of the bright nebulosities excited by high-temperature stars. If any intrinsic variables share the spiral structure, we should expect the classical Cepheids to do so. The distribution of these stars in the galactic plane does, indeed, seem to suggest a concentration parallel to the spiral structure suggested by the bright nebulosity, but the features are extremely broad and indefinite.

Even if we allow for the possible dispersion about the period-luminosity curve that seems to follow from the Magellanic material, it is difficult to believe that the galactic Cepheids are confined to narrow, armlike regions. Rather they seem to be spread into a sheet, which perhaps shows a tendency to concentration in spiral lanes. The few Cepheids that were found by Hubble in Messier 31 seem also to be broadly scattered, rather than to be concentrated in narrow, arm-like regions such as Baade has recently photographed by means of the bright nebulosities. The classical Cepheids, therefore, while definitely affiliated with population I, are not such extreme members of it as the high-luminosity hot stars which are the brightest members of many galactic clusters.

NEWS and VIEWS

National Chemical Laboratory of India: Prof. G. I. Finch, M.B.E., F.R.S.

Prof. G. I. Finch has been appointed by the Council of Scientific and Industrial Research, India, as director of the National Chemical Laboratory of India, Poona, in succession to Prof. J. W. McBain, who has recently retired. Prof. Finch has had a long and distinguished academic career. After studying physiology under Charles Richet in Paris, he went to Zurich to read chemistry and physics under Treadwell, Willstätter, Bredig, Lunge, Berl, Weiss and Einstein. On graduating, he served as assistant to Bredig and later under du Parc at the University of Geneva. This long and varied course of stimulating study, combined with frequent vacation work, laid the basis for the deep interest which Finch has maintained throughout his career in the industrial application of scientific knowledge and advances. After serving as assistant research chemist under the late Sir Robert Robertson at the Royal Arsenal in Woolwich, Finch, early in 1913, joined the late Prof. W. A. Bone as his demonstrator in the newly formed Fuel Department at the Imperial College, where, except for absences during the two World Wars and with the 1922 Mount Everest Expedition, he has remained as lecturer, assistant professor in electro-chemistry and (since 1936) professor of applied physical chemistry for nearly thirty-nine years.

As might be expected from his comprehensive early training, Finch's researches have ranged over many fields. Under Bone's influence he first turned towards the efficient use of coal and its by-products, safety in mines and catalytic combustion, and these interests were reflected in his early researches on the ignition and combustion of gases. His recognition of the vital part played by surface structure in heterogeneous catalysis led him to the study of surfaces by electron diffraction, a technique with which his name is internationally associated, and which he has applied to the examination of a wide range of chemical and physical problems. This work was recognized by his election to the Francqui chair in the University of Brussels during 1937–38 and, in conjunction with his important fundamental work on the electrical ignition of gases, by the award of the Hughes Medal of the Royal Society in 1944. In his new sphere Prof. Finch will find ample opportunity to pursue his many interests in the field of applied chemistry to the advantage of Indian economy.

Institute of Welding: New President and Vice-President

At the annual general meeting of the Institute of Welding, held at the Institution of Civil Engineers on July 22, Mr. A. Robert Jenkins and Mr. H. B. Fergusson were installed as president and vice-president, respectively, for the year 1952–53. Mr. Jenkins is a graduate in mechanical engineering of the University of Sheffield, and after his apprenticeship entered in 1931 his family business of Robert Jenkins and Co., Ltd., of Rotherham. He is now deputy managing director of the firm and also, since 1946, works director, in which position he is responsible for the whole of the production and technical side of a works now producing about a thousand tons of fabricated products a month. Mr. Jenkins has travelled widely, visiting factories in Sweden, Germany and the United States, and was a member of the Specialist Productivity Team on Welding which visited the United States in 1950. Mr. Fergusson was educated as a mining engineer in Freiberg, Germany, and later had a distinguished career in railway construction and other engineering projects in Canada, Spain, South America and Russia, where during the First World War he was in charge of 750 Canadian railway-men building the Murmansk Railway. For the past fifteen years he has been a director of G. A. Harvey and Co. (London), Ltd.

University College of the West Indies: New Principal

Dr. W. W. Grave, registrary of the University of Cambridge since 1943, has been appointed principal of the University College of the West Indies in succession to Sir Thomas Taylor, who has been elected principal of the University College of the South-West of England, Exeter. He is expected to take up his new duties in 1953. Dr. Grave was educated at King Edward VII School, King's Lynn, and at Emmanuel College, Cambridge. He took his B.A. degree in 1924, after being placed in the first class in both parts of the Modern and Medieval Languages Tripos. He was elected Fellow of Emmanuel College in 1926, and was a tutor of the College during 1936–40. In 1936 he was appointed University lecturer in Spanish, and during 1940–43 was a temporary administrative officer in the Ministry of Labour and National Service.

British Standards Institution: New Appointment

At the annual general meeting of the Britis Standards Institution, held at 24 Victoria Stree London, S.W.1, on July 23, it was announced tha Mr. John Ryan had been elected chairman by th General Council in succession to Sir Roger Duncalf who has completed his three-year term of office. A the meeting Viscount Waverley was re-electe president of the Institution for the third year, an Sir Roger Duncalfe vice-president. Sir Roger, wh has been chairman of the Institution during thre years of most rapid growth, is widely known i industry as the chairman of British Glues an Chemicals, Ltd. He is also a past chairman an past president, and now a vice-president, of th Association of British Chemical Manufacturers, an a vice-president of the Federation of British Industries. Previously in the Institution he had bee chairman of the Adhesives Industry Standards Committee and of the Finance Committee. Mr. J. Rya is vice-chairman of the Metal Box Co., Ltd., and he for many years played a leading part in the standardization policies implemented through the Britis Standards Institution by the packaging industry He was appointed chairman of the Packagin Standards Committee on its formation in 1941 an was intimately concerned with the development o the war-time Packaging Code, which resulted no only in great economies during the Second Worl War but has also been of much importance to Britis industry in peace-time, particularly in the expor field. Since 1948 he has been chairman of th Institution's Finance Committee. Widely know as an expert in company finance and administration, Mr. Ryan is a member of council and Fellow of the Royal Statistical Society and hold senior offices in many trade organizations and th British Institute of Management.

University Degrees in Nutrition and Househol Science

Courses for the two new degrees of B.Sc. (Nutr tion) and B.Sc. (Household Science) will start a King's College of Household and Social Scienc (University of London) in October 1953. The degrees will replace the present degree of B.S (Household and Social Science). The B.Sc. (Nutritio degree is designed to make available for the fir time in Britain an integrated course in this relativel new science. The course will include a study of foo production, taking into account such factors climate, soil, pests and diseases; food processing an preparation; food chemistry; food consumption an its economic and social deficiency. It will be a val able preparation for those who intend to go in f nutritional research, to become dietitians, or to tak up advisory and research posts with international national organizations, with local authorities an other bodies which are increasingly undertakin work on the problems of nutrition. The cour for the degree of B.Sc. (Household Science) will comprise work in the practical and scientific aspects the preparation of food, the chemistry of food-stuff the principles of institutional management and hou planning; and other subjects which come under th general title of household science, with a backgroun of chemistry, physiology and other allied science It is designed to meet the same sort of requiremen as the present course for the degree of B.Sc. (Hous hold and Social Science) and will be specially suitab or those who intend to make their careers in the eaching of domestic science, in institutional management, and in various branches of scientific research.

Sub-Fossil Hekla Pumice from Denmark

PROF. A. NOE-NYGAARD has written a paper on the "Sub-Fossil Hekla Pumice from Denmark" *Medd. Dansk Geol. For.*, 12, Heft 1, 35; 1951), in which is reproduced a photograph showing immense fields of drifting pumice in the sea off the Westmann Islands only a few days after the beginning of the Hekla eruption of March 1947. Hekla and several other volcanoes in the south of Iceland have emitted many flows of a uniform type of oversaturated glassy basalt; but investigations during the past decade have proved that intermediate to acid rocks are also represented to a considerable extent in the Hekla volcanic area, and that lavas and ashes of like composition, especially andesitic pumice, were ejected during the eruption of 1947. Prof. Noe-Nygaard has investigated the finds of sub-fossil pumice which have been made at three places in North Jutland. This pumice is of intermediate composition and is almost identical in chemical composition and petrography with andesitic pumice and ash from the recent eruption of Hekla, as well as with similar finds of sub-fossil pumice on the coasts of western Norway, Novaya Zemlja, Spitsbergen and Greenland. It is therefore taken as highly probable that these pumices were derived from former eruptions of volcanoes in the Hekla region. A question thus arises as to the age of the beds in which the sub-fossil pumice has been found. In Jutland the pumice fragments are associated with rolled pieces of wood, lignite, hazel nuts, small pieces of amber, and one fragment of dopplerite—all light materials capable of floating in currents and liable to drifting and stranding on coasts. One of the beds is covered with peat of the Sub-boreal period. In western Norway the pumice bed is found on the uppermost *Tapes*-line, by which the time of the eruption that supplied the pumice can be fixed at about 2000 B.C. Hence it is probable that four thousand years ago the Hekla volcanoes were erupting material of a nature and composition similar to their present products. Prof. Noe-Nygaard finally envisages the possibility of establishing a synchronous level in the Quaternary beds of several Atlantic coasts by means of the Hekla pumice, in addition to the pollen analyses and archæological considerations which have hitherto been used for chronological purposes.

Ornithological Congress at Bamburgh

A BRITISH ornithological conference was held at Bamburgh, Northumberland, during June 26–July 1, under the joint auspices of the British Ornithologists' Union and the British Trust for Ornithology, local arrangements being in the hands of Dr. E. A. R. Ennion, director of the Monks' House Bird Observatory and Field Centre. Emphasis in the programme was on the field excursions. Members of the conference were able to visit the Farne Islands, which are National Trust bird sanctuaries with unique sea-bird colonies, and other interesting half-day visits were paid to Hulne Park, Alnwick, and to Chillingham and Ross Castle, where there is a memorial to Lord Grey of Fallodon. An all-day excursion was made to the Cheviot to see Northumbrian moorland habitats, and various short excursions were also made by small parties to other interesting localities. It is believed that at least 110 species were identified in the field during the conference, a striking indication of the wealth and variety of bird-life in north Northumberland. The indoor sessions, which took place in the Pavilion immediately below Bamburgh Castle, a setting specifically enhanced by the presence, on the rock face above, of several pairs of nesting fulmars, consisted of three discussions, six papers and two illustrated talks. The discussions, on fighting and threat in birds, on visible migration and on sea-bird populations, were led by Dr. N. Tinbergen, Colonel R. Meinertzhagen and James Fisher, respectively. The titles of the papers were as follows: high-water-mark ecology (E. A. R. Ennion), observations on the hawfinch (Guy Mountfort), the work of the Madingley Ornithological Field Station of the Department of Zoology, University of Cambridge (W. H. Thorpe), observations on the lapwing (K. G. Spencer), Northumberland birds (G. W. Temperley) and paper-tearing by birds (W. M. Logan Home). For his talk on "The Ornithological Year in Yorkshire", Mr. Ralph Chislett used some of his own fine collection of slides, and the other talk, on "The Pied Flycatcher at the Nest", by Bruce Campbell, was illustrated with slides from photographs by John Markham. In addition, members were entertained during one evening by Dr. and Mrs. Ennion at Monks' House, where the various trapping devices and other equipment of the Bird Observatory were demonstrated.

French Bibliographical Digest: Physics and Chemistry

NOS. 7 and 8 of "The French Bibliographical Digest", which have recently been issued (No. 7, pp. 87; No. 8, pp. 72. New York: French Embassy, 1951), deal with physics and chemistry respectively and complete the first series of bibliographical digests devoted to scientific works published in France during 1940–48. Several works published in the French language by Belgian and Swiss men of science are also included. A second series will list works published during 1949–51. The booklets contain, in addition to a useful list of the appropriate French scientific periodicals and publishers' addresses, the titles, with full bibliographical references, of the more important physics or chemistry books of university or more advanced standard. The inclusion of doctorate theses is most valuable. Many of the titles are accompanied by reviews, in English, reprinted by permission from British, American and French scientific journals. No prices are quoted because of the rapid fluctuations in exchange value. Prof. Y. Rocard, a member of the advisory board of the "Digest", contributes an introduction to No. 7, in which he describes briefly the effects of the German occupation on French physical research. He pays tribute to the many physicists, including H. Abraham, E. Bloch, G. Bruhat, F. Holweck, L. Cartan and J. Solomon, who died either in concentration camps or because of their participation in the resistance movement. Finally, he surveys briefly post-war activities and mentions the various French laboratories and the branches of research being pursued there. The chemistry booklet is similar in lay-out to the one on physics. The arrangement is alphabetical by authors under the following headings: chemistry, general; organic chemistry; inorganic chemistry; analytical chemistry; physical chemistry; industrial chemistry, technology and metallurgy; colloid chemistry; and biochemistry. Librarians, as well as research workers, will find the two booklets extremely useful for reference purposes.

Conception of Science in Education

The summer number of *The Use of English*, edited by Denys Thompson (Chatto and Windus), is notable for the amount of space which it devotes to the problems of teaching the humanities to the science specialist, particularly in the senior forms of grammar and public schools. F. W. Westaway, and more recently P. A. Gaskill and A. Towers, have already written excellent small books on English for science students. The editorial of the periodical under review goes further and gives a most useful outline of a scheme for enlarging the conception of science, its nature, its methods, its strength and its limitations in the field of knowledge. Such a scheme could well be developed for all sixth-formers in addition to those specializing in science. An excellent reading list on the values of science, science and civilization, the scope of science, science and religion, and science and politics is provided. The editor is wise in saying that "every sixth form teacher knows that it is not only the scientist who suffers from lack of balance and humility. In their refusal to see that true science is a major human activity, specialists in other subjects are quite as obtuse and obstinate as any scientist". This, indeed, is exemplified in another otherwise useful contribution by a writer in the same issue, who says: "Western civilisation is not only a weaving together of Greek, Roman and Hebrew strands; for good or ill we must admit the presence of modern western technology". Here again is the failure to realize that technology is a part of the application of science and not science itself. It now remains for some wise educationist to continue the work of redeeming the philistinism of so many students of the arts. Examples of this are only too common: for example, the master of the college who dreams of a neo-Hellenic Utopia but does not despise the use of anæsthetics and aeroplanes and adds to his income by broadcast talks.

National Museum of Canada, Ottawa: Annual Report for 1949–50

The year 1949–50 was an important one in the history of the National Museum of Canada, for it inaugurated a new era. The Museum began and grew up within the Geological Survey; but in 1920 the two were separated and placed under separate directors. They continued, however, to occupy the same building—the Victoria Memorial Museum—and to share some of the same services and even the same administration. By a reorganization which became effective in January 1950, the two passed into different government departments—the Geological Survey into the Department of Mines and Technical Surveys, and the National Museum into that of Resources and Development. This development is recorded in the annual report of the Museum for 1949–50 (Bulletin No. 23; pp. 261+60 pl.; 1951; 1 dollar). As is usual with museums in Canada and the United States, the Museum has been able to carry out an extensive series of expeditions and archæological excavations. The report gives details of field-work in zoology, undertaken in British Columbia, and botanical studies along the east coast of Hudson Bay; archæological sites were investigated on Cornwallis Island, North-West Territories, and in Manitoba and Saskatchewan. It is a matter worthy of note that these field exhibitions are undertaken as part of the normal work of the Museum, such is the faith of the trustees and managing bodies in their ultimate value to the Museum and the common weal.

Research at the University of Birmingham during 1950–51

The twenty-second annual report of the Joint Standing Committee for Research of the University of Birmingham covers the session 1950–51, in which the new Aitchison laboratories in the Department of Industrial Metallurgy were brought into use for teaching and research purposes. These laboratories consist of two main sections equipped with full-scale plant for foundry and for metal-working operations, and there is also a machine shop used principally for the construction of apparatus and for service and maintenance purposes. The laboratories, with modern manufacturing plant and equipment at their disposal have been constructed and equipped in the hope of supplying the metallurgical industries with men of good metallurgical training. The most valuable feature of the report is, as in previous years, the departmental lists of published work which is regarded as contributing to original knowledge. Each list i prefaced by a short note directing attention to specia features of the year's work. Three examples of such special features are as follows: in the Department of Mathematical Physics a new method has been evolved of treating bound states in field theory which has led to the development of new mathematical methods; work on the dielectric breakdown of pure liquids has now attracted a grant from the Department of Scientific and Industrial Research and the Department of Chemistry has been selected by the International Union of Chemistry as the British laboratory for the standardization of the molecular weights of high polymers.

University of London

The title of professor emeritus in the University has been conferred on the following: Prof. S. P Bedson (bacteriology), on his retirement from the Goldsmiths' Company's chair of bacteriology at the London Hospital Medical College which he has held since 1934; Sir David Brunt (meteorology), on his retirement from the chair of meteorology at the Imperial College of Science and Technology which he has held since 1934; Sir Alfred Egerton (chemica technology), on his retirement from the chair of chemical technology at the Imperial College of Science and Technology which he has held since 1936; Prof G. I. Finch (physical chemistry), on his retirement from the professorship at the Imperial College o science and technology which he has held since 1936 Prof. J. R. Marrack (chemical pathology), on his retirement from the chair of chemical pathology at the London Hospital Medical College which he has held since 1934; Prof. J. A. S. Ritson (mining), on his retirement from the chair of mining at the Imperial College of Science and Technology which he has held since 1935; Sir George Thomson (physics), on his retirement from the chair of physics at the Imperial College of Science and Technology which he has held since 1930.

The following other titles in the University have been conferred: reader in pharmacognosy on Dr J. W. Fairbairn, in respect of the post held by him at the School of Pharmacy; professor of pharmacology and therapeutics on Dr. C. A. Keele, in respect of the post held by him at the Middlesex Hospital Medical School; reader in biochemistry on Dr William Klyne, in respect of the post held by him at the Postgraduate Medical School of London; reader in bacteriology on Mr. B. W. Lacey, in respect of the post held by him at Westminster Medical School; professor of chemical pathology on Mr. N. H. Martin, in respect of the post held by him at St. George's Hospital Medical School; reader in morbid anatomy on Mr. A. D. Morgan, in respect of the post held by him at Westminster Medical School; reader in structural geology on Dr. Gilbert Wilson, in respect of the post held by him at the Imperial College of Science and Technology; degree of doctor of science on F. H. Burstall, P. C. C. Garnham, T. C. S. Morrison-Scott, Prof. Joseph Rotblat, D. B. Scott and Prof. P. E. Vernon.

Centrifuges and *p*H Meters

As a result of suggestions that existing models of centrifuges and *p*H meters have various and considerable disadvantages, the Institute of Biology is making a survey of the views of biologists on the desirable qualities of such instruments. It is hoped that the information obtained will enable the Institute to make constructive suggestions to manufacturers and will provide guidance for intending purchasers. Copies of questionnaires, one on centrifuges, the other on *p*H meters, may be obtained from the General Secretary, Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.1.

Clayton Awards for 1952 of the Institution of Mechanical Engineers

UNDER the terms of the Clayton Bequest, the Institution of Mechanical Engineers has made the following awards for 1952 for special experience, postgraduate studies or research in mechanical engineering, the amounts totalling about £5,200 in value. *Clayton Fellowships:* B. J. Beale (Guildford), J. R. Botterill (Harrogate), F. J. Feltoe (Port Talbot), E. J. Forster (Bromley), P. M. Moreton (Whitchurch), C. E. H. Morris (Swansea), D. J. Myles (Arbroath), H. Naylor (Shipley), J. R. Willetts (Birmingham), R. G. Woolacott (London). *Clayton Grants:* C. K. Gulland (London), J. R. Plant (Burnley), J. L. Raynes (Bournemouth), T. F. Roylance (Allenton).

Institute of Metal Finishing: Endowment of New Awards

THE Council of the Institute of Metal Finishing has recently approved the establishment of the following awards. *Hothersall Memorial Medal and Lecture:* The Mond Nickel Company, Ltd., has endowed the annual award of a palladium medal (with which will be associated a sum of £50) for an initial period of seven years, in memory of the late Mr. A. W. Hothersall; the Council of the Institute will choose the recipient, who will then be asked to deliver a lecture. *Johnson Matthey Silver Medal:* This Medal, which has been endowed by Johnson Matthey and Co., Ltd., will be awarded annually, or at such times as may be decided by the Council, for the best paper presented to the Institute on the deposition of precious metals. *Westinghouse Brake and Signal Co., Ltd., Prize:* An award for the best publication appearing in the *Journal* of the Institute, which, in the opinion of the Publications Committee, shows the most valuable advance in the science or practice of electrochemistry in general and electrodeposition in particular, has been endowed by the Westinghouse Brake and Signal Co., Ltd., for a preliminary period of seven years; it will amount to £25 annually and will consist mainly of a selection of books. In the case of the last two awards, both members and non-members of the Institute are equally eligible, and papers should be submitted direct to the Institute at 32 Great Ormond Street, London, W.C.1.

International Astronomical Union: General Assembly at Rome

THE eighth General Assembly of the International Astronomical Union will be held in Rome during September 4–13. The inaugural ceremony will take place in the Campidoglio, in the Hall of the Orazi and Curiazi, and other sessions will be in the University of Rome and near by in the building of the Italian National Research Council. Besides the various Commission meetings, the programme will include three symposia on stellar evolution, astronomical instruments and the astrometry of faint stars, respectively. In addition, excursions will be made to the Castelli Romani, with a stop at Castel Gandolfo for visiting the Vatican Observatory, and to the archæological excavations at Ostia Antica. Non-members of the International Astronomical Union may participate in the Congress on payment of a fee of 5,000 lire. Further information can be obtained from the assistant secretary-general of the Union, Prof. P. Th. Oosterhoff, Leyden Observatory, The Netherlands.

Beta- and Gamma-Ray Radioactivity: Conference in Amsterdam

A CONFERENCE on beta- and gamma-ray radioactivity, which has been organized by the Netherlands Physical Society with the support of the International Union of Pure and Applied Physics and of Unesco, will be held in Amsterdam during September 1–6 under the presidency of Prof. G. J. Sizoo. The conference will be open to all nationalities and will consist of invited papers of about forty-five minutes in duration, and short communications, to be given by guests or visitors, of about fifteen minutes in duration. The principal sessions and headquarters of the conference will be at the Koninklijk Instituut voor de Tropen, Mauritskade 63, Amsterdam-O; the sectional meeting on the Monday afternoon will be held in the Vrije Universiteit, de Lairessestraat 174, and those on Wednesday and Friday afternoons in the physical laboratories, Plantage Muidergracht 4–6. All the lectures will be published in a special issue of ***Physica***. Further information regarding the conference can be obtained from Prof. J. de Boer, Bunsenstraat 98, Amsterdam-O.

Announcements

WE regret to announce the death on August 5 of Sir Jack Drummond, F.R.S., director of research to Boots Pure Drug Co., Ltd., and of Lady Drummond, both well known for their work on human nutrition.

PROF. PAUL KARRER, professor of organic and practical chemistry in the University of Zurich, has been elected a foreign associate of the Paris Academy of Sciences in succession to the late Sir Charles Sherrington; Prof. Maurice Fréchet, honorary professor in the Faculty of Sciences, University of Paris, has been elected *correspondant* for the Geometry Section of the Academy in succession to the late Prof. G. Castelnuovo.

DR. S. KRISHNA has been appointed deputy director of the Council of Scientific and Industrial Research, New Delhi, on the expiry of his term of office as Scientific Liaison Officer for India in Great Britain.

PROSPECTING BY GEOPHYSICAL METHODS

THE European Association of Exploration Geophysicists held its second meeting at Manson House, London, during May 22 and 23. About ninety members and visitors attended, half of whom came from abroad. The Society of Exploration Geophysicists of the U.S.A., with which the Association has close ties, was represented by its official delegate, Dr. Alexander Wolf, of Houston, Texas, and the chair was taken, in turn, by the president, Mr. van Weelden (Netherlands), and Mr. G. Westby, president of the Seismograph Service Corporation of the U.S.A. Nine technical papers from France, Germany and Great Britain were presented. Four of these related to seismic prospecting, three mainly to gravity and two to the telluric current method.

In a paper presented by Mr. H. Linsser (Germany) the author attempted to explain, in a simple manner illustrated by diagrams, the mechanisms of a seismic explosion, and to decide which phases of the explosion contribute to the seismic energy propagated. His investigations were supported by experiments, and he has come to the rather surprising conclusion that no perceptible ground motion is set up by a rarefaction wave following the initial compressional impulse. The latter creates a zone of deformation within which the rock medium is stressed beyond the elastic limit and compressed: and apparently this zone assumes a permanent set which withstands the rarefaction rebound.

The significance of diffraction in the detection and mapping of faults was the subject of a paper by Mr. T. Krey (Germany). By theoretical treatment and field observations, Mr. Krey has demonstrated that the overlapping on a seismic record of reflexions from a faulted bed is not necessarily due to thrust faulting or, in the case of a normal fault, a difference in dip of the bed on either side of the fault: it can be due to the effect of diffraction at the edges of the faulted bed. The attenuation of the energy of the diffracted waves with distance from the fault is gradual, and makes precise location of the fault a difficult problem. When employing the customary interpretation technique, the error involved could be of the order of hundreds of feet, and depends on the depth of the reflecting bed and the signal-to-noise ratio of the seismic recording. Errors may also result in the determination of dip.

In stressing the importance of this paper, Dr. A. Wolf suggested that the practical implications of diffracted waves in seismic prospecting were not fully appreciated. He had been able to register them by using geophones connected in opposition and placed 200–300 ft. apart. With such an arrangement the normal reflexions would not be recorded; but waves diffracted at a fault would arrive at the two geophones out of phase and would be registered. In this way he had successfully located faults in the United States.

Mr. J. Goguel (France) described a special slide-rule which he has developed for the rapid determination of the depths of a series of refracting beds, with small dip, from the observed time-curve. The design of the slide-rule is based on the 'intercept time' method of depth calculation and, when adjusted for the velocity values determined from the time curve, it furnishes directly the cosine factors which are required in the depth formulæ.

Laboratory investigations on the variation of the elastic constants of rocks with frequency were described by Prof. J. M. Bruckshaw and Mr. P. C. Mahanta (Great Britain). It is an established fact that there is an appreciable difference (up to 20 per cent) between the statically determined elastic modulus and the effective value at high frequencies, and the experiments described were designed chiefly to secure further information on this change. American investigators have demonstrated that no appreciable change occurs over the frequency-range 140–4,500 c./s., and the authors' investigations were therefore confined to a lower region, between 40 and 120 c./s.

Measurements made on six different rock specimens exhibited a gradual increase of Young's modulus with frequency, but the total increase over the frequency-range employed was only 2·1–2·6 per cent. The trend of the curves suggested that considerably greater changes could be anticipated below 40 c./s. The authors made use of the results to demonstrate the magnitude of the internal dissipation of energy over the frequency-range considered and were able, also, to show that the influence of dispersion in seismic prospecting is unlikely to cause appreciable error in the interpretation of field seismograms.

Much attention has been paid in recent years to the problem of securing the maximum information from gravimeter observations by devising improved methods of removing the effect of the 'regional anomaly'. Papers relating to this problem were presented by Dr. O. Rosenbach (Germany) and Dr. V. Baranov (France).

The former described a development of the 'second derivative' method of interpretation originally published by T. A. Elkins[1]. Dr. Rosenbach explained that Elkins's formula, while applying quite satisfactorily to deep-seated structures which give rise to low fluctuations of the second derivative at surface, cannot handle adequately the more extreme variations of the second derivative which result from density anomalies at shallower depths. The new approach which he described is to expand the gravity values at suitably spaced points on concentric circles as series in G_P (the gravity at the centre) and its derivatives. By combining sets of these series he has derived practical formulæ which furnish a very close approximation to the theoretical curve for the second derivative.

Dr. V. Baranov presented an interesting analytical method of determining the regional anomaly. The problem in practice is to divide the Bouguer anomaly, B, into two component parts, $B = R + A$, R being the regional anomaly and A the sum of the residual anomalies. The isogals which define the regional gravity anomaly should exhibit only slight curvature and should be fairly regularly spaced. Dr. Baranov therefore assumes that the anomaly can be expressed as an analytical function which may be expanded in a power series, and he neglects terms beyond those of the second or third degree. In order to determine the coefficients of this function, he utilizes the conlition that the residual anomalies, A, have only a ery limited influence, which implies that the integral

$$\psi = \iint (B - R)^2 \, dx \, dy,$$

ver the area within which the regional anomaly is equired, is a minimum. A complete description of he method was presented, and illustrated by practical xamples.

The discussion which followed these two papers on gravity was very lively, and some speakers, led by Prof. Vening Meinez, expressed their doubts of the real practical value of the various methods which attempt to eliminate the 'regional effect' from the Bouguer picture. Dr. Rosenbach, in his reply, emphasized the importance of an appreciation of the scale of the problem in gravity prospecting. It must be realized that a very close network of stations is adopted, and that the modern gravimeter can be read with an accuracy of at least 0·1 milligal.

Prof. K. Jung (Germany) described two elegant geometrical constructions for determining the approximate positions of buried bodies of simple form from their gravity or magnetic anomalies. He explained that these constructions were developed for use by geologists and others with a restricted mathematical background who require to assess roughly the results of a geophysical survey. He described also a simple mathematical development of Nettleton's method of determining near-surface densities from a series of gravity observations along a profile over a topographical feature.

The telluric current method of prospecting has been developed and used with considerable success by French geophysicists. A paper by Mr. M. Mainguy and Mr. A. Grepin (France), describing some practical examples of interpretation of telluric maps obtained in Languedoc (south-east France), was written from the point of view of a geologist, and was therefore of particular interest. The results of telluric surveys in the Beziers and Alés–Maruéjols basins and the Lunel area were described, and compared with gravity and seismic investigations in the same areas.

The outstanding feature of this particular geophysical work is that, in general, the telluric method has apparently furnished more detailed and accurate information than any other method. In the case of the Alés–Maruéjols survey, the results of the telluric observations contradicted to a considerable extent the prevailing geological ideas and the findings of other geophysical methods; but subsequent drilling evidence confirmed the accuracy of the telluric interpretation and resulted in the discovery of oil. In the Beziers basin the telluric results agreed quite well with the gravity findings, but, in common with the seismic work, the method was unable to secure detail from the depths required. The survey in the Lunel area was very difficult to interpret, but despite this the telluric method appears to be the most promising one to employ.

Mr. G. Kunetz (France) dealt with the problem of eliminating the effect on telluric observations of stray earth currents originating from installations such as electric railways, tramway systems, etc. For surveys where the source of disturbance is, say, a large industrial town at a considerable distance, it is possible to represent the disturbing field approximately by a function the parameters of which can be determined experimentally. A 'regional anomaly' map can thus be produced. Where the disturbing source, or sources, are in the immediate proximity, and the parasitic currents are liable to violent fluctuations, much more laborious methods are required, involving numerous field measurements. It speaks highly of the work of our French colleagues that it has been found possible to produce telluric maps of practical value in such difficult circumstances.

D. T. GERMAIN-JONES

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[1] *Geophysics*, 16, 1, 29 (1951).

CONFERENCE ON FERTILITY

THE scientific proceedings of the third annual Conference on Fertility, held by the Society for the Study of Fertility in London during June 27 and 28, were opened by Dr. Carl G. Hartman (United States), who presented formidable evidence for the theory of germ-plasm defect as a major cause of fœtal wastage. His early studies on the aplacental opossum, in which he found some 10 per cent of all the developing eggs to be grossly faulty, led him to favour the view put forward by Streeter—that early death of the embryo was due mainly to defective germ plasm—rather than the older idea of Mall that implantational defects were chiefly responsible. Later studies on mouse eggs, using intra-vital staining techniques, supported the same view by demonstrating, in many instances, dead and living blastomeres within the same zygote. He referred also to the recent studies by Hertig and Rock of early human ova; in none of the cases wherein these were abnormal did the authors find any evidence of endometrial deficiencies, although Dr. Hartman admitted that Hughes has claimed that a lack of a glycogen could be demonstrated in the endometrium in some cases of early abortion.

Prof. S. A. Asdell (United States) gave a provocative contribution on the effect of intelligence upon fertility, basing his conclusions on a study of the pedigrees of royal houses. Although the assessment of 'intelligence' was made as objective as possible, he admitted the possibility of many sources of error. Nevertheless, with the exception of genius, which appears to make its own laws, definite correlations appeared to exist, many of which were contrary to popular beliefs. Thus, although the incidence of inbreeding decreased with rising intelligence, the proportion of childless marriages was highest with least intelligence and smallest with average intelligence, and the number of children in the family was highest with average intelligence. It seemed that Nature favoured the average in intelligence, as in most other biological attributes. Another finding was that, contrary to Galton's view, the families of only children of high intelligence (judges who had been elevated to the peerage in Stuart and Georgian times) tended to be large, averaging five to six offspring. Naturally, this paper evoked lively discussion.

Prof. S. Zuckerman (Birmingham) reviewed the cellular components of the ovary, particularly from the point of view of their plasticity. He referred to his own recent work, which leads him to conclude that, in the rat at least, no formation of new oocytes from the germinal epithelium occurs in the adult. He considers the function of the germinal epithelium to be mainly protective; it is highly phagocytic and resilient, continually changing in size and shape as follicles mature and corpora lutea develop and regress. He stressed its sensitivity to trauma, to which it responds vigorously by the formation of ingrowths and outgrowths. The other highly plastic element of the ovary is the theca interna cell, which transforms from a fibroblastic cell into an epithelioid secreting cell, luteinizes to become—very likely—the only functional endocrine element of the corpus luteum, and finally can become transformed back into a fibroblastic structure.

Dr. Henri Bayle (Paris) discussed spermatophagia in the human epididymis in cases of excurrent duct obstruction and showed slides of spermatorrhage—rupture of the epididymal tubules through excessive internal pressure, with outflow of spermatozoa into the peritubular spaces, leading to oblrteration of the epididymal canal. He then demonstrated his film showing the operative technique of vaso-epididymostomy; the beauty and lucidity of this film are beyond description. Dr. Bayle does not perform testicular biopsy first, but prefers to incise the head of the epididymis after having mobilized the testicle; if moving spermatozoa are seen in the epididymal fluid, he proceeds with the operation, provided patency of the vas deferens can be demonstrated. He uses seven sutures of fine tantalum wire to anastomose the vas to the epididymis. Delicacy of touch and the avoidance of trauma are the prime requisites of success in this difficult operation. Out of 143 cases explored surgically, anastomosis was found impossible in thirty cases, and in a further six congenital absence of the vas was discovered. Vaso-epididymostomy was performed bilaterally in sixty cases, and unilaterally in forty-five; in a further four cases anastomosis of the vas deferens direct to the testicles was attempted. Of sixty-five surgically satisfactory cases, the azoospermia was cured in forty-five (66 per cent), twenty of these men producing in all thirty-two children. This rate of success, of course, is far better than any other surgeon has achieved.

The morning of June 28 was devoted to a symposium on spermatozoan morphology; this was opened by Prof. L. Harvey (Exeter), who gave a review of spermatogenesis and spermateliosis. The National Institute for Medical Research team of workers (C. F. Challice, P. E. Lake, E. J. C. Polge and J. Smiles) reported ultra-violet microscopy studies on living fowl germ cells and electron-microscope studies of mouse and rabbit spermatozoa. They showed how the Golgi zone of the fowl spermatid developed into the acrosome. The tail filament was found to be motile from the earliest stage, the tail granule being the source of motility. Chromosome material aggregates, becoming a homogeneous mass within the nuclear membrane. It then elongates, later to shrink, leaving behind a free portion of the nuclear membrane, thus forming the manchette which later forms a rigid tube around the first part of the tail. Considerable advances in our knowledge of the morphology of rabbit and mouse spermatozoa have been afforded by the technique developed by these workers of cutting sections 0·2 μ thick followed by electron microscopy. There is strong evidence for a double spiral structure of the mid-piece and tail around the axial filament, all within a fine outer membrane. The axial filament contains nine fibrils arranged circularly around a central one, and there appears to be a flange running lengthwise down the tail.

Mr. Geoffrey Grigg (Cambridge) also contributed electron-microscope studies on fowl spermatozoa, his findings being mainly in agreement with those of the previous speakers. The apical cap dissolves in distilled water, leaving the apical spine partly embedded in the head. He has regularly found eleven fibrils in the axial filament—two central and nine outer. There seems to be an inner core to each fibril which is more elastic and more resistant to tryptic digestion than the surrounding material. Dr. Bayle showed electron-microscope photographs of human spermatozoa. Dr. John McLeod (United States) discussed spermatozoan morphology in relation to human fertility and, as a result of his large-scale studies, he has come to the conclusion that little correlation between sperm morphology and fertility can be discovered in the human. Poor morphology is commonly associated with poor motility—which has a very definite bearing on fertility—but otherwise, provided the sperm density exceeds 20 millions per ml. and the percentage of active cells is not much below 40, fertility seems to depend mainly upon the quality of sperm motion.

Dr. John Wilkinson (Exeter) described the effects of aspermy virus upon nuclear behaviour in solanaceous plants. In the pollen and embryo sac mother cells, the pachytene threads become disorganized in the prophase of meiosis and the nucleoli are multiplied. Some of the chromosomes fail to pair, leaving behind univalents at metaphase and anaphase. This probably accounts for the 25 per cent diminution in seed production shown by affected plants. It was suggested that a competition may exist between the virus and the chromonematal material of the chromosomes for ribose-nucleic acid. Mrs. C. Harvey (Exeter) said she had made similar observations on testicular biopsy material from subfertile men, having also noted collapse of the chromonemata at prophase and loose and lagging chromosomes at metaphase and anaphase. This seemed to suggest a possible viral etiology for some cases of human male infertility.

In the last two papers, Dr. F. X. Gassner (United States) showed that the rate of fructolysis in seminal fluid is better correlated with the breeding efficiency of bulls than the conventional criteria of seminal analysis, and Dr. E. W. Macmillan (Liverpool) described the vascular pattern of the epididymis in the rat and the sequence of changes in the epididymis and testis following interruption of the superior epididymal and accessory capital arteries; the vasa efferentia became packed with spermatozoa, which led to their gross enlargement and to severe degenerative changes within the testis, while the caput epididymis underwent necrobiosis followed by obliterative fibrosis.

EMULSIONS AND FILMS

SYMPOSIUM AT SHEFFIELD

THE British Society of Rheology organized a symposium on "Emulsions and Films" which was held in the University of Sheffield during March 28–29. All the papers were followed by discussion, and on the second day the meeting visited the chemistry laboratories of the University and inspected the apparatus used by the speakers at the meeting.

In the first paper, Dr. A. S. C. Lawrence pointed out that emulsions are always placed in a separate category of colloids as liquid-in-liquid systems—a classification to which objection can be made on two grounds: the fact that the liquid state of the disperse phase makes possible dispersion by shaking is of no fundamental importance (it is not even true for dispersions of true colloidal size, that is, oil hydrosols which are typical hydrophobic systems) ; and it has distracted attention from the really basic criteria—namely, that, although hydrophobic, very high concentrations (74 per cent) of the disperse phase are easily attained, and the particle size is much larger than in all other hydrophobic colloidal solutions. Emulsions are not, strictly, colloids at all ; they are opaque, and sedimentation, as creaming, is one of their most distinctive properties. They belong, in fact, to the neglected class of protected colloids.

It has become accepted that the stability of emulsions is due to the lowering of the free surface energy of the system by adsorption of surface-active emulsifying agent and that interfacial tension is a coagulating tendency'. This error of identifying the potential reduction of free energy with the driving force causing the reduction is one against which students learning thermodynamics are warned year after year. In any case, a lowering of the free surface energy can reduce only potential instability and cannot give an absolute stability : even if this thermodynamic quantity were the driving force in coagulation, reduction to zero would be required to give absolute stability. This, however, is the condition for miscibility of the two phases, and it is also a characteristic of emulsions that there is some residual interfacial surface tension which is responsible for the spherical shape of the droplets of the disperse phase. The emulsifying agent should be regarded as an energy barrier which is needed, as in all hydrophobic systems, to prevent aggregation or coalescence of particles subsequent to collisions due to their Brownian motion. The action of the energy barrier is to prevent coalescence following collision ; it has no effect upon collision frequency. The mean Brownian velocity depends upon T and inversely upon η—that is, the viscosity of the continuous phase and not that of the whole emulsion, which is always larger, usually by a large factor. Collision frequency will be highly dependent upon concentration obviously as a function of the cube root of it, since it is dependent upon the mean distance of separation of the droplets, all other factors being the same. Creaming will always increase collision frequency because it reduces the mean separation distance. For fine dispersions, Brownian motion is the rate-determining factor in the collision process. but, as particle size increases, sedimentation becomes increasingly the rate-determining factor. Every chemist has had the opportunity of seeing this transition every time he has done an ether extraction. This kinetic picture must be extended because there will be a Maxwell distribution of Brownian velocities, and the number with sufficient energy to overcome the energy barrier to coalescence, E, will be given by the usual $n/n_0 = \exp(-E/RT)$. 'Stability' means that n/n_0 is vanishingly small.

Surface tension has no place in this scheme ; it determines the work to be done in dividing the disperse phase ; it has nothing to do with the stability of emulsions. Adsorption of the emulsifying agent to the interface requires that it must lower the interfacial tension, but this lowering need not be large. It could be said that surface tension is involved in the coalescence stage in breaking : since, however, the first step in coalescence must involve an increase of the surface area of two spherical drops, it would appear that high interfacial tension will resist this step while a low value favours it and, therefore, instability—again, this is the opposite to the accepted view that low interfacial tension favours stability.

The energy barrier provided by the emulsifying layer may be electrical, mechanical or due to surface tension. The last-named class consists of powders acting by a differential wetting-angle with the two phases. Amphipathic substances which are also ionized may be good emulsifiers but some are not. It therefore seems that some other property is concerned, and Dr. Lawrence suggested that this is viscosity ; either a high two-dimensional η or a plasticity. It is likely, but not proved, that objection may be made against rigidity in the sense that, when such a layer is fractured, it cannot spread again to close a gap. Dr. Lawrence's emulsions of sea water in fuel oil are a case in which very high surface viscosity, without a charge and with very slight surface activity, is responsible for stability.

The work carried out in Sheffield which Dr. Lawrence reported to the meeting is based upon the following idea. The viscosity of the continuous medium may be increased and therefore reduce ξ and, therefore, collision frequency, but this is only a reduction : it cannot give absolute stability in a liquid system. The high and anomalous viscosity of an emulsion of 50 per cent or more oil in soap solution is an indication of the surface viscosity of the emulsifying layer : laminar flow requires droplets to slip between their neighbours and, to do so, they must be distorted into ellipsoids ; if, after passing, they relax to spheres before the next passage, the work used in deforming them will be dissipated as a micro-turbulence of the liquid medium associated with the flow of the droplet, and non-Newtonian flow will result. One immediate result is that the extent of the anomalous viscosity will be proportional to the surface area of the drops ; that is, inversely proportional to their diameter. Direct measurements have been made of the surface viscosity and plasticity of solutions of soaps with various polar groups.

Other researches in progress at Sheffield are an investigation of the kinetics of coagulation using micro-photographic recording with phase-contrast objectives—no method exists for assessing the stability of emulsions other than counts of particle size. Some less laborious method is urgently needed and is under consideration. ζ potentials are also being studied, and a drop-profile apparatus is being used for measuring interfacial tensions, especially when small. The work is being extended to the action of complexes of soap plus a molecule containing a polar group such as carboxyl, hydroxyl or amine.

The present views upon which the work is proceeding are fourfold : that best emulsifying efficiency requires the closest packing of the soap molecules at the interface ; that soaps alone are not the best emulsifiers (carboxylates are an apparent exception because the acid soap is the useful agent) ; that closest packing and maximum efficiency are provided by complexes of soaps (of all sorts) and molecules containing a hydrocarbon chain of not less than six normal carbon atoms and a polar group such as hydroxyl, carboxyl or amine ; and that these complexes, at sufficient concentration in bulk, are all liquid crystalline of the smectic type.

Mr. E. Rothwell (University of Sheffield and Imperial Chemical Industries, Ltd., Ardeer) reviewed the work of Hatschek and Sibree and the later empirical relations between η and concentration proposed by Richardson, Broughton and Squires and by Goodeve. He then mentioned the work of Rossi, Lyttleton and Traxler and of Richardson upon the effect of particle size upon η. He described his own experimental work with particular reference to the effects of the packing-density in the emulsifying layer, to the effect of particle size and to the composition of the soap adsorbed at the interface. η was inversely proportional to particle size diameter for a given physical state of the emulsifier layer. For a given particle size viscosity decreases with increase of area per molecule adsorbed—that is, viscosity increases with increase of packing density, and therefore with fall of interfacial tension. This proves that the work done in flow in deforming droplets is not work done against γ, since that would require η to vary with γ in the opposite sense to that found, and the work must therefore be done against a surface viscosity, plasticity or elasticity. In agreement with Hatschek, it was found that, at very low rates of shear, η is independent of rate of shear corresponding with a complete relaxation of droplets between successive distortion; η then falls with increase of rate of shear but becomes constant again at high values corresponding with permanent distortion during flow.

The next speaker, Mr. B. C. Blakey (University of Sheffield), described measurements of the surface viscosity of soap solutions by the oscillating bob method. Sodium carboxylates, sodium alkyl sulphates and kationic soaps all have a high surface viscosity which is non-Newtonian except in the *n*-alkyl sulphates: the kationic soaps developed surface viscosity only on standing. The minimum concentration for appearance of surface viscosity is well below the critical concentration: in the carboxylate series, η rises with increase of chain length at 20° C. Sodium soaps have a higher value than that for potassium compounds. The effect is very large; for solutions of sodium cetyl sulphate the viscous drag on the bob due to the surface viscosity is equivalent to an immersion in water of the bob of 2–5 in.

The greatest care needs to be taken to exclude impurities even in very minute concentrations, and fractionation by frothing is especially valuable as a check. The addition of fatty acid to a carboxylate soap causes surface viscosity to appear at lower concentration than for the soap alone; but alkali has the opposite effect, which suggests that the surface species is acid soap. Alkyl trimethylammonium soaps showed a pronounced maximum at the critical concentration, the most obvious explanation of which was impurity which was solubilized at the higher concentrations. This has since been confirmed. A solution sufficiently pure to show no minimum in the surface tension concentration curve did give a maximum in the surface viscosity curve, and surface viscosity is therefore a more sensitive method for detection of small amounts of impurity than is surface tension. The sodium alkyl sulphates show Newtonian surface and interfacial viscosities when pure, but anomalous when not rigorously purified.

Work on solubilization of substances such as alcohols and fatty acids upon soaps was described by Mr. A. J. Hyde (University of Sheffield). This differs from solubilization of hydrocarbons in two fundamental respects: the inert substance in excess passes to emulsion, the polar addition, as soon as excess is added, separates with the soap as a liquid layer, the other being water, and the soap additive complex becomes oleophilic; at sufficient concentration and with a longer hydrocarbon chain in the additive, liquid crystals of the smectic layer type are always formed. The texture of the smectic phase varies with the composition giving either anisotropic spherulites; Dupin's cyclides or myelinic figures. The last are usually of the normal curved form, but occasionally have sharp angles as if simulating crystals. The general scheme seems to be:

spherical micelle in soap solution + additive →
smectic layer complex

With less hydrophobic additive, for example, benzyl alcohol, considerable further lowering of surface tension occurs, paralleled by charges of electrica conductivity. This lowering of surface tension must mean closer packing in the adsorbed film. With these more hydrophilic complexes, emulsification does not take place.

In a theoretical paper on the rheological behaviour of an emulsion, Dr. J. G. Oldroyd (Research Laboratory, Courtaulds, Ltd., Maidenhead) described how a finite interfacial tension between the two phases must give rise to elastic as well as viscous properties, since it provides a force tending to restore each deformed droplet of the disperse phase to its original spherical form. On the assumption that the droplet size is sufficiently small and uniform, an equation of state for a dilute emulsion subjected to small rates of strain was derived in the form of a linear relation between stress, rate of change of stress, rate of strain, and rate of change of rate of strain. The three constants in the equation were expressed in terms of the viscosities of the two phases, the interfacial tension and the volume concentration. The predicted effect of introducing a stabilizer would be principally to increase the relaxation time and retardation time of the system (by decreasing the interfacial tension) without changing the viscosity. But if hydrodynamic slipping were possible at the droplet boundaries due to the presence of a film of stabilizer, all three constants would be affected; preliminary calculations showed that it might be very difficult to detect slipping of this kind experimentally.

A. S. C. LAWRENCE

SECOND SEMINAR FOR EUROPEAN SANITARY ENGINEERS

THE second seminar for European sanitary engineers, sponsored by the Italian Government, the Rockefeller Foundation and the United Nations World Health Organization, was held in Rome during November 1951; representatives from sixteen European countries attended. The report of this meeting, published by the World Health Organization*, contains a great deal of information, which has not hitherto been easily available, on sanitary conditions on the Continent.

There was general agreement that there should be closer collaboration between sanitary engineers in different European countries. Many rivers, for example, flow through more than one country before reaching the sea, and it is clearly desirable that the discharge to them of polluting substances should be controlled in the common interest. The problems which arise in this kind of international planning are, of course, partly political, but are more likely to be solved if there is general agreement on the technical issues involved. At present the importance of the profession of sanitary engineering differs a good deal from country to country, and there is no general agreement on what the basic training of a sanitary engineer should be. Generally, however, this training falls somewhere between the two extremes represented by United States and British practice. In the former the student is trained in a university school of sanitary engineering, whereas in Great Britain the sanitary engineer is a man who is first trained in civil engineering and then specializes in the field of sanitation or public health. It may be mentioned, however, that in addition to a sanitary engineer thus defined, there are in Great Britain many men working in the field of sanitation whose basic training was in chemistry or biology and who are usually members of the Royal Sanitary Institute or the Institute of Sewage Purification, or who are professional associates of the Institution of Water Engineers. In this matter of training, there is probably no one best way, and the method found most efficient for any particular country will depend on the complexity and importance of the problems to be solved.

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* World Health Organization. Second Seminar for European Sanitary Engineers, Rome, 11–17 November 1951. Pp. v+280. (Geneva: World Health Organization, 1952.)

There was general agreement at the seminar that the ultimate formation of an international association of sanitary engineers is desirable. Here it may be recalled that a somewhat similar body—the International Water Supply Association, formed in 1947—is flourishing strongly and is holding its second congress in Paris this year. Some of the problems which would be encountered in introducing any standardization in sanitary matters in Europe were apparent in the discussion of a paper by Prof. U. A. Corti, of Switzerland, on the possible development of international standards for drinking water. Until recently there was general agreement on the more obvious standards required in a potable water—the absence, for example, of toxic metals and of pathogenic bacteria. It is clear, however, that if an attempt were made at present to lay down precise standards for all the minor constituents found in natural waters, or added during the course of treatment, a wide difference of opinion would be revealed. This is obvious, indeed, from the discussions which have followed recent proposals to add fluoride to water to reduce the incidence of dental decay. In any proposal to develop international standards the first step would seem to be to introduce standard methods of chemical analysis and bacteriological examination, and this point was made by several speakers during the discussion.

An important part of the Seminar was given up to discussions on the treatment and disposal of sewage, particularly from single houses and small communities. Installations of this kind, consisting usually of a septic tank and percolating filter, are in common use in some parts of the Continent and, to a small extent, in rural districts in Great Britain. Although they are one of the earliest types of treatment plant, surprisingly little is known about the principles on which their operation depends. This applies also to the disposal of the final effluent—which may contain pathogenic organisms—by subsurface irrigation, and much more work on this subject is required. It may be mentioned, for example, that in some parts of Great Britain lack of knowledge of the movement of liquids underground, and of the removal of bacteria from them in passing through various formations, limits the disposal of household refuse by controlled tipping in abandoned gravel pits—a method which has the advantage of being the cheapest form of disposal and of reclaiming otherwise derelict land. The seminar concluded with a very well-documented paper by Prof. M. Petrick, of Yugoslavia, on the utilization of night-soil and sewage sludge in agriculture, a subject on which there is now a considerable amount of quantitative information. There was general agreement that the series of seminars for European sanitary engineers should be continued, and it has since been announced that the third will be held in Great Britain in October this year.

BIOLOGICAL ASSESSMENT OF CHEMOTHERAPEUTICS

THE Biological Methods Group of the Society of Public Analysts and Other Analytical Chemists held its summer meeting in Nottingham during June 12–13, at the invitation of the directors of Boots Pure Drug Co., Ltd.

On June 12, the members of the Group visited the Pharmacology and Bacteriology Divisions of the Research Department, and the Bio-Assay Division of the Standards Department. In the Pharmacology Division demonstrations were given of the methods used for examining new substances for chemotherapeutic activity against the organisms of some tropical diseases, including amœbiasis, leishmaniasis, schistosomiasis and trypanosomiasis. Particularly interesting was the exhibit showing all stages of the life-cycle of *Schistosoma mansoni*, including ova, miracidia, cercariæ and adult worms. A demonstration was given of the value of the phase-contrast microscope for the examination of living, unstained Protozoa.

A cartesian diver apparatus was shown in use to measure the rates of oxygen uptake of small numbers of *Trypanosoma congolense* under various conditions. The apparatus was based on that first described by Linderstrøm-Lang: it has been adapted for use at 37° C., and to allow addition of substrates and inhibitors to the respiring organisms.

The examination of compounds for anti-tumour activity was demonstrated. Transplanted tumours such as the Walker carcinoma in rats and the mouse sarcoma 37 were shown, and the effect of the administration of such substances as nitrogen mustard and triethylene melamine on their development.

Methods of assessment of pharmacodynamic activity in new compounds which were shown included the estimation of local anæsthetic activity by a modification of the Bulbring–Wajda method, and the estimation of antihistamine and bronchodilator activities by the inhibition of bronchoconstriction produced in guinea pigs by the intravenous injection of histamine and other bronchoconstrictor agents. A demonstration was given of a possible method of assessing cortisone-like activity by the inhibition of granuloma-formation around implanted cotton-wool pellets and other foreign bodies in the rat.

Methods for examining acute and chronic systemic toxicity were demonstrated: a simple device was shown for dispensing drug-containing diet to mice in such a way that the daily consumption can be accurately measured. Several methods of assessing local toxicity and tissue damage were shown, including intradermal injection in guinea pigs, prolonged surface application to the shaved abdomen of mice under a fluid-tight cap, and the use of a small glass vacuum-cup to extract histamine-containing tissue fluid through the skin of a rat immediately over the site of a subcutaneous injection of an irritant substance.

In the Bacteriology Division, demonstrations were given of the various techniques used in the screening of new substances for possible activity against bacteria, viruses, and pathogenic fungi. In the Tuberculosis Section, the animal room was shown in which infected animals are maintained behind glass in a continuous current of air drawn into the room and expelled through filters. Laboratory demonstrations showed *in vitro* tests by the floating pellicle technique, and *in vivo* tests using guinea pigs and intracerebrally infected mice, and the method of assessment of drug activity on the basis of gross pathology. Groups of lungs taken from tuberculous mice, treated with known drugs such as *p*-aminosalicylic acid, thiacetazone, streptomycin, isonicotinic acid hydrazide, etc., were shown.

In the Virus Section, the use of bacteriophage as a screening virus was demonstrated. Methods with embryonated eggs for screening against influenza *A* and other viruses were shown, and with chicks against the Rous sarcoma virus. In the General Chemotherapy Section, a demonstration was given of an *in vivo* test in mice for the assessment of delay activity in penicillin preparations.

The Antibiotic Section showed the types of small-scale fermenters used for the experimental study of antibiotic production by new mutants of *Penicillium chrysogenum* or by newly isolated organisms. These included revolving tubes, shaker flasks, and larger fermenters. Methods of isolation and study of new organisms were displayed, as also were the biochemical studies carried out on the cultures during fermentations.

In the Bio-Assay Division, demonstrations included the assay of routine batches of insulin using the mouse convulsion method, and the determination of the delay activity exhibited by protamine zinc insulin in rabbits. The use of thermocouples for the determination of the rectal temperature of rabbits in pyrogen tests was shown. Other exhibits included the sulphated ox blood method of heparin assay, the rat 'line test' technique for the estimation of vitamin D and the standardization of posterior pituitary extract using the isolated uterus of the guinea pig.

On June 13 the Group visited the Veterinary Science Division at Thurgarton Priory. Demonstrations were given of the symptomatology and pathology of blackhead infection in turkeys, and methods of producing infection artificially were discussed: the use of artificially infected poults for drug assessment was described. Methods employed for the evaluation of new drugs against the common helminth parasites of domestic animals included a simple *in vivo* screening method using the free-living nematode *Turbatrix aceti*, cultured in serial dilutions of the drug.

A demonstration of work on Johnes disease in cattle included pathological specimens showing massive infection of the tissues. A brief account of the naturally occurring disease was given, and attempts at treatment with streptomycin and thiacetazone were described. A biochemical study of the digestive metabolism of ruminants was discussed. The changes which occur in the leucocyte picture and in certain blood constituents of the ewe in late pregnancy were described, and their possible relation to the adrenocortical hormones was discussed. An account was given of a method of field evaluation of sheep dips, in which an attractant solution is applied to the skin and wool of sheep at intervals after dipping, and the efficiency determined by the effect on blowflies attempting to oviposit on the wool.

Demonstrations were given of the methods used in the evaluation of disinfectants for dairy use. Disinfectants for hatching eggs were tested on eggs infected on the surface with a *Salmonella* culture. Disinfectants for dairy utensils were assessed by their effect on plate counts on standard metal strips infected with cultures suspended in milk. Field trials of dairy disinfectants under working conditions were described.

The meeting ended with a short scientific session at which papers by Dr. G. F. Somers on "The Assay of Adrenaline in Creams", and by Dr. P. W. Muggleton on "The Standardization of Pertussis Vaccine" were read and discussed. The chairman of the Group, Dr. H. O. J. Collier, expressed the appreciation of the members to Mr. W. A. Broom and his colleagues for organizing the meeting.

TRANSPARENT CONDUCTING FILMS OF GOLD

In an article in *Nature* describing recent work in the Light Division of the National Physical Laboratory, Teddington, on methods of producing transparent electrically conducting films on glass[1], the films then mentioned were oxide films; and, although the conductivity of some, especially tin oxide, had been abnormally enhanced by special treatment, the *modus operandi* is not yet fully understood. One object of the work was to provide means for heating the glass electrically; but it was noted that the resistance of the films was rather high, making necessary the use of voltages of some hundreds for the effective de-icing of coated aircraft windows in adverse conditions.

A further investigation has rapidly followed this, by the same workers, and with the same practical aim. The results are noteworthy because they touch upon a rather different field of research. It has long been known that metallic films, made by no matte what process, almost always have a much greate resistivity than the bulk metal, even after allowanc for an expected increase due to the thinness of th films. This discrepancy between observed an predicted resistivities is assignable to the differenc between the granular or non-coherent structure o the actual films, and the homogeneous plane-paralle model assumed in the theory.

The starting-point of the new investigation was study of the influence which the condition an material of the substrate might have upon th properties of superposed gold films. For example, gold film laid down on glass cleaned with dry pre cipitated chalk was found to have a resistivity les than half that of similar films on glass cleaned b more ordinary methods, while the colour of the fil was a dull yellowish-green instead of the familia bluish-green. These experiments were made wit gold films about 70 A. in thickness, laid down unde strictly controlled conditions by cathodic sputtering Similar films were then laid down on glass freshl coated with substrate films of various oxides, als made by sputtering. In some such cases, especiall with substrates of the oxides of cadmium, lead, bismut and zinc, the properties of the gold film were eve more strongly modified. Films on zinc oxide were always blue, with almost infinite resistance. Films 70 A. in thickness (on a weight–bulk density basis) on bismuth oxide were, however, of a pale-straw colour, and had a resistance of about 15 ohms between opposite edges of a square sample. The transmission factor for white light was about 70 per cent. On heating such a sample to 200° C. for a few minutes the colour became paler still, the transmission factor rose to about 73 per cent, and the resistance dropped to about 10 ohms. Moreover, these results were very closely reproducible from sample to sample. For comparison, it is to be noted that a similar film on glass cleaned by ordinary methods would be blue-green in colour, and have a transmission of about 35 per cent and resistance of unpredictable value in a range of roughly 80–200 ohms.

It is further of interest to note that, with these ilms of gold on a substrate of oxide, the transmission can be further enhanced by using various methods analogous to 'blooming'.

For the moment, the structure of the highly conducting films is a matter of speculation but is being mmediately investigated. It is, however, remarkable hat the resistance value obtained is very close to the heoretical value for a plane-parallel lamina having he same weight of gold per unit area as the actual ilm. It seems also that the low optical absorption may be consistent with the optical constants for gold n bulk, with some form of 'thinness' correction, hough this has not yet been fully investigated.

Whatever film-structure may be revealed by further xamination, this work appears to offer an interesting ew field for the study of surface forces and states, s well as providing for practical applications a ransparent film of a novel type and exceptionally ow resistance. It is understood that the Ministry of upply, for which the research is being undertaken y the National Physical Laboratory, is actively ngaged in studying the problems of producing and sing windows having a coating of this double-layer lm.

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HOMING ABILITY IN BIRDS

A RECENT issue of *Ibis* contains two important articles on the direction-finding abilities of irds (94, No. 2).

In the first article G. V. T. Matthews describes an xtensive series of homing experiments carried out ith 249 lesser black-backed gulls (migratory species) nd 91 herring gulls (a restricted nomad), together ith twenty other sea birds. On release the lesser lack-backed gulls showed a significant homeward rientation which was absent when the sun was bscured by clouds; some direct evidence and an nalysis of the homing success indicated that a large roportion of the gulls were homing by an inefficient method, probably random exploration for known isual landmarks. A minority, however, were homing y a method not dependent on the distance or area f release, the orientation behaviour suggesting some orm of sun navigation. The herring gulls showed a much lesser ability to 'home', and this could be xplained by there being a much smaller proportion able navigators among them. Matthews also arried out experiments in which the earth's magnetic eld was masked by airborne magnets; this in no ay affected homing ability.

In the second article Gustav Kramer describes experiments carried out with starlings and homing pigeons. The starling's ability to reproduce constant compass directions was demonstrated in two ways: first, by using migratory activity as an indicator, the bird tending to take up a constant direction; second, by training the birds to choose one of several (up to twelve) feeders symmetrically distributed around the cage. If the incidence of light were changed by use of a mirror arrangement the direction chosen by the bird changed correspondingly. The sun was shown to be a governing factor, the orientation faculty (in experimental conditions) vanishing if the sun were hidden. The correct direction was reproduced regardless of the time of day.

Experiments with homing pigeons showed that these birds were able to home over an unknown stretch of two hundred miles. Some sort of astronomical navigation is suggested by the fact that the pigeons seemed to be orientated even before starting. Apart from this orientation method direction, learning could be produced by training the pigeons along one homing line; by displacing the bird sideways they are misled, this being taken as the test of direction learning.

Like starlings, pigeons were trained to choose food from a definite direction under experimental conditions, and here again the sun was the physical clue for orientation.

BRITISH COAL UTILIZATION RESEARCH ASSOCIATION

REPORT FOR 1951

WITH an annual fuel crisis tending to become an accepted feature of British life, means of increasing the output of coal from all indigenous sources have been widely publicized and implemented, so that coal production has been rising steadily during recent years. The nation's fuel problem remains, however, for coal consumption has also increased, so that now a gap exists between demand and supply which will doubtless widen unless and until coal is used more wisely and far more efficiently than at present. It is gratifying to note, therefore, that the resources of the British Coal Utilization Research Association are being devoted to bringing "in our time" a real improvement in the efficiency of using coal in all its conditions of availability.

Progress towards that aim is described in the annual report of the Association[*], which was presented by the president, Sir Charles Ellis, to the annual general meeting on May 7. The many investigations being pursued include a new method of conditioning slurry, the automatic control of coal-fired gas producers, the reduction of smoke from domestic open fires, and the use of coal for chemical purposes.

Several million tons of wet coal slurry are produced each year in colliery washeries. As produced, the slurry is a water-logged aggregate which, even after dewatering, is too finely divided to burn satisfactorily. If it could be converted into a usable form, however, this material would make a substantial contribution to the nation's fuel supplies. A pelleting process has now been devised in which the slurry, pre-treated to form a wet mud, is first broken up and then agglomerated into spherical particles of either $\frac{1}{8}$–$\frac{1}{4}$ in. or $\frac{1}{4}$–$\frac{3}{8}$ in. diameter. The pelleting device is simple; the pellets themselves, when dried, are strong enough to withstand moderate handling, and have been burnt successfully on a mechanical stoker plant and do not disintegrate in the fuel bed of a gas producer.

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[*] British Coal Utilization Research Association: Annual Report for 1951. Pp. 52. (Leatherhead: the Association, 1952.)

The work on the automatic control of gas producers is aimed at improving practice in respect of the coal-fired producer so that coal may compete more favourably with imported oil as a fuel for the steel and glass industries. Two systems of control of the coal feed to gas producers have now been developed which maintain, under conditions of variable load, a constant quality of the gas. In one, which is recommended for use in steelworks, the rate of coal feed is linked directly to the rate of air feed to the producer. In the other, which is simpler, the controller is operated by the gas off-take temperature, and is to be preferred for use in the glass industry. A recent development of the former system is the use of blast steam pressure as the main controlling variable instead of air flow.

The ever-present problem of smoke emission is being studied in four different ways, namely: an investigation of the factors affecting the release of smoke from burning coal; the destruction of tar vapours in smoke; the possibility of reducing smoke formation by chemical pre-treatment of coal; and reduction of smoke by modified appliance design. Work on the first three problems is still in its early stages. Modifications to the design of domestic open fires have led to reduced smoke emission, but only under such rigid control as cannot yet be obtained under normal home conditions.

Although the work of the Association is concerned primarily and inevitably with the use of coal as a fuel, the possibility of coal replacing oil as a source of essential chemical substances in the future has not been overlooked, and a first method of attack by solvent treatment is being made.

The work of the Association as a whole must be regarded as of great value to a country the economy of which is based on coal, and it is to be hoped that circumstances will permit of its future expansion and acceleration.

WILD LIFE IN ARABIA

OPEN plains, scorching and shadeless during the summer, windswept and freezing during the winter night, present a hard environment. Yet up to the beginning of the present century an interesting assemblage of animals existed in the Arabian desert. Even when modern rifles came into general use the species held their own to a satisfactory extent. But the last decade has witnessed the advent of a mechanized predator, the 'jeep', and, according to a recent article by Desmond Foster-Vesey-Fitzgerald, it cannot be long before motorized hunting parties will sweep Arabia's fauna away (*Oryx*, 1, No. 5; April 1952).

It may be of value, therefore, to record the status of some of the more interesting animals during recent years. The Arabian oryx is now extinct in the northern sands of the Great Nafud. Some interesting pictures of this species have been scratched by idle shepherds on sandstone outcrops in the vicinity of Hail. In the southern sands of the Rub Al Khali the oryx still exists.

Three species of gazelle are still widespread and reasonably numerous. The northernmost species is Loder's gazelle, the 'rhim' or the Arab (*Gazella leptoceros marica*), which inhabits the gravel plains, limestone plateaux and sands of Central Arabia. This is a gazelle of the steppe where perennial dwarf shrubs are supplemented by abundant annual herbage following winter rains. It is a stocky, whitish animal which congregates in large flocks composed of fifty to a hundred individuals. It has not been observed to leap or bound like the other species, but travels nevertheless at a deceptively fast speed. The 'rhim' is the only species found on the northern gravel plains and along the fringes of the central Arabian sands, being especially abundant on the Bisaita plain and Teisiya plateau. It extends southwards into the tropic, where it has been observed congregating with the other species.

The other two species, the dorcas gazelle (*Gazella dorcas saudiya*) and the Arabian gazelle (*Gazella gazella arabica*) are both graceful reddish animals which leap and bound in a manner quite unlike the 'rhim'.

The dorcas gazelle or 'afri' appears to be confined to those parts of the interior of the peninsula where *Acacia* grows. It ranges widely over the great gravel plains which lie to the east of the Hejaz mountains but is only encountered in very small parties or alone.

The Arabian gazelle or 'idmi' is also a gazelle of *Acacia* country and appears to be the common species of the coastal plains. But it also occurs on the highland plains of the interior with the dorcas gazelle and is, in fact, the commonest species in all the country to the east of Taif.

Gazelle in Arabia never drink and they are able to exist without green herbage or dew. It must be presumed that the necessary moisture for their welfare is obtained from buds of perennial plants which, although encased within dry scales during drought periods, remain viable and ready to burst as soon as rains fall. Probably the most important plant in this category for the 'rhim' is the dwarf shrub *Rhanterium eppaposum*, and for the other species the various kinds of *Acacia*.

The ibex exists in Arabia where a suitable habitat occurs. Such places include the sandstone gorges around Medain Saleh in the Hejaz, the basalt ranges of the Jebel Shammar around Hail, and the drier mountains of Dhofar in Southern Arabia.

The wolf (*Canis lupus* var.) is still fairly common in Central Arabia, especially in the limestone country where springs are frequent and caverns provide suitable dens. The striped hyena is widespread but nowhere common, although tracks are often seen on the Red Sea coastal plains.

The leopard is rare but exists in the Red Sea hills south of Jedda, where baboons are plentiful, and also in the more generously wooded hills of Dhofar.

In Arabia the ostrich is extinct, although it would appear that these birds existed in some numbers over the open gravel plains of the Bisaita in North Western Saudi Arabia until about twenty years ago. During the 1930's there was a big massacre in order to obtain plumes; but a few survivors lingered on until about 1944, when the last were killed. In south eastern Arabia the ostrich became extinct about sixty years ago; but fragments of egg-shell can still be quite frequently found in the Bainuna country between the base of the Qatar peninsula and the Trucial coast.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

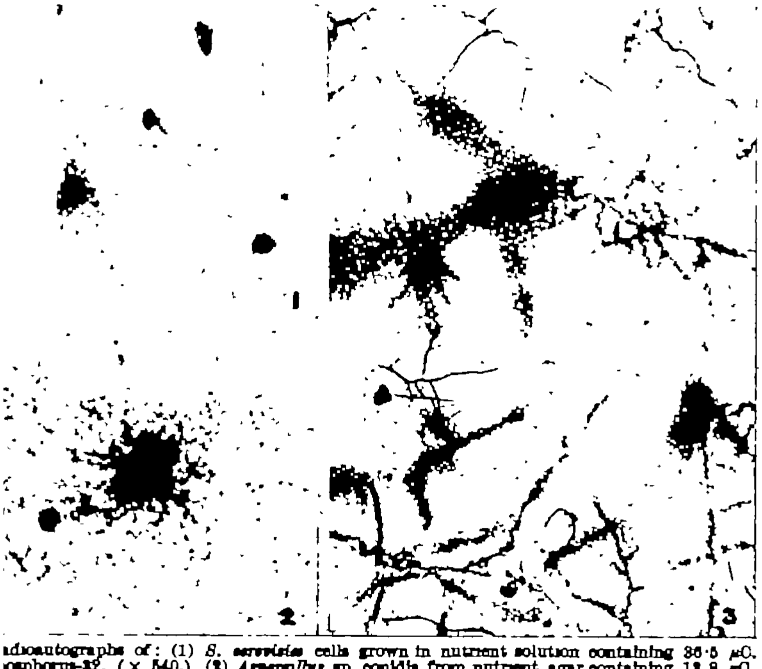
Detection of Radiophosphorus in Cells and Spores of Fungi by Radioautography

THE employment of radioautographic techniques as been of much value in botanical studies in emonstrating the presence and localization of tracer lements within plant organs and tissue. In this espect the work of Arnon *et al.*[1], Colwell[2], and Iarrison *et al.*[3], may be cited as typical. Pearson t *al.*[4] prepared radioautographs of fungus cultures, ut stated that because of the limitations of the aterials and methods employed it was not possible o obtain radioautographs of single cells or hyphæ. oyd *et al.*[5], however, were able to obtain single cell utographs of leucocytes and erythrocytes. More ecently, Fitzgerald *et al.*[6], using tritium, obtained adioautographs of single yeast cells and *Paramecia*.

In the method employed here, phosphorus-32 was dded to the nutrient medium in the form potassium lihydrogen phosphate. *Aspergillus* sp., *Hormodenrum* sp. and *Penicillium* sp. were grown on nutrient gar ('Difco') containing 5 per cent glucose. *accharomyces cerevisiae* was grown in nutrient broth 'Difco') containing 5 per cent glucose. Cells harvested rom these media were washed and placed directly pon the surface of a photographic emulsion. Best esults were obtained with a special emulsion (*NTB* lates) developed by the Eastman Kodak Research aboratories, Rochester, N.Y. After exposure, the lates were developed in a 'fine grain' developer.

The accompanying photographs are from representtive radioautographs obtained in this work. It eems of interest to note that localization of activity ccurred not only in mycelium but also among conidia rom the same test-tube culture, some producing radioautographs and others not. Perhaps conidia of different ages vary in their phosphorus content. A like condition was noted among cells of *S. cerevisiae* from a single broth culture. This is in agreement with the results of Boyd and Levi[7], who reported finding evidence of non-uniform uptake of phosphorus-32 by yeast cells.

This work was conducted in the Department of Botany, McMaster University, Hamilton, Ontario.



adioautographs of: (1) *S. cerevisiae* cells grown in nutrient solution containing 36·5 μC. osphorus-32. (× 540.) (2) *Aspergillus* sp. conidia from nutrient agar containing 13·8 μC. osphorus-32. Exposure period, 14 days on Kodak *NTB* emulsion. (× 540.) (3) *Penicillium* . mycelium from a nutrient solution containing 250·0 μC. phosphorus-32. Exposure period, 30 days on Kodak *NTB* emulsion. (× 120)

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Effect of Œstradiol Benzoate and Orchidectomy on the Toxicity of Trypan Blue

PRIBELKOV[1] found that the toxic effect of trypan blue was manifested in guinea pigs by loss of weight and hair, apathetic appearance, fall in hæmoglobin content, accumulation in the blood of large numbers of polychromatophiles and normoblasts and the appearance of erythrocyte decomposition products in many organs. Nicol[2] pointed out that some animals appeared to be more susceptible to the toxicity of the dye during œstrus. The toxic effect of injections of trypan blue on the tissues has been studied histologically by Downey[3], who observed that the cells of connective tissue first showed diffuse staining of the cytoplasm and the nucleus which he considered to be the appearance of dying cells. Many cells died, but some were able to eliminate the dye and recover, except the eosinophiles. The reticulo-endothelial cells, which specifically store the vital dye, are affected in the same manner, and it is probable that the resulting inhibition of the functional capacity of the reticulo-endothelial system is partly responsible for the toxic manifestations of trypan blue.

In view of the stimulating effect of œstrogens on the reticulo-endothelial system[2,4], it was considered desirable to ascertain their influence on the toxicity of trypan blue.

In the present experiments, the toxicity of trypan blue, judged by the mortality-rate and by the effect on body-weight, was studied in ninety guinea pigs, all of which received one daily subcutaneous injection of trypan blue for six days. The daily dosage of the dye was calculated on the basis of 0·8 ml. of a 1 per cent solution in distilled water per 100 gm. body-weight. The animals were weighed immediately before the first and after the last injection of trypan blue. They were divided into three groups: 30 intact males, 24 orchidectomized animals and 36 ovariectomized animals. Each group included animals which received only the dye injections and therefore served as controls, and also animals which received one daily intramuscular injection of 0·5 mgm. œstradiol benzoate for one to four weeks, during the last six days of which they also received the dye. Œstradiol benzoate was selected for the present investigations because of its low toxicity compared with other œstrogens[6].

Results in intact male animals. Trypan blue was responsible for the death of one out of seven animals not given hormone, and one out of twenty-three animals treated with hormone. The changes of weight observed after the course of trypan blue injections averaged a loss of 6·5 per cent in seven animals not given hormone, a loss of 6·2 per cent in six animals given œstradiol benzoate for one week, a loss of 0·9 per cent in six animals given œstradiol benzoate for two weeks, a gain of 1·9 per cent in five animals given œstradiol benzoate for three weeks and a loss of 1·3 per cent in six animals given œstradiol benzoate for four weeks.

To ascertain to what extent these changes of weight were due to the trypan blue, five intact animals were given one daily intramuscular injection of 0·5 mgm. œstradiol benzoate for four weeks and were not given trypan blue. They were weighed regularly at weekly intervals. No animals died as a result of the hormone treatment. The average weekly change in body-weight in these animals was a gain of 2·4 per cent during the first week, a gain of 1·8 per cent during the second week, a gain of 1·9 per cent during the third week and a gain of 0·8 per cent during the fourth week. The gain in weight is probably due to the water-retaining power of the œstrogen[6].

Comparison between the changes of weight produced by trypan blue alone, by the hormone alone and by the hormone together with the dye indicates that the œstrogen conferred a certain degree of immunity against the toxicity of the trypan blue, and that this immunity was most marked in the animals which received the œstrogen for three weeks.

Results in orchidectomized animals. Trypan blue was responsible for the death of one out of ten animals not given hormone and two out of fourteen treated with hormone. The changes of weight observed after the course of trypan blue injections averaged a loss of 5·6 per cent in ten animals not given hormone, a loss of 1·3 per cent in four animals given œstradiol benzoate for one week, a gain of 2·3 per cent in three animals given œstradiol benzoate for two weeks, a gain of 6·4 per cent in two animals given œstradiol benzoate for three weeks and a gain of 5·1 per cent in five animals given œstradiol benzoate for four weeks.

Comparison between the above changes of weight in the orchidectomized animals and those in the intact animals shows that the toxic effect of trypan blue was less in the orchidectomized than in the intact animals, and indicates that orchidectomy adds to the protective influence of the œstrogen.

Results in ovariectomized animals. Trypan blue was responsible for the death of two out of twelve animals not given hormone, and four out of twenty-four treated with hormone.

The changes of weight observed after the course of trypan blue injections averaged a loss of 5·9 per cent in twelve animals not given hormone, and a loss of 3·5 per cent in twelve animals given œstradiol benzoate for one week, while in twelve animals given œstradiol benzoate for two weeks practically no change in weight occurred. The results, therefore, show that œstradiol benzoate reduced the loss in weight produced by the toxic effect of the dye.

The protective influence of œstradiol benzoate against the toxicity of trypan blue, observed in all the groups of animals, may be attributed to its stimulating effect on the reticulo-endothelial system, which thus becomes more capable of dealing with the dye and detoxicating it. The effect of orchidectomy may be explained by a similar stimulating influence on the reticulo-endothelial system.

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Antagonistic Effects of Cortisone and Salicylate

THE injection of cortisone has been observed to cause glycosuria in normal rats fed on a high carbohydrate diet[1]. Sodium salicylate reduced this glycosuria (Fig. 1) and also reduced the hyperglycæmia obtained in these animals after feeding (Fig. 2).

The changes in the liver glycogen content of adrenalectomized rats produced by cortisone in the presence and absence of salicylate were also studied. The rats were maintained on 0·5 N saline and a normal diet for four days after operation. Forty-eight adrenalectomized rats were divided into seven groups, three of these groups, each containing six animals, being killed at 0, 4 and 6 hr.; two groups were injected with 5 mgm. of cortisone per rat at 0 hr. and killed at 4 hr. (seven rats) and 6 hr. (eleven rats), respectively; and in two further groups of six animals each rat received 5 mgm. of cortisone and 100 mgm. of sodium salicylate at 0 hr., one group being killed at 4 hr. and the remaining group at 6 hr. The animals were fasted during

Time of sacrifice (hr.)	Liver glycogen content (gm./100 gm. wet wt.) with standard deviations					
	Untreated	No. of rats	Treated with cortisone	No. of rats	Treated with cortisone/salicylate	No of rats
0	2·33 ± 0·55	6				
4	1·77 ± 0·81	6	3·30 ± 2·90	7	0·50 ± 0·12	6
6	1·45 ± 0·7	6	3·91 ± 1·99	11	0·60 ± 0·2	6

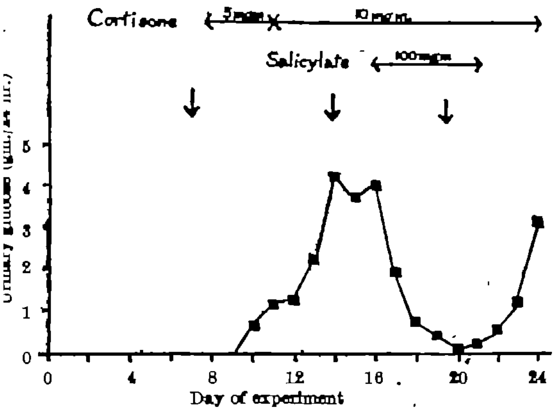

Fig. 1. Mean 24-hr. urinary glucose for a group of four normal rats fed on a high carbohydrate diet and injected with cortisone and sodium salicylate. Cortisone: 5 or 10 mgm. as saline suspension of cortone acetate (Merck) daily; sodium salicylate: 100 mgm. in 1 ml. arachis oil daily. The arrows indicate the days on which the blood sugar curves in Fig. 2 were obtained

he experiment. The glycogen content of liver vas estimated by the method of Good, Kramer and omogyi[2], and the results are shown in the accompanying table.

Comparison of these results showed that salicylate, n the presence of cortisone, caused significant deple- ions of liver glycogen at 6 hr. compared with both he group treated with cortisone ($P = 0·01$) and the ntreated group ($P = 0·01$). Cortisone produced a ignificant deposition of liver glycogen at 6 hr. $P = 0·1$) when compared with the initial value at) hr. Salicylate therefore not only caused breakdown f existing glycogen but also prevented the formation f new glycogen by cortisone.

These antagonistic effects of salicylate and cortisone ire of interest for two reasons. First, it has been uggested that the therapeutic activity of salicylates s mediated by the pituitary and adrenal cortex, eading to the production of adrenal corticoids[3]. If his hypothesis is correct, then salicylates and adrenal orticoids, of which cortisone may be considered a ypical example, should have the same general effects n the tissues. Secondly, salicylates have been ob- erved to reduce the glycosuria and blood glucose of lloxan-diabetic rats[4]; in these animals there is ncreased gluconeogenesis due to the action of adrenal orticoids, and an inhibition of this process by salicylates may provide at least a partial explanation of these effects.

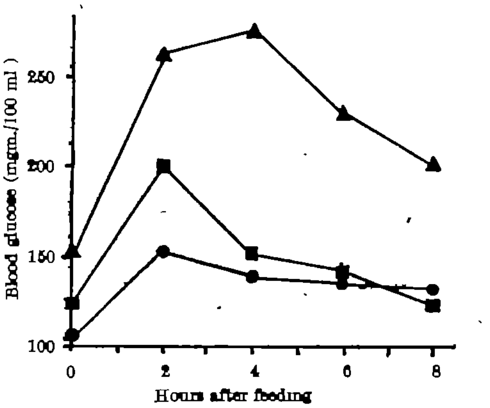

Fig. 2. Mean blood sugar curves after feeding the rats described in Fig. 1. The animals were fasted for 16 hr. before being given the same amounts of the high-carbohydrate diet by stomach tube. ●, control period; day 7, Fig. 1; ▲, cortisone period; day 14, Fig. 1; ■, cortisone/salicylate period; day 19, Fig. 1

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Effect of Tissue Cultures of Maize Endosperm on the Growth of Excised Maize Embryos

IN 1947, LaRue reported the regeneration of sporophytes from maize endosperm tissue, and also limited growth of the endosperm tissue without regeneration or differentiation when excised and placed on an appropriate artificial medium[1]. In 1948, continuing this study, he succeeded in obtaining a culture of maize endosperm of a callus-like nature having unlimited growth[2]. This original stock has been in culture for more than two years, and I also have stocks in culture from two other varieties of maize.

Ziebur and Brink reported in 1951 the stimulative effect of freshly excised *Hordeum* endosperms on the growth of immature plant embryos *in vitro*[3]. It was thought of interest to study the effect of cultured endosperm tissue on the growth of freshly excised maize embryos of various ages to observe whether or not it would still function as a nutrient endosperm for the embryos[4]. A preliminary experiment has therefore been carried out at the University of Michigan.

The cultured maize endosperm tissue employed in this experiment was that of LaRue's original stock. This tissue has been found to grow well only on a basal medium supplied with certain additional substances. White's basic medium plus tomato juice has been used for obtaining good growth.

The embryos were placed directly upon (1) White's basic medium, (2) White's plus tomato juice, and on masses of maize endosperm tissue from culture which had been transferred previously to (3) White's and (4) White's plus tomato juice. Embryos were also placed on masses of crown gall tumour tissue growing on (5) White's and (6) White's plus tomato juice medium. The results, recorded after five days, are given in the accompanying table. Growth is indicated by the plus signs and no growth by the minus signs.

Medium	16-day embryo var. 'Our Choice' 0·5–1·0 mm. length	20-day embryo var. 'Surprise' 3·0–4·0 mm. length
1	+	+ + + + +
2	+	+ + +
3	—	+ + +
4	—	+ +
5	—	+
6	—	+

1. Endosperm cultured on White's medium + tomato juice.
2. ,, ,, ,, ,,
3. White's medium + tomato juice.
4. ,,
5. Crown gall tissue growing on White's medium + tomato juice.
6. ,, ,, ,, ,, ,, ,, ,,

It is apparent from these results that the endosperm tissue in culture does improve the growth of the excised embryos. The growth of the older embryos is better than on the nutrient medium alone. It stimulates some growth of the younger embryos. Crown gall tissue does not improve growth of the embryos. It is noted that the addition of tomato juice improves the growth of the embryos on the basal medium. It may be concluded that the cultured endosperm has retained its endosperm function.

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A New Technique for the Sterile Culture of Plant Embryos *in vitro*

THE two essentials for successful tissue culture are a sufficient supply of nutrients and adequate aeration. In the culture of plant embryos from an early stage of development it is also often desirable that cultures shall be suitable for microscopical examination.

The relative merits of different culture containers are discussed by White[1], and the technique here described combines the simplicity and freedom of manipulation of the flask method with ease of microscopical examination afforded by the hanging drop.

The embryos are grown on two strips of filter paper (No. 1. 4 × 1 in.) supported on a glass strip (3 × $\frac{3}{4}$ in.). This is placed in a boiling tube (6 × 1 in. 'Pyrex') containing 5 c.c. of liquid medium so that it rests nearly vertically with one end in the medium. The tubes are afterwards plugged with cotton-wool and sterilized ready for inoculation. The medium is absorbed by the filter paper and is readily available to the embryos, which are thus surrounded by a film of nutrients and also have free access to the air. If, however, the dimensions of the filter paper do not exceed those of the slide, the medium is less accessible to the embryos.

Embryos placed centrally on the slide can be examined in detail during all stages of development through a microscope with a 1-in. objective without their being removed from the tube. Tubes can be placed horizontally, or nearly so, without spilling or wetting of the cotton-wool plugs by the medium; the dimensions are such that the liquid runs down beneath the slide, and with care there is little danger of the embryos being washed out of position. Measurements can therefore be made with an eyepiece micrometer and camera lucida. In later stages of development the seedling grows in an upright position and can be measured against a scale on the filter paper or a ruler with reasonable accuracy.

Cultures are economical and easy to maintain over long periods of time. Evaporation from the tubes is low, and it has been found that a change of medium once a fortnight is satisfactory. This can be done by removing the embryos singly with forceps into a new tube, or by transferring the whole slide from one tube to another with no disturbance to the embryos.

Large numbers of samples can be maintained at any one time in a small space since tubes are easy to store, and in the early stages of development five or even ten, embryos can be grown in one tube.

It is possible that this method may prove equally satisfactory for culturing tissues other than plant embryos, where a liquid medium is required without the disadvantages of immersion.

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Autonomic Ganglion Depressant Properties of Barbiturates

THOUGH the central nervous system depressant and anticonvulsant properties of the many derivatives of barbituric acid have been extensively studied, relatively little is known of their effects on the autonomic nervous system.

Depressant effects of amylobarbitone on the cardiac vagus were first described by Lieb and Mulinos[1], and have been confirmed by other workers. Depressant effects on salivary secretion were shown by Stavraky[2], for amylobarbitone, and by Emmelin[3], for hexobarbitone. It is not clear from any of this work whether the depressant effects were exercised at the autonomic ganglion or more peripherally.

Initial experiments showed that amylobarbitone sodium, administered intravenously to the cat in doses of the order of 5 mgm. per kgm., depressed ganglionic transmission without depressing the peripheral structures. By a method involving periodical electrical stimulation of the pre-ganglionic trunk of the cervical sympathetic, and recording of the contractions of the nictitating membrane, ganglion depressant effects of amylobarbitone were compared quantitatively with those of tetraethylammonium iodide; amylobarbitone was about one-quarter as potent as tetraethylammonium iodide. In a similar manner, the depressant properties of some fifteen of the commoner barbiturates were compared with those of amylobarbitone. The accompanying table shows the results obtained with a few of the more interesting derivatives.

Barbiturate (as sodium salt)	(*A*) Mean potency on sup. cerv. gang. ± stand. errors	(*B*) Relative anæsth potency	Ratio $\frac{A}{B}$
Amylobarbitone	100·0	100·0	1·00
Butobarbitone	99·1 ± 6·2	71·0	1·40
n-Hexylethyl	43·4 ± 2·7	69·2	0·63
Pentobarbitone	42·5 ± 1·5	163·6	0·26
Hexobarbitone	31·7 ± 2·9	186·2	0·17
Barbitone	17·1 ± 1·3	23·1	0·74
Phenobarbitone	14·2 ± 0·6	40·3	0·35
Thiopentone	12·8 ± 1·2	450·0	0·03

The first two columns show: (*A*) mean ganglion depressant potencies determined from a number of experiments, and (*B*) relative intravenous anæsthetic potencies (calculated from data of Butler[4]). The figures are expressed in terms of amylobarbitone, which has been allotted the arbitrary figure 100·0 in each instance. It is interesting to note that, for the different drugs, ganglionic and anæsthetic potencies show no direct correlation one with the other; amylobarbitone and butobarbitone show the highest activity on the ganglion and thiopentone the lowest. Pentobarbitone, which is isomeric with, and more otent an anæsthetic than, amylobarbitone, shows n activity of only 42·5 on the ganglion. The relationhip between ganglionic and central nervous deressant activities is expressed in the third column s the ratio *A*/*B*. The highest ratio (1·40) is given y butobarbitone.

Other barbiturates, which are not in current clinical se, are now being investigated with the view of letermining the structure – action relationships reponsible for conferring increased ganglion depressant ffects.

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Rigid-Body Motions in Special Relativity

The rigid-body motions proposed by Born[1] and Herglotz[2] have, in general, only three degrees of freedom, so that the world line of one point determines the complete motion. My purpose here is to define a group of rigid-body motions with six degrees of freedom as in Newtonian mechanics. Any such definition must be regarded as tentative, and its physical significance tested by experiment (see following communication from Prof. J. L. Synge).

In the space-time of Minkowski, where a point has the four co-ordinates x^1, x^2, x^3, x^4 ($= ict$), let a world line be determined by the equations:

$$x^r = a^r + b_1\mu_1{}^r + b_2\mu_2{}^r + b_3\mu_3{}^r + b\lambda^r, \quad (r = 1, 2, 3, 4). \tag{1}$$

Here a^1, a^2, a^3 are three arbitrary functions of a parameter u, and $a^4 = icu$; λ^r is the unit 4-vector in the direction of the da^r/du; $\mu_1{}^r$, $\mu_2{}^r$, $\mu_3{}^r$ form an orthonormal triad of 4-vectors orthogonal to λ^r, which triad may be specified by three arbitrary functions of u giving, say, its Eulerian angles; b_1, b_2, b_3 are constants and $b = (b_1{}^2 + b_2{}^2 + b_3{}^2)^{1/2}$. By letting b_1, b_2, b_3 have a range of values, we get a congruence of world lines depending on six arbitrary functions of u. If a body moves so that the world lines of all the particles form such a congruence, then we shall say that the body has a rigid motion.

The curve $x^r = a^r$ is the history of the particle for which the b's vanish; this particle, which takes a special role, may be called the 'drag-point'. Since $a^4 = icu$, the parameter u may be interpreted as the time along the world line of the drag-point.

The connexion with Newtonian rigidity and the Lorentz contraction may be seen as follows. If x^r and y^r are two events of the congruence with the same value of u, then the invariant $(x^r - y^r)(x^r - y^r)$ with r summed, which is the square of the Minkowski distance, is independent of u and therefore remains constant throughout every rigid motion. The value of $\lambda^r(x^r - y^r)$ also remains constant. This latter condition implies that whenever the body, initially at rest, is accelerated and finally moves in uniform translation, it is shortened in the direction of motion by the Fitzgerald–Lorentz contraction factor.

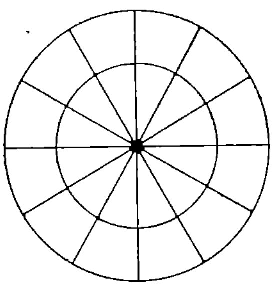
Fig. 1

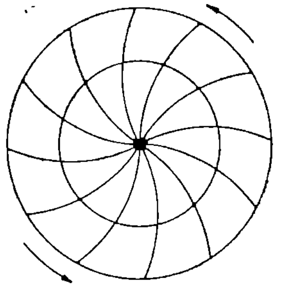
Fig 2

The following example of rigid motion is a relativistic analogue of the Newtonian rotating disk. Choose for the drag-point the origin of a Galileian observer S so that a^1, a^2, a^3 are all zero. For the rotating triad take $\mu_1{}^r = (\cos\theta, \sin\theta, 0, 0)$, $\mu_2{}^r = (-\sin\theta, \cos\theta, 0, 0)$ and $\mu_3{}^r = (0, 0, 1, 0)$, where θ is some function of u. With b_3 equal to zero, equations (1) give the motion of all points in the x_1, x_2 plane, the first and second derivatives of $\theta(u)$ representing the angular velocity and angular acceleration of the body respectively. Fig. 1 shows the disk at rest in S with radial lines and circles about the origin etched on its surface, and Fig. 2 shows the same etchings as they appear to S when the disk has acquired a constant angular velocity ω, drawn for the case when the peripheral velocity is $\frac{1}{2}c$. The straight radial lines become curved with polar equation $r\omega = c(\theta + \text{constant})$. The radii of the circles remain the same, as indeed is true even in non-uniform angular motion.

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Gardner's Hypothesis and the Michelson–Morley Experiment

When Gardner's hypothesis (see preceding communication) is applied to the Michelson–Morley experiment, performed with an interferometer with horizontal rigid arms, carried on the rotating earth, it yields the following formula for fringe-shifts if we take the drag-point to be the centre of the earth:

$$\delta/w = (D/\lambda)(E/c)\,\varphi \sin 2\theta.$$

Here δ is the fringe-shift, w the fringe-width, D the arm-length of the interferometer, λ the wave-length used, E the velocity of the earth's surface due to the earth's rotation alone, c the velocity of light, φ the deviation of the plumb line, and θ the azimuth of the telescope arm, from the north eastward. If, on the other hand, the drag-point is near the interferometer, the predicted fringe-shift is below the limits of observation.

In a set of experiments involving a very great number of observations, D. C. Miller[1] observed fringe-shifts resembling those predicted by the above formula, which reads, when we insert the numerical values appropriate to Miller's experiments:

$$\delta/w = 0{\cdot}23 \sin 2\theta.$$

The theoretical amplitude is about four times that observed by Miller; but the variation as sin 2θ is like that which Miller found, for the harmonic analysis of his results gave a strongly predominant term with period 180°, and the azimuths giving maximum shift showed a fairly strong preference for the north-easterly quadrant; indeed, his observations of June 1, 1925, give an average azimuth of 42°, to be compared with the value of 45° given by the above formula. A small shift with period 360°, on the existence of which Miller insisted, can be explained by a slight inclination of the arms to the horizontal, which yields terms in sin θ and cos θ, omitted from the above formula for the sake of simplicity.

The positive results obtained by Miller have long remained an anomaly because experiments by Joos[2], Kennedy[3], Illingworth[4] and Michelson (with collaborators)[5] gave essentially null results. I suggest as a possibility that the discrepancy between these results and those of Miller may be found in the mountings of the interferometers. Joos supported his instrument on springs and so insulated it mechanically from the earth; the others used flotation on mercury, as did Miller, but Miller used a substantial pin attached to the interferometer and passing loosely through a bearing. This pin is shown by Miller (Fig. 5, *loc. cit.*, p. 208), and I am much indebted to Prof. R. S. Shankland, of the Case Institute of Technology, for further information obtained from the mechanic who worked with Miller.

Although the pin was far from attaching the interferometer rigidly to the earth, it may have provided sufficient constraint to make the interferometer behave, at least partially, as though it were part of the earth itself, and so give us an excuse for taking the earth's centre as drag-point (the most natural point, surely, if we were dealing with the earth itself as a rigid body).

However that may be, the concept of rigid-body motions is important in physics and an adequate theory of these motions is most desirable. It is true that we have the Born–Herglotz theory; but I have been unable to see how that theory leads to any definite prediction regarding the Michelson–Morley experiment performed on the rotating earth. Now that the special theory of relativity is firmly established, we should look on experiments like the Michelson–Morley experiment as experiments on rigid bodies rather than on light propagation. But as a test of Gardner's hypothesis, an interferometer with horizontal arms is very inefficient. When the arms are tilted up, the theory predicts quite a large effect with period 360° in azimuth. Indeed, with one arm inclined to the vertical at 45° and the other horizontal, Gardner's hypothesis predicts a fringe-shift of a full fringe-width with an arm-length of only 20 cm., provided, of course, that the interferometer is firmly mounted on a vertical axis to ensure that it may be regarded as part of the rotating earth and so have the earth's centre as drag-point.

A fuller account of this work will appear in the issue of the *Scientific Proceedings of the Royal Dublin Society* commemorating the centenary of the birth of George Francis Fitzgerald.

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Solar Outbursts at 8·5-mm. Wave-length

Sudden large increases in solar radio radiation, characterized by a rapid rise in intensity and a slower fall and usually associated with chromospheric flares, have been observed in the last few years by Hey[1] and others at all frequencies at which solar radiation has been measured, except at the highest frequencies. We can now report the measurement of several outbursts at a frequency of 35,000 Mc./s., or 8·5-mm. wave-length.

In the spring of 1951, a radiometer operating at a wave-length of 8·5 mm. was put in operation at the Naval Research Laboratory, Washington, D.C., and adjusted to follow the sun during the daylight hours and record continuously the intensity of the sun's radiation. Previous work at a wave-length of 8·5 mm.[2,3] had shown that the intensity of the sun's radiation at this wave-length was much more constant than at longer wave-lengths. However, the previous work was done with a highly directive beam, so that only a portion of the surface of the sun was observed at one time.

The radiometer used in the present experiment has an antenna of 24-in. aperture and beam-width of 1·1°; hence the sun is seen as a point source. The object of the experiment was to watch for sudden

Solar Outbursts at 8·5-mm. Wave-length

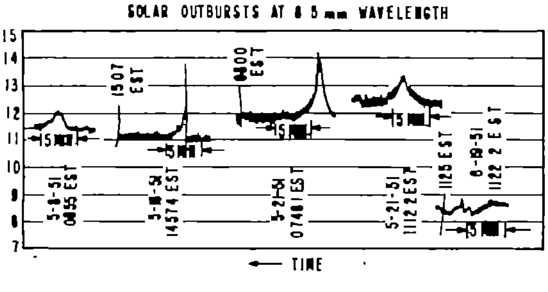
		Outbursts				Flares		Sudden ionic disturbance (S.I.D.)	
Date	λ cm.	Time (U.T.)	Amplitude	Source	Position	Time	Source	Time	Source
8/5/51	0·85 3·14 150	1455 1505 1455	0·055 4·23	N.R.L. N.R.L. Cornell	N. 10° E. 90°	1505–08 1503±2	H.A.O. Mich.	1506–30 1506–30 1510–65	H.A.O. Mich. Mich.
18/5/51	0·85 3·14 65 150 190 600	1957·4 1958·3 2002 1958 1958 1958	0·260 2·50	N.R.L. N.R.L. N.B.S. Cornell N.B.S. N.B.S.	N. 17° W. 35°	1959–2002·5 1956	H.A.O. Mich.	1955–2040 1955–2040 2005	H.A.O. Mich. N.B.S.
21/5/51	0·85 150	1248·1 1247	0·230	N.R.L. Cornell		None		None	
21/5/51	0·85	1612·2	0·075	N.R.L.	N. 14° W. 80°	1610–1700 1609–35	H.A.O. Mich.	1610–30 1610–30	H.A.O. Mich.
19/6/51	0·85 3·14	1622·2 1622·2	0·060 >0·37	N.R.L. N.R.L.	S. 12° W. 18°	1620–28 No obs	H.A.O. Mich.	1622–1700 1625–1700	H.A.O. Mich.

ıanges in the intensity of the radiation and to orrelate these changes with those observed at cm. wave-length in a similar apparatus at this boratory, with changes observed at longer ave-lengths at other institutions, and with visual bservation of solar flares.

During the period May 1–October 1, five bursts f radiation were found with the 8·5-mm. wave-ngth apparatus. The times of occurrence of four f the bursts coincide with observed flares, and at ıe time of the fifth, May 21, 1951, 12h. 48.1m. U.T., ıere was an active region on the west limb of the un. Details are given in the accompanying table, where the 8·5-mm. bursts are shown along with ata on known bursts at other wave-lengths associated with the same occurrence. The position and time of he associated flare and the time of the associated udden ionic disturbance (S.I.D.) are given. We are ndebted to Miss H. Dodson of the University of Iichigan, to the High Altitude Observatory, Cornell Jniversity, and to the National Bureau of Standards or making available data used in this table.

The character of the bursts at 8·5 mm. is illustrated n the accompanying record, which is a tracing of he recording milliammeter in the output of the adiometer. Tracings for five outbursts are shown. Zero is at the level of sky noise. Variations in level rom day to day are due more to changes in the gain of the receiver than to variations in the solar lux. The width of the trace is indicative of the nherent fluctuation level in the instrument. The burst of May 18 had a time of rise comparable with he time constant of the instrument, 1 sec., whereas he burst of May 8 rose to full amplitude in about min. The times of rise of the other bursts fall between these two extremes. The steadiness of he trace is affected by the presence of clouds. This is most clearly shown in the trace of June 19, where the small rise preceding the burst was due o a change in cloud cover. The 8·5-mm. bursts differ from those at longer wave-lengths in two principal respects: the burst is in general of much shorter duration and the amplitude is much smaller. The largest burst yet observed on a wave-length of 8·5 mm. caused an increase in the total solar adiation of only 27 per cent. The duration of the bursts has all been less than 5 min.

Observation of bursts at very short radio wave-engths is of interest since presumably the escaping adiation comes from deeper layers of the sun's atmosphere than it does for the longer wave-lengths[3]. The observation of two types of outbursts, one when the time of onset is nearly the same for different wave-lengths, as in the burst of June 19, and the second when the time of onset occurs at later times for longer wave-lengths, has been reported before by several observers[4-9]. The single observation reported here of simultaneity of occurrence at two wave-engths, 8·5 mm. and 3 cm., is significant in that for this occurrence a transport of material[4-6,8] as the source of burst energy is highly improbable.



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A New Molybdenum Carbide

STUDIES of the products formed by carburizing molybdenum with carbon monoxide have confirmed the existence of Mo$_2$C (β-phase) and MoC (γ-phase), the latter having the tungsten carbide (WC) structure. But in addition to these two phases, a new carbide (called here the γ′-phase) has been found. The X-ray diffraction lines of this new carbide have not been reported by earlier investigators.

When the carburization takes place at low temperatures, the γ′-phase is the first to be formed after the β-phase. If the γ′-phase is kept at sufficiently high temperatures, either in a stream of carbon monoxide or in vacuum, it transforms (fairly rapidly above approximately 800° C.) into the γ-phase. At high temperatures the γ-phase is evidently more stable than the γ′-phase. The γ-phase may also be the more stable of these two phases at low temperatures, although the speed of the transformation $\gamma' \rightarrow \gamma$ is then very low.

The γ′-phase is hexagonal and the unit cell contains 4 molybdenum atoms. In the accompanying table its dimensions are compared with the dimensions obtained (in our carburization experiments) for the β- and γ-phases.

	β, Mo$_2$C	γ′	γ, MoC
a (A.)	3·002	2·932	2·898
c (A.)	4·724	10·97	2·809
c/a	1·574	3·742	0·9 9
Mo per unit cell	2	4	1
Vol. per Mo (A.^{3})	18·44	20·42	20·42

The space-group is $C6/mmc$ and the molybdenum atoms occupy the position $4(f)$ with $x = \frac{1}{8}$. If the three projections of these positions on the basal plane are designated by A, B, and C, the molybdenum lattice can be symbolized by the sequence $AABBAABB$ . . . . In the β-phase (hexagonal close-packed molybdenum lattice) the sequence is $ABAB$ . . . and in the γ-phase it is $AAAA$ . . . . In this respect the molybdenum lattice of the γ′-phase forms an intermediate stage between the β- and γ-phases. However, no indication of a stacking disorder has been found.

The parameter x seems to be very close to $\frac{1}{8}$. This is remarkable, as the distance between layers A and B is then equal to the distance between layers A and A. One would expect the former to be smaller.

No signs of definite positions of the carbon atoms have been found. The composition of the γ′-phase could not be based on analyses as the entirely pure phase was never obtained. A comparison of the lengths of the c axes and the volumes per molybdenum atom of the three phases indicates that the carbon content can scarcely be less than that corresponding to the formula MoC. The fact that the transformation $\gamma' \rightarrow \gamma$ takes place without any other changes in the powder photographs suggests the formula MoC.

A metal lattice similar to that of the γ'-phase has been found by Kiessling[1] for the tungsten boride, W_2B_5. In this case the parameter z is slightly different from $\frac{1}{8}$, namely, 0·139.

A detailed report will be published elsewhere.

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Preparation and Magnetic Susceptibility of an Oxygen Clathrate Compound

DURING attempts to prepare samples of β-quinol by the method of Powell and Riesz[1], we observed that the crystals obtained, which gave X-ray powder photographs characteristic of β-quinol, effervesced when dissolved in water. When 1 gm. of a sample of this substance which had been dried *in vacuo* was dissolved in water, 7·9 c.c. (at N.T.P.) of a gas were evolved. This gas contained 28 per cent oxygen, and the rest appeared to be nitrogen. It therefore seems probable that this is an 'air' clathrate[2] compound of β-quinol in which about 12 per cent of the available spaces are filled.

This suggested that an oxygen clathrate compound might be prepared if oxidation of the quinol could be prevented. A warm saturated solution of quinol in air-free alcohol was placed in a monel metal bomb and allowed to cool slowly over a period of about 24 hr., under a pressure of 25–40 atmospheres of oxygen. Faintly yellow crystals were obtained which, when dissolved in water, evolved a gas. The volume of gas obtained corresponded in different samples to clathrate compounds in which 40–50 per cent of the available spaces had been filled. The densities of the samples were consistent with this interpretation. In one case, the gas was analysed and found to contain 97·6 per cent of oxygen.

The magnetic susceptibility of a finely powdered sample was measured, and it was found to be paramagnetic ($\chi = + 3{\cdot}31 \times 10^{-6}$ at 17° C.). Analysis of the same sample gave 39·0 per cent of the available spaces filled. Assuming the specific susceptibility[3] of quinol to be $- 0{\cdot}604 \times 10^{-6}$, this leads to a value of $\chi = + 109{\cdot}5 \times 10^{-6}$ at 17° C. for the oxygen molecules trapped in the spaces. The experimental values for χ for gaseous oxygen range from 104·5 to $110{\cdot}0 \times 10^{-6}$ at 17° C., the theoretical value[4] being $107{\cdot}7 \times 10^{-6}$. This shows that there is very little magnetic interaction between the oxygen molecules in the crystals. The magnetic behaviour of the oxygen molecules at low temperatures might well prove interesting, since they will not have the opportunity of forming loose complexes O_4 as occurs in liquid and solid oxygen. Since the concentration of oxygen molecules in these samples corresponds to gaseous oxygen at a pressure of about 40 atmospheres, the magnetic properties are easy to observe.

A method of preparing pure β-quinol containing no enclosed gases has now been devised in which a warm strong solution of quinol in air-free alcoho is seeded with a crystal of argon clathrate compound and allowed to cool in a refrigerator. Unless it is kept in a very dry atmosphere, pure β-quinol tends to revert to α-quinol.

A more detailed account of these and other measurements on clathrate compounds will appear elsewhere.

We are grateful to Mr. H. M. Powell for carrying out X-ray measurements on the samples of β-quinol and to Dr. B. Lambert and Mr. A. B. Webster for analysing the gas liberated from the oxygen clathrate compound. We thank the Department of Scientific and Industrial Research for a maintenance grant to one of us (D. F. E.).

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Stabilization of Free Radicals: its Importance in Reaction Kinetics

A PREVIOUS paper[1] reported on a reaction of the radical chlorine oxide:

$$ClO + O_2 \rightleftharpoons ClO_3 \rightleftharpoons \tfrac{1}{2}\, Cl_2O_6,$$

enabling the transfer of chlorine oxide by means of addition of oxygen into the more stable chlorine trioxide and eventually, at a low temperature, into the stable chlorine hexoxide (Cl_2O_6). Similarly, the discussion[2] of the mechanism of the decomposition of ozone sensitized or catalysed by chlorine points to the fact that chlorine dioxide can also be considered as a chlorine atom stabilized by an oxygen molecule. The process $Cl + O_2 = ClO_2$ is exothermic to an extent of 1·5 kcal., and runs down practically without activation energy[3]. On examining the other cases in which the oxygen atom or molecule behaves in a similar manner, the cases of HO_2, NO and NO_2 radicals are striking. HO_2 and NO_2 are hydrogen and nitrogen atoms stabilized by an oxygen molecule, whereas NO is a stabilized complex from $N\cdot$ and $O\cdot$ and can also be transformed by addition of O_2 into NO_3.

In the mechanisms of organic pyrolyses and oxidation reactions, $R\cdot$ and $R\cdot C\cdot$ radicals are also frequently encountered, forming in the presence of oxygen $RO_2\cdot$ or $RCO_3\cdot$, or, in other cases, only with atomic oxygen $RO\cdot$ or $RCO\cdot$ respectively. In the reaction schemes they are considered to be rate-determining, fairly stable, intermediate products[4]. In their halogenated forms, these radicals behave in a similar fashion. They are characterized by all having unpaired electrons and being paramagnetic. On the other hand, radicals having even numbers of electrons do not exhibit analogous behaviour in any instance. Taking numerous other examples into account, the following rule can be established.

The paramagnetic radicals containing unpaired electrons combine with the similarly paramagnetic oxygen atoms as well as with oxygen molecules, or more generally with other paramagnetic molecules, such as nitric oxide, into more or less strongly bonded mplex radicals, thus prolonging the life of the dical.

Obviously the extent of stabilization will be a nction of the heat liberated at stabilization. The ight activation energy as well as the small heat of action results in a reversible stabilization. On the her hand, if more energy is released on association, e stabilized radical participates more sluggishly in e further process; consequently, stabilization rresponds to the slowing down of the reaction. If e energy liberated at stabilization is very great, the abilized radical may even exist as a fairly stable mpound. Nitric oxide and nitrogen dioxide can be nsidered to represent such examples.

Considering that the fate of a radical is either the ropagation of the chain by reacting with another w molecule or its destruction, stabilization can fluence the rate of reaction in different ways. If it reserves radicals which otherwise are disappearing uickly, thus saving them for the subsequent steps the process, then the stabilization increases the tal rate of the reaction.

On the other hand, stabilization of a radical may celerate the recombination of the radicals, by lowing the reaction:

$$R{\cdot}X + R = R_2 + X,$$

hich simplifies the original three-body collision to a molecular process. If this recombination removes e chain carriers from the process, it is natural that abilization should result in the diminution of the locity of the total reaction.

The variation of the rate of reaction by nitric oxide ovides a suitable illustration of reaction kinetics sed on these statements. Nitric oxide is paraagnetic and exerts—as proved by the analyses of ses hitherto investigated—an influence only on the te of chain reactions proceeding by paramagnetic dicals. This influence can be two-fold. If nitric ide is present only in small amounts, it is not able stabilize all the chain carriers having odd numbers electrons, and hence there is a greater possibility r association to occur:

$$R{\cdot}\mathrm{NO} + R = R_2 + \mathrm{NO};$$

is is equivalent to the rupture of the chain and so creases the velocity.

If, on the other hand, the concentration of nitric de is greater, it diverts the chain carriers from s association, thus resulting in a positive catalytic tion. In the sequence of reactions:

$+ R + M = R_2 + M$ (rupture of the chain)
$+ A = R' + A'$ (propagation of the chain)
$\mathrm{NO} + R{\cdot}\mathrm{NO} = R_2 + 2\mathrm{NO}$ (rupture of the chain)
$\mathrm{NO}+A=R'+A'+\mathrm{NO}$ (propagation of the chain)
$\mathrm{NO} + R = R_2 + \mathrm{NO}$ (rupture of the chain),

e activation energies of the processes diminish cording to the sequence of the equations. Conseently, a large quantity of nitric oxide preserves e chain carriers from the destruction effected other ways.

The role of nitric oxide in promoting association comes also manifest at the recombination of the drogen atoms[3]. It can be demonstrated experintally that the recombination of hydrogen atoms the presence of nitrogen oxide is far more rapid an in the case of any other three-body collision rtners. By intense cooling the product $(\mathrm{HNO})_n$ be frozen out from the reaction mixture.

In the case of stabilization not being reversible, complex radical decomposing into other constituents can only effect a decrease of the rate of reaction.

The stabilization of the free radicals is pre-eminently a catalytic process, since it modifies the reaction-rate by means of an intervening substance. We have restricted the possibility of stabilization of the free radicals to paramagnetic ones. Of course, as a consequence of the prolongation of the life of these substances possessing the greatest reactivity, the extent of the reaction increases. This requires the presence of other paramagnetic substances.

From this concept, the rule[1] is not only confined to homogeneous processes, but also may involve heterogeneous ones. The catalysing effect of paramagnetic substances lies in prolonging the life of the most reactive paramagnetic radicals. If a process takes place via free radicals containing even numbers of electrons, the paramagnetic catalysts do not exert any appreciable effect, and conversely a non-paramagnetic catalyst does not influence considerably the rate of a reaction proceeding by paramagnetic radicals. Accordingly, the extent of the surface alone cannot determine the activity of a catalyst. The number of the paramagnetic molecules on the surface is an essential factor. The most effective catalysts are mixed catalysts, in which smaller or larger groups of components have only the role of a supporter promoting the development of the virtual catalyst, the paramagnetic substance, and maintaining its activity.

These facts point to the significance of the magnetic properties of substances in chemical processes, and thus to the role of magnetochemistry in reaction kinetics.

A detailed discussion of this work will be published in English in *Acta Chimica Hungarica*.

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Formation Constants of some Metal-Tropolone Complexes

THE formation constants of several metal derivatives of tropolone have been determined in order to compare the co-ordination tendency of tropolone with that of other co-ordinating groups. The order of stability of the various metal derivatives is $\mathrm{Cu^{II}} > \mathrm{Be} > \mathrm{Pb} > (\mathrm{Zn}, \mathrm{Ni}) > \mathrm{Co^{II}}$. In general, this order agrees with that found for the co-ordination compounds of ammonia[1], ethylenediamine[1,2], salicylaldehyde[1–4], salicylaldehyde-5-sulphonic acid[5], β-diketones[4,6,7], 8-hydroxyquinoline[4], 8-hydroxyquinoline-5-sulphonic acid[8], and α-amino-acids[8,9]. The metal-tropolone compounds are more stable than the corresponding acetylacetone compounds, which may be further evidence of the greater stability of five-membered chelate rings compared to six-membered rings.

Tropolone was synthesized in the manner described by Cook *et al.*[10] (found: m.p., 48–50°; $pK_D = 6{\cdot}97 \pm 0{\cdot}02$ at 30°; reported m.p., 49–50°; $pK_D = 7{\cdot}00 \pm 0{\cdot}2$ at 20°).

Formation constants were determined by the potentiometric method of Bjerrum[11] as modified by Calvin and Wilson[12]. Because of the slight solubility of these complexes in water, all titrations were carried out in a solvent containing 50 per cent dioxane by volume. Determination of the pK_D of tropolone in this medium at an ionic strength approximately equal to that existing in these solutions at the midpoint of the neutralization of excess tropolone yielded a value of 7·92. It was found that the pK_D was very sensitive to slight changes in ionic strength, so for each determination pK_D was taken directly from the titration curve and this value used in the calculation of the formation constants.

Of the six metals discussed here, it was found that three (zinc, nickel and divalent cobalt) were able to co-ordinate with three molecules of tropolone to form a singly charged anion, MCh_3^-, while the other three (divalent copper, beryllium and divalent lead) combine with only two molecules of the tropolone to form neutral species, MCh_2. This behaviour was noted earlier for hinokitiol, β-*iso*propyltropolone[13–15].

The constants were calculated from concentration data, assuming all activity coefficients to be unity.

Metal	log K_1	log K_2	log K_3
Cu(II)		7 83	
Be	8 31	6 93	
Pb(II)	7·88	5 92	
Zn	7·48	6 29	3·44
Ni	7·61	6 03	3 88
Co(II)	7·04	5·71	3·68

Co-ordination with copper was so strong that log K_1 could not be determined.

The low solubilities of the complexes of several of the trivalent metals have introduced difficulties in the determination of their formation constants. Although the formation of complexes has been demonstrated with calcium, strontium and divalent mercury, additional work is necessary to obtain accurate data.

Formation curves for the complexes are shown in Figs. 1 and 2.

Crystalline material was obtained in several instances by partial evaporation of the solutions after titration. The cobalt derivative was a lustrous, reddish violet, and the zinc solution yielded light yellow octahedra. The copper compound was found to decompose at *c.* 300°, whereas the other two compounds were unaffected at temperatures up to 275°.

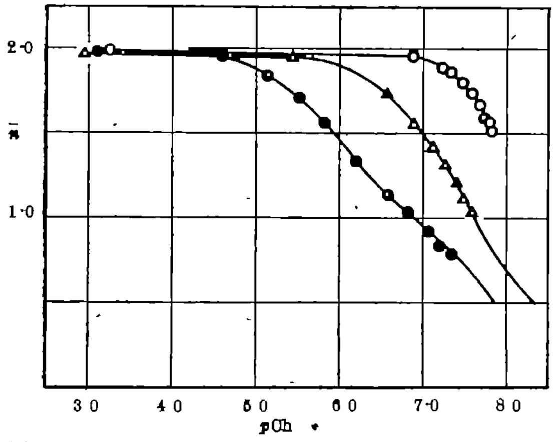

Fig. 1. Formation curves for complexes with copper (○), beryllium (△) and lead (●)

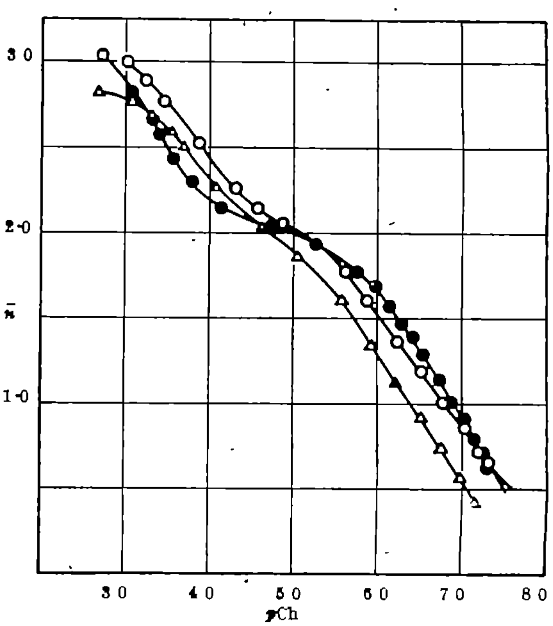

Fig. 2. Formation curves for complexes with zinc (●), nickel (○), and cobalt (△)

This work was carried out under Contra At(30–1)–907 with the Atomic Energy Commissio

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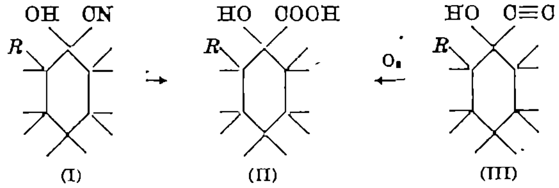
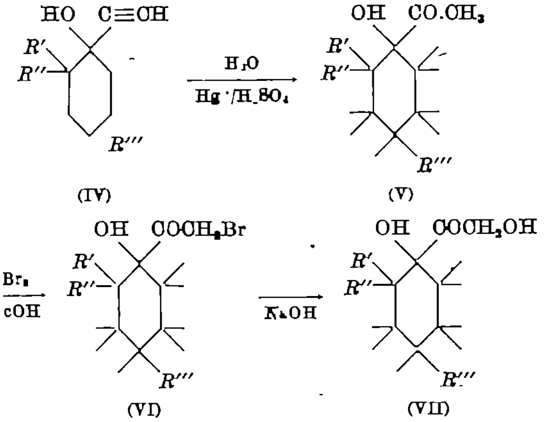
Simple Analogues of Cortisone

IN continuation of previous work from t Department[1], some methyl-substituted analogues 1-hydroxyacetyl*cyclo*hexanol have now been p pared. The previous method employed an α-hydro acid (II, R=H) obtained from its cyanohyd (I, R = H). 2-Methyl*cyclo*hexanone cyanohyd



(I) (II) (III)

uld not be hydrolysed to the corresponding acid I, R=CH$_3$), and although this acid was obtained r the oxidation of the corresponding 2-methyl-1-hynylcyclohexanol (III, R=CH$_3$), the low yields ndered the product unsuitable as a starting material. ence, for further work the method was modified as llows:



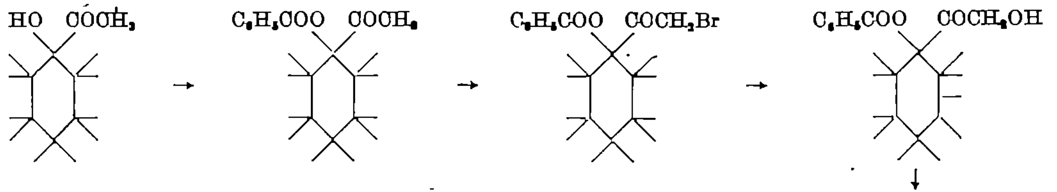
(IV) (V)

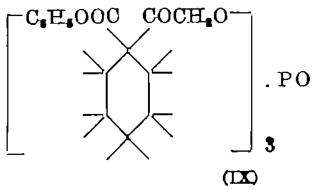
(VI) (VII)

Methylcyclohexanone with sodium acetylide in quid ammonia furnished excellent yields of the s/trans-2-methyl-1-ethynylcyclohexanols[2], which ere roughly separated into the cis- (m.p. 58°,) per cent) and the trans- (b.p. 76°/15 mm., 1·4689, 60 per cent) forms by crystallization. oth forms were hydrated with dilute sulphuric id in the presence of a mercury salt, and the tones so obtained (V, R'=CH$_3$, R''=R'''=H) mpletely purified at this stage through their semirbazones (cis-2-methyl-1-acetylcyclohexanol, m.p. ° ; semicarbazone, m.p. 229–230° ; trans-2-methyl-acetylcyclohexanol, b.p. 92°/10 mm., n_D^{18} 1·4635; micarbazone, m.p. 218–219°). Bromination of the spective ketones yielded cis-2-methyl-1-bromoetylcyclohexanol (VI, R'=CH$_3$; R''=R'''=H, .p. 68–69° ; pyridinium quaternary salt, m.p. 8–190°) and trans-2-methyl-1-bromoacetylcyclo-xanol (b.p. 70°/10^{-4} mm., pyridinium salt, m.p. 2–203°).

The corresponding cis-2-methyl-1-hydroxyacetyl-clohexanol (VII, R'=CH$_3$; R''=R'''=H, m.p. –80°) and the trans-2-methyl-1-hydroxyacetylcyclo-xanol (viscous liquid; semicarbazone, m.p. 199–1°, and thiosemicarbazone, m.p. 210° (dec.)) were tained by hydrolysis of the cis- and trans-bromides.

4-Methylcyclohexanone gave 4-methyl-1-ethynyl-clohexanol (m.p. 20°, evidently a cis- and trans-ixture from which only very small yields of one re form, m.p. 36°, could be separated). On dration, the mixture yielded a ketone (V, R'= ''=H ; R'''=CH$_3$, b.p. 99–100°/10 mm.; semi-rbazone, m.p. 181–182°). Bromination and hydrosis further yielded 4-methyl-1-bromoacetylcyclo-xanol (VI, R'=R''=H ; R'''=CH$_3$, b.p. 125°/0·004 m.) and 4-methyl-1-hydroxyacetylcyclohexanol (VII, R'=R''=H ; R'''=CH$_3$, m.p. 80–81°). Similar reactions on 2 : 2 dimethylcyclohexanone furnished only very small yields of 2 : 2 dimethyl-1-hydroxyacetylcyclohexanol (VII, R'=R''=CH$_3$, R'''=H, m.p. 56°).





(IX)

The present method of introducing the dihydroxyacetone chain into simple compounds allows any desired acylation on the primary and tertiary alcohol functions without resorting to selective acylation, and, as a model, a phosphate of the type (IX) has been prepared (1-acetylcyclohexyl benzoate, b.p. 124·5°/10^{-4} mm., 2 : 4 dinitro-phenylhydrazone, m.p. 200° ; 1-hydroxyacetylcyclohexylbenzoate, m.p. 76° ; phosphate (IX), m.p. 80–81°).

Further details of preparations and biological tests will be published elsewhere.

I am indebted to Prof. N. F. Maclagan for suggesting this work and for advice and encouragement throughout it. I am also indebted to the Empire Rheumatism Council and the Standring Research Fund, Westminster Hospital, for financial assistance.

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Paper Chromatography of Phenolic Substances

SEVERAL recent publications have attested to the utility of the technique of paper partition chromatography in the separation and identification of phenolic substances. Bate-Smith[1] described its application to anthocyanins, flavones and other polyphenolic substances using a butanol – acetic acid – water system and ammoniacal silver nitrate as a detecting reagent. Evans, Parr and Evans[2] used butanol – pyridine – aqueous sodium chloride and diazotized sulphanilic acid (Pauly reagent) to separate and detect simple phenols and their derived phenolic acids. Gosta Lindstedt[3], applying the technique to the separation and identification of nine phenolic constituents of pine heartwood extracts, found that best results were obtained with a water-saturated mixture of benzene and ligroin containing traces of methanol. *Bis*-diazotized benzidine was used as the detecting reagent. A phosphomolybdic acid detecting reagent was used by Riley[4] in applying the technique to

Concentration, 14 mgm./c.c., resolved in 3 hr

common phenols in benzene – alcohol – water systems. In studying lignin degradation products, Hossfeld[5] first coupled the phenol mixtures with diazotized sulphanilic acid and then separated the sodium salts of the dyes formed using a methyl ketone – water system.

In work at the Vancouver Forest Products Laboratory on phenolic extracts of conifer heartwood and phenolic compounds related to lignin, the best results have been obtained using carbonic acid solution alone as a developing solvent, and a fine spray of an aqueous mixture of ferric chloride and potassium ferricyanide as detecting reagent. The latter, easily prepared by mixing equal volumes of one per cent ferric chloride and one per cent potassium ferricyanide a few minutes prior to use, gives an instantaneous deep blue spot similar to Turnbull's blue with all phenols thus far tested. A permanent record is secured by washing the paper with dilute hydrochloric acid followed by water.

The formation of a blue spot by ferric chloride and potassium ferricyanide in the presence of phenols may possibly be explained by the formation of a 1 : 1 complex of ferric ion and phenol, as suggested by Broumand and Smith[6], which then gives the ferrous reaction (Turnbull's blue).

The single-phase carbonic acid developing solvent, prepared by bubbling carbon dioxide through distilled water at 21° C. until a pH of 4 2 is reached, gives rapid development (38 cm. in four hours) an good resolution with most phenols.

This simple, but very useful, combination of de veloping solvent and detecting reagent has been use successfully in this laboratory during the past tw years. Results of its application to simple pheno run individually in descending chromatogram o Whatman No. 1 paper at 22° C. are given in th accompanying table. In each case well-define circular spots were detected.

DISTANCE TRAVELLED BY SOME SIMPLE PHENOLS IN FOUR HOU

Substance	Distance (cm.)
α-Naphthol	17 0
β-Naphthol	15·2
Pyrogallol	24 8
Catechol	28 1
Resorcinol	26 0
Phloroglucinol	20·7
Hydroquinone	27·0
Gallic acid	23 6
Vanillin	24·6
Syringaldehyde	20 8

Application to phenols and complex polyphenolic from heartwood extracts is illustrated in the photograph, the chromatograms being, from left to right those of the acetone extract of mountain hemloc (*Tsuga mertensiana*), western hemlock (*Tsuga heter phylla*), western red cedar (*Thuja plicata*), and Dougla fir (*Pseudotsuga taxifolia*), respectively. The usefulne of this technique in family and species identificatio is indicated clearly. The strong spot at R_F 0·26 f the Douglas fir was readily shown by colour tes and comparison with a reference sample to be du to the 3, 3^1, 4^1, 5, 7 pentahydroxy flavanone isolate by Pew[7].

Details of the work on extracts of conifer hear wood will be published elsewhere.

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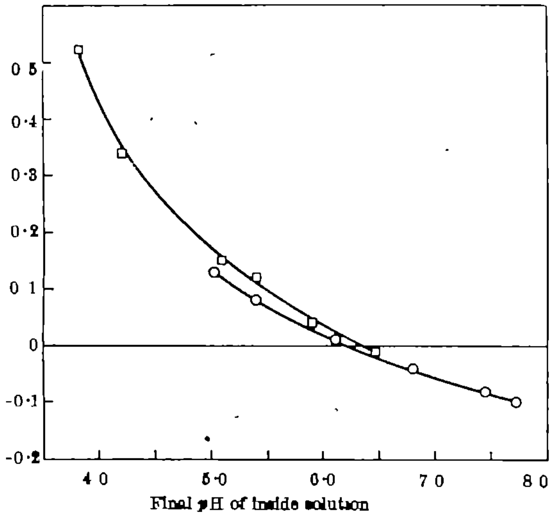
Isoelectric Point of Chymotrypsinogen by a Donnan Equilibrium Method

Kunitz and Northrop[1] found the isoelectric poin of crystalline chymotrypsinogen to be near pH 5 b their method of microcataphoresis[2]. Recentl Anderson and Alberty[3] and Laskowski[4], using electr phoretic mobilities, gave values of pH 9·5 and 9· respectively. As it is now possible to crystalliz chymotrypsinogen salt free from aqueous alcohol it was thought worth while to attempt to determin the isoelectric point of such a preparation by method based on the Donnan equilibrium.



, 8 per cent chymotrypsinogen solution, acetate buffer, 0 004 *M* ; , 9 per cent chymotrypsinogen solution, phosphate buffer, 0 005 *M*

;hymotrypsinogen was prepared by the method of nitz and Northrop[1] and crystallized six times from ıte aqueous alcohol[5]. A 10 per cent solution of protein in water was prepared with the aid of a drops of 1 *N* hydrochloric acid; the final *p*H 3·6. The liquid, which was slightly turbid, was rified by centrifugation at 5° C. Sodium hydroxide, , was added gradually and samples of 4·0 or 4·5 c.c. re withdrawn from time to time and mixed with or 0·5 c.c., respectively, of the appropriate fer of the same *p*H. Lengths of sausage casing, n. diameter (Nu Jax Visking cellulose sausage ing, Visking Corp., Chicago), previously washed l each containing a small glass bead, were filled h this solution to such a length that they fitted ıveniently into a test-tube. This was filled with same buffer suitably diluted, so that the con- trations of buffer salts were identical on both es of the membrane. The initial *p*H of the inner l the outer solutions differed by less than 0·02 *p*H ts. The test-tube was then closed with a rubber pper, leaving a small air-bubble to provide stirring the outer solution. Several of these tubes were tened along the radii of a slowly revolving vertical k and were thus kept stirred for 24 hr. at 5° C. unopened tubes were allowed to warm to room nperature for 20 min. The *p*H of the outer solution s measured first, followed immediately by measurent of the inner solution.

'he graph of the final *p*H of the inner solution inst the difference in *p*H between the solutions the two sides of the membrane is reproduced ewith; the point of zero difference, which is the electric point, is seen to lie at *p*H 6·3. It is interest- to note that the monovalent acetate buffer and polyvalent phosphate gave almost identical values the isoelectric point. A similar experiment with onal–acetate buffer, 0·004 *M*, gave less clear ults, but indicated an isoelectric point between 6 and 7.

This method has the advantage that it can be ried out very simply with a minimum of equipnt, provided that the protein is readily available l is stable under the conditions employed. It none of the disadvantages of the other methods rently in use, except the possibility of combination between protein and the buffer salts; this can, however, be investigated by using diverse types of buffers.

The microcataphoresis[4] of collodion particles coated with chymotrypsinogen gave indications that the protein concentration affects the value of the isoelectric point, higher values being obtained in stronger concentrations. For example, the above preparation of chymotrypsinogen gave a value of *p*H 7·2–7·4 when the concentrations were as high as 0·4–0·8 per cent, $\mu = 0 \cdot 0058$. The state of purity and the previous history of the protein appear also to have an important influence on the result.

I am indebted to Dr. M. Kunitz for his guidance and help and for permission to work in his laboratory. The experiments were carried out during the tenure of a Rockefeller Foundation Fellowship.

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Basic Chromosome Numbers in the Genus *Cerastium*

AN investigation of mitotic chromosomes of *Cerastium semidecandrum* L. (British material) has revealed that, of the 36 metaphase chromosomes, four are nucleolar-organizing chromosomes. These each have a satellite. The nucleoli fuse early in telophase since the resting nuclei have only one, two or, more rarely, three nucleoli, though once a cell with four nucleoli was seen. It would thus seem that these $2n = 36$ plants are tetraploid, although no plant with $2n = 18$ has, as yet, been reported, and that nine is finally established as the basic number. From chromosome counts most species in the genus have nine as the basic number; however, there is a group of species, all annuals, which have the chromosome number $2n = 38$. In these plants the nucleolar-organizing chromosomes cannot be distinguished in somatic tissues; but in the pollen-mother cells there are two nucleolar-organizing chromosomes clearly visible during prophase. These two chromosomes each have a distinct deeply staining region in contact with the nucleolus, such as McClintock[1] described in *Zea mays*. It would thus seem that in this section of the genus the plants are truly diploid with 19 as the basic number. A list of species for which chromosome counts are available is given below, with the species grouped according to their basic numbers. Unless otherwise stated the material is continental; undated counts are published here for the first time.

From these lists it is apparent that the majority of the species in the section Orthodon have the basic number 9, while those in the section Strephodon have the basic number 19. A few species, for example, *C. dichotomum*, normally placed in the section Orthodon, would appear from cytological evidence to have a closer relationship with the

$x = 9$

Species	2n	Author
C. *alpinum* L.	72	Bocher, 1938; A and D. Love, 1944; Sorensen and Westergaard, 1948; Brett 1950 (Britain).
	108	Sorensen and Westergaard, 1948 (Greenland); Brett, 1950
	c. 144	Brett, 1951
C. *arvense* L.	72	Rohweder, 1939; Mattick, 1949; Sollner, 1950, Brett, 1951 (Britain)
	36	Sollner, 1950; Brett (Canada)
	38	Brett, 1950
C. *banaticum* (Roch) Heuff	72	Sollner, 1950
C. *brachypetalum* Pers.	c. 52	Mattick, 1949
	90	Hagerup, 1944; Brett (Britain)
C. *cerastoides* Britton	36	Mattick, 1949
	38	Favarger and Sollner, 1949
	40	Bocher, 1938; Sorensen and Westergaard, 1948
C. *candidissimum* Correns	36	Rohweder, 1939
C. *fontanum* Baumg.	c. 120	Mattick, 1949
	c. 144	Bocher, 1938
C. *glomeratum* Thuill.	72	Rohweder, 1939; Brett, 1951 (Britain)
C. *glutinosum* Fries.	72	Hagerup, 1944
C. *holosteoides* Fries. (C. *vulgatum* L.)	c. 111	Heitz, 1926
	126	Hagerup, 1944
	136	Brett, 1950 (Britain)
	144	Rohweder, 1939, Mattick, 1944
	136–152	Brett (Britain)
C. *latifolium* L.	36	Mattick, 1949; Favarger and Sollner, 1949
C. *pedunculatum* Gaud.	36	Favarger and Sollner, 1949
C. *regelii* Ostf.	72	Flovik, 1940
C. *semidecandrum* L.	36	Rohweder, 1939; Brett (Britain)
C. *tetrandrum* Curt.	36	Wulff, 1937; Rohweder. 1939
	72	Brett (Britain)
C *subtetrandrum* (Lange) Murb.	72	Hagerup, 1941
C. *tomentosum* L.	38	Rohweder, 1939
	72	Brett, 1951
C. *uniflorum* Clairv.	36	Mattick, 1949; Favarger and Sollner, 1949

$x = 19$

Species	2n	Author
C. *anomalum* Waldst. and Kit.	38	Favarger and Sollner, 1949, Brett
C. *chloraefolium* Fisch. and Mey	38	Rohweder, 1939; Sollner, 1950; Brett
C. *dahuricum* Fisch.	38	Sollner, 1950; Brett
C. *dichotomum* L.	38	Brett, 1951
C. *maximum*	38	Brett (Alaska)
C. *perfoliatum* L.	38	Brett, 1950; Sollner, 1950

Strephodon species *C. perfoliatum*. It would also appear, as Söllner[2] has already suggested, that the Dichodon species *C. anomalum* is related to *C. perfoliatum* and, in my opinion, to *C. dichotomum* also. Further investigation it is hoped will result in a more natural classification than that formulated by Seringe and published originally by de Candolle[3].

Other counts in these lists call for comment. Three species, *C. cerastoides*, *C. arvense* and *C. tomentosum*, appear to have both basic numbers. The morphological and geographical evidence would suggest that they belong to the $x = 9$ group and possibly, therefore, the 38 and 40 chromosome members are aneuploids, $4x + 2$ and $4x + 4$.

The species *C. holosteoides* (*C. vulgatum*) is peculiar in that its chromosome number is not constant even for the offspring of the same plant after selfing. This species is a very high polyploid, probably 16-ploid, and it would seem that, at this degree of ploidy, loss or gain of a few chromosomes at meiosis has little if any effect upon the viability and fertility of the seed. The range of chromosome numbers given as 136–152 is probably wider than this, as approximate counts have been made which indicated even lower and higher numbers. Many multivalents are found at first metaphase, and it is thought that different numbers pass to the poles at first anaphase. Lagging chromosomes, though found, are by no means the
rule, and usually all the chromosomes are includ
in one of the four nuclei at the end of meiosis.

The question of the origin of these two bas
numbers remains. It is possible that their origi
are quite distinct; but, alternatively, it could
that as a result of hybridization the plants wi
38 chromosomes have the activity of all but two
their nucleolar-organizing chromosomes suppresse
the situation being similar to that discovered
Nevashin[4] in *Crepis*.

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Colonization of Plant Debris by *Coprinus* Species in Soils

ISOLATION of members of the group Basidiomycete
as compared with other soil fungi, directly from s
by either the soil dilution plate[1] or the root buri
technique[2] has met with little success, though bett
results have been obtained by the soil plate techniqu
Hitherto, studies on their distribution were most
confined to the recording of fructifications (whi
may be of seasonal occurrence) in Nature[4]. Howeve
in the course of investigations in this laboratory
survival of *Macrophomina phaseoli* by the root buri
technique in Madras garden soil amended wi
ammonia at different concentrations (2, 5 and 10 p
cent), it was observed that a Basidiomycete regular
colonized and produced fructifications on pieces
cotton root when plated on agar media (potat
dextrose and Horne and Mitters's media). The incub
tion period needed in the soil for this colonizati
was only two weeks. The control pieces of root buried
untreated soil failed to yield the fungus. This wo
was extended to cotton-growing soils, namel
Coimbatore, Udamalpet and Kovilpatti soils (Madr
State). In all cases similar fructifications we
observed only in the soils treated with ammonia. T
Basidiomycete was also found to colonize and produ
its fructifications on pieces of root soaked in 50 p
cent ammonia solution for one hour and incubat
for one week in the above-mentioned soils. T
fungus has been identified as a species of *Coprin*

I am indebted to the Director, Royal Bota
Gardens, Kew, for the identification of the Basid
mycete, and to Prof. T. S. Sadasivan, for help a
guidance during this investigation. My thanks
due to the Government of India for the award o
Junior Research Scholarship.

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Botanical Laboratory,
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Feb. 19.

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Filarial Infections in Mosquitoes

Mosquitoes which on dissection show infective ırial forms are often regarded as vectors of human ıriasis in a particular area where mosquito coltions are made. As mosquitoes of the same species ıy also play the part of vectors of animal filarial ections, findings in any given area have to be erpreted carefully. A short account of conditions rtaining in a small village in Sakhigopal, Orissa State, dia, where *Wuchereria bancrofti* is the known cause filarial infection in man, is given below.

Of 3,307 *Culex fatigans* and 1,928 *Mansonioides nulifera* dissected locally, 55 of the former and 41 of ə latter were found with infective larval forms in ə head/proboscis. In addition, some *M. annulifera* owed microfilariæ or their developing forms in the alphigian tubes. In view of the fact that *M. nulifera* are not suitable for transmission of *W. ncrofti* and that *Wuchereria* develop in thoracic ıscles[1], the possibility of filariæ of other origins ısting in the same area was explored. Infective rvæ dissected out from *C. fatigans* were longer than ose noted in *M. annulifera*. The former had more an one caudal protuberance, indicating that they ɪre probably *Wuchereria*.

Precipitin tests of blood-meals of mosquitoes ɪre carried out to determine the sources of blood. ıey showed a higher predilection of *C. fatigans* for ıman blood than *M. annulifera*, which fed mainly domestic animals and birds.

Four out of forty dogs examined were found sitive for microfilariæ, morphologically similar to *rofilaria repens*.

Separate batches of clean *C. fatigans* and *M. nulifera* were allowed to feed on dogs showing *repens* infection, and on human cases with *W. ncrofti*. Results showed that a high percentage *M. annulifera* became infective with *D. repens* but ɪre refractory to infections with *W. bancrofti*. On e other hand, *C. fatigans* showed high susceptibility infections with *W. bancrofti* and definite refractoriss to development of *D. repens* in them. These ints serve to bring out the importance of correct sis of infective forms of filarial infections in uitoes.

annulifera has been incriminated as a vector *D. repens*.

N. G. S. Raghavan
B. G. Misra
Radhagovinda Roy

Malaria Institute of India,
Delhi. Feb. 14.

---

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bnormal Leaves of *Cycas revoluta* Thunb.

During the course of an investigation on the position of xylem in the rachises of cycads, I me across a peculiar abnormality in *Cycas revoluta* ıunb. In some female specimens, several leaves essed a subsidiary rachis which bore subsidiary nnæ in a spiral fashion. This was noted in several ccessive whorls.

Each subsidiary rachis appeared to originate by a nspicuous fold of the main rachis. It was filled ainly by parenchyma. The sides were composed of a nified epidermis and one to two layers of thickılled hypodermal cells. The epidermis was heavily tinized, but was interrupted by sunken stomata of the normal type. There was a layer of palisade tissue immediately below the epidermis at several places; but its disposition was not uniform (Fig. 1). The vascular bundle was mesarch and included in the inner margin of the rachis. The subsidiary rachis was observed only in the distal half of the leaf, and did not exceed 7 cm. in length.

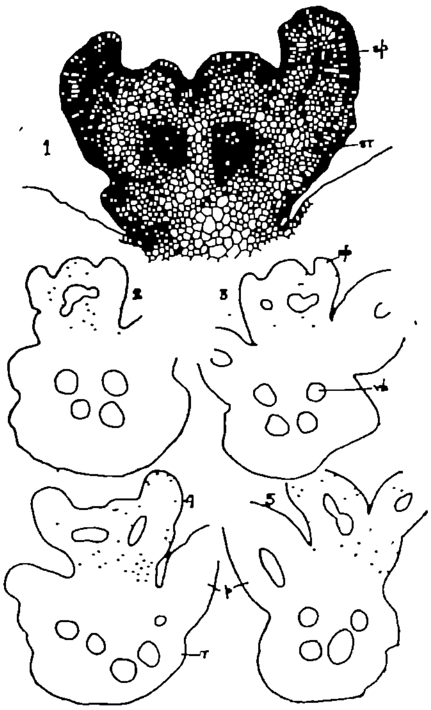

Fig. 1. A part of the transverse section of rachis showing the vascular bundle of subsidiary rachis in division. (× 44)

Figs. 2–5. Changes in the outline of the rachis during the emergence of subsidiary pinnæ. (× 12)

p, Normal pinnæ; *r*, principal rachis; *sp*, subsidiary pinnæ; *sr*, subsidiary rachis; *vb*, vascular bundles

The subsidiary leaflets were formed by lateral elongation of the rachis and the constriction of the newly formed parts. Each leaflet had the normal structure; but the vascular tissue was very scanty. The transfusion tissue was formed by gradual thickening and elongation, from a mass of loose cells in the rachis which appeared while the leaflet primordium was yet being formed. The vascular bundle of the subsidiary pinna was diffuse at the origin but gradually assumed concentric and then mesarch structure[1].

In an examination of the successive stages of the origin of the subsidiary pinnæ (Figs. 2–5), it was found that the subsidiary rachis lost its identity as the pinnæ matured. The normal structure of the principal rachis was regained by a gradual suppression of the subsidiary rachis and disappearance of its vascular bundle.

Such a feature is unknown in other cycads and has not been reported hitherto as a normal occurrence in *Cycas*.

I am grateful to Prof. Shri Ranjan for his encouragement, and to Mr. G. P. Agarwal and Mr. B. B. S. Raizada for help in the preparation of sections.

Ramesh Kumar Srivastava

Botanical Laboratories,
University of Allahabad.
Feb. 10.

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APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Biochemist (fully qualified with training and experience in hospital laboratories)—The Superintendent, Hope Hospital, Salford 6 (August 16)

Assistant in Mathematics—The Secretary, The University, Edinburgh (August 21).

Assistant in the Department of Geography—The Secretary, The University, Edinburgh (August 23).

Assistant Professor in the Physics and Electrical Engineering Department—The Director of Studies, Royal Naval College, Greenwich, London, S.E.10 (August 23).

Chemist (with honours degree in chemistry or A.R.I.C. and post-graduate analytical and research experience) at the Central Laboratory at County Hall—The Medical Officer of Health (PH/D.1), London County Council, County Hall, London, S.E.1 (August 23).

Lecturer in Physiology and Pharmacology in the School of Pharmacy—The Principal, Technical College, Dundee (August 23).

Research Demonstrator in Zoology—The Registrar, The University, Sheffield (August 23).

Senior Lecturer in Metallurgy (with a wide knowledge of the metallurgical industry, with detailed knowledge of at least one branch of importance locally) in the Department of Applied Science, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Educational Committee, Education Offices, North Street, Wolverhampton (August 23).

Head of the Department of Science (comprising chemistry, physics, biology, mathematics)—The Principal, College for Further Education, Wellington Road South, Stockport (August 27).

Plant Physiologist (with a good honours degree in botany, with special reference to plant physiology, and preferably some post-graduate experience) under the Colonial Development Welfare Cocoa Research Scheme, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (August 29).

Soil Chemists and Soil Surveyors (with a good honours degree in chemistry (or geology for soil surveyors) and, preferably, some postgraduate experience) under Colonial Development and Welfare Research Schemes for Soils and for Cocoa, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (August 29).

Assistant in the Department of Animal Husbandry and Preventive Medicine in the University Veterinary School—The Assistant Secretary of University Court, The University, Glasgow (August 30).

Assistant Lecturer in Geology (with special qualifications in petrology)—The Registrar, The University, Sheffield (August 30).

Assistant Lecturer or **Lecturer in the Department of Electric Power Engineering**—The Registrar, The University, Liverpool (August 30).

Operational Research Posts in the Field Investigation Group of the Directorate of Scientific Control—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/511 (August 30).

Research Officer (with an honours degree in zoology or agricultural science, or equivalent, with first-hand experience in the conduct of field ecological investigations on either mammals or birds) **in the Wildlife Survey Section** of the Commonwealth Scientific and Industrial Research Organization, either at headquarters at Canberra or at the field station at Albury, N.S.W., to undertake field ecological studies of mammals and birds of economic importance—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3925 (August 30).

Teacher of Chemistry, and a **Teacher of Physics**, to undertake part-time teaching of intermediate standard—The Registrar, Nottingham and District Technical College, Shakespeare Street, Nottingham (August 31).

Examiners in Chemistry and Physics, Biology (Botany and Zoology), **Physiology** (including Biochemistry) **of the Domesticated Animals, Histology and Embryology, Animal Management, Anatomy of the Domesticated Animals, Pharmacology, Materia Medica and Pharmacy, Veterinary Hygiene, Dietetics and Animal Husbandry, Veterinary Pathology, Veterinary Parasitology, Veterinary Medicine, Veterinary Surgery**—The Registrar, Royal College of Veterinary Surgeons, 9–10 Red Lion Square, London, W.C.1 (September 1).

Principal Scientific Officer (with a first- or second-class honours degree in engineering, mathematics or physics, or equivalent qualifications) at the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, to lead a small team on work initially concerned mainly with the general field of stress analysis, both analytical and experimental, and later including vibration and photo-elasticity—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4159/52 (September 4).

Research Officer—Physical Chemist (with University honours degree in physics or chemistry, or equivalent qualification) **in the Division of Food Preservation and Transport** at the University of Sydney, for studies in the physical chemistry of proteins—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3932 (September 6).

Lecturer in Physics at University College, Dundee—The Secretary, The University, St. Andrews (September 8).

University Graduate (with first- or second-class honours in botany, with qualifications in mycology) **in the Microbiological Section** of the Department of Soil Organic Matter—The Secretary, Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen (September 12).

Experimental Officers at the Atomic Energy Research Establishment, Harwell, for mechanical engineering experimental and developmental work—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.209/52A (September 13).

Lecturer or **Assistant Lecturer in Biochemistry**—The Registrar, The University, Sheffield (September 13).

University Lecturer in Philosophy of Science—Mr. L. Harvey, The Old Schools, Cambridge (Septe[illegible]r 14)

Lecturer, Grade II (graduate in pure [illegible]pplied science or equivalent, with bacteriology as a ma[illegible]bject) **in Patholog** at the University of Queensland—Th[illegible]retary, Association Universities of the British Commonwea[illegible], Gordon Square, Londo W.C.1 (September 15).

Principal Scientific Officer and a **Senior Scientific Offic** at a Ministry of Supply Experimental Flying Establishment ne Salisbury: **Principal Scientific Officer** (engineer or physic with mathematical ability, or an applied mathematician with practical outlook) to cont[illegible] staff engaged mainly in research a development of flight testing methods and techniques: **Senio** **Scientific Officer** (engineer, physicist or applied mathematici with some experience in aeronautical research) to undertake theoretic and analytical work on the development of helicopter testing tec niques and general research on helicopter flight problems—The Civ Service Commission, Scientific Branch, Trinidad House, Old Burlingt Street, London, W.1, quoting S.4160/52 (September 25).

Senior Lecturer in General Chemistry at the University Melbourne—The Secretary, Association of Universities of the Britis Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

Assistant (Grade A or B according to qualifications and experienc **in the Mathematics Department**—The Principal, Derby Technic College, Normanton Road, Derby.

Assistant Lecturer in Natural Philosophy—The Secretar Royal Technical College, Glasgow.

Assistant Lecturer, Grade B (with a University degree) to tea botany and zoology at intermediate standard and physiology an anatomy for ophthalmic optics—The Principal, West Ham Colle of Technology, Romford Road, London, E.15.

Biochemist (with an appropriate science degree or the A.R.I.C **in the Department of Pathology**—The Group Secretary, Roy Infirmary, Bolton.

Chemists (Principal Scientific Officer or Senior Scientific Offic grade) at Ministry of Supply London headquarters: duties includ the initiation and progressing of research and development on textil for Service purposes—The Ministry of Labour and National Servic Technical and Scientific Register (K), Almack House, 26 King Stree London, S.W.1, quoting F.533/52A.

Chemists and **Chemical Engineers** (Senior Scientific Officer grad at Ministry of Supply London headquarters for work concerned wit guided weapons: (*a*) to sponsor the development and exploitation new materials, structures, and technical development for engineerin processes (Ref. F.519/52A); (*b*) to assess the relative performance different propellants and warheads under service conditions and t progress and assist development work on them (Ref. F.520/52A)—The Ministry of Labour and National Service, Technical and Scientifi Register (K), Almack House, 26 King Street, London, S.W.1, quotin the appropriate Ref. No.

Electrical Engineers and **Physicists** (with a first- or second class honours degree or equivalent in electrical engineering or physic (Scientific Officer grade) at the Royal Aircraft Establishment, Farn borough—The Ministry of Labour and National Service, Technic and Scientific Register (K), Almack House, 26 King Street, Londo S.W.1, quoting D.302/52A.

Junior Analyst (with good experience in metallurgical analytic work)—The Secretary, British Welding Research Association, 29 Par Crescent, London, W.1.

Mycologist (with rank of Assistant Professor) **in the Botan Department**—The Chairman, Department of Botany, McGill Univer sity, Montreal 2, Canada (apply by airmail).

Research Engineer (B.Sc. or equivalent, and some engineerin workshop and drawing office experience essential) for design and testin of experimental equipment—The Assistant Secretary (Ref. A.19, British Coal Utilisation Research Association, Randalls Road, L[illegible]therhead, Surrey.

Scientific Officer (with a first- or second-class honours deg[illegible] chemistry, physics or chemical engineering) at the Food Investiga[illegible] new Humber Laboratory, Hull, to carry out research in physica[illegible] physico-chemical problems on the preservation of fish by smo[illegible] drying, etc.—The Ministry of Labour and National Service, Tech[illegible] and Scientific Register (K), Almack House, 26 King Street, Lon[illegible] S.W.1, quoting F.303/52A.

Senior Physicist (with experience in medical physics) for Radi therapy Service of the Southampton area—The Secretary, Southampto Group Hospital Management Committee, Bullar Street, Southampton.

Senior Services Engineer in the Division of Atomic Energ (Production), Capenhurst, Chester, to be directly responsible to th Chief Factory Engineer for all the engineering services (electrical, civil mechanical) and the associated workshops required in the operatio and maintenance of a large chemical engineering factory—Th Ministry of Supply, Division of Atomic Energy (Production), Risley Warrington, Lancs, quoting Ref. 358.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Department of Scientific and Industrial Research and Fire Office Committee. Fire Research Special Report No. 1: The Heating Panels by Flue Pipes. By D. I. Lawson, L. L. Fox and C. T. Webste Pp. vi+41+4 plates. (London: H.M. Stationery Office, 1952 2s. 6d. net. [12

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JOINT CONSULTATION IN MANAGEMENT

WHEN the Committee on Industrial Productivity, appointed in December 1947, formed its Panel on the Human Factors affecting Industrial Productivity, under the chairmanship of Sir George Schuster, one of the first subjects to which the Panel turned its attention was current managerial practice. The soundness of this decision has been confirmed by the experience and reports of the productivity teams which have since been sent by the Anglo-American Council on Productivity to study American practice in various industries. Two of the outstanding lessons to be learned from the experience of these teams are the extent to which efficient management sets the pace of productivity and the importance of dealing with those engaged in industry as human beings whether at the level of the operative, the foreman, the technologist or the manager.

Two extensive surveys in this field were planned by the Panel and were undertaken under its sponsorship by the National Institute of Industrial Psychology : one was into the status, selection and training of foremen and the second was into methods of joint consultation. Both inquiries were designed to present a picture of current practice in the whole range of industry and to relate the nature and the effectiveness of the methods in use to the size, location, internal structure and history of the firms approached. A report on the first project has already been published. That on the second, which occupied three years, during which 189 factories were visited and information received from many others, has now appeared*, appropriately enough when the Acton Society Trust has issued a corresponding but slighter study of joint consultation in the nationalized industries, which were excluded from the inquiry initiated by the Panel on Human Factors†.

The report seeks to elucidate the factors associated with successful joint consultation, and after defining the scope of the inquiry, the purposes of joint consultation and the criteria of success, analyses, in successive sections, psychological conditions and their effect, the bearing of technical and economic factors, the organization and finally the achievements of joint consultation. In the last two chapters of the book joint consultation is discussed first from the point of view of the worker in broad terms and then from that of the manager, both as leader and as employer. There is also a foreword by Sir George Schuster.

It is by no means clear to whom the book is addressed, and probably something much more concise would have been surer of reaching the average factory executive, trade union official or works council representative, particularly if the details were made accessible to those sufficiently interested. Much of the material or evidence here presented is indeed of general interest ; but the task of exposition seems scarcely to have been attempted and is perhaps the more important because the conclusions drawn from this study are so slender. There can, in fact, be no one best form of structure and procedure for joint consultation. An appropriate system for a particular company must take into account the circumstances of that company—the material conditions, its organization, and the relationships and prevailing attitudes of the people at all levels within it. Those concerned with setting up a new organization or system will undoubtedly find that this report will amply repay a careful study.

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* Joint Consultation in British Industry. A Report of an Inquiry undertaken by the National Institute of Industrial Psychology sponsored by the Human Factors Panel of the Committee on Industrial Productivity. Pp. 276. (London : Staples Press, Ltd., 1952.) 21s. net.

† The Framework of Joint Consultation. By J. H. Smith and Miss R. J. Carey. (Nationalized Industry Series, 10.) Pp. iii+35. (Claygate : Acton Society Trust, 1952.) 2s.

"Any system of joint consultation, however, cannot long remain static and effective: it must develop to meet the changing needs of the organization or its usefulness will decline and it will gradually decay." To preserve vitality involves a task of mutual understanding and of education on both sides, and it is here that something more is required in the way of exposition or interpretation than we are given here. As a technique of management the scope of joint consultation is limited, and unless those limitations are clearly and generally understood there is the danger that unfounded expectations may lead to disappointment and further distrust instead of to confidence and harmony.

As a philosophy of management, joint consultation has wider possibilities; but here again there is much educational work to be done before it is fully understood and accepted with all its implications as the development of a democratic principle. Adoption of the consultative relationship as the basis for day-to day conduct of the affairs of an organization is likely to foster the growth of understanding and realization of a common purpose between people whose interests may appear to them to be opposed; but there are examples enough given in this book to show how much has yet to be done to remove misconceptions and misunderstandings. Sir George Schuster, in his foreword, indeed suggests that while some important firms are making great advances, British industry as a whole is still only tinkering with the subject. Joint consultative methods, he urges, are a means to an end—the making of each industrial unit a harmonious, live, co-operating community, working together with a sense of common purpose which is understood and accepted by all its members. That ultimate aim is kept in view in this book, and if it does not go quite so far as is desirable in the task of exposition and interpretation, at least it provides a large amount of material from actual experience on such matters as the form of committees, the methods of selecting representatives, the difficulties of 'reporting back' the problems of relations with the trade unions and the like with which others could complete that task.

The Acton Society Trust paper brings out quite as well the need for a clear understanding of what is meant by joint consultation and advisory functions; but the position in the nationalized industries as given in this pamphlet differs considerably from that given by the study initiated by Sir George Schuster's Panel. All the industries nationalized since the War have been placed under a statutory obligation to set up machinery for joint consultation as well as for the negotiation of wages and conditions for employees. Primarily the Acton Society Trust sought to compare the varying organization established in the different industries, to inquire as to its effectiveness in practice and to consider the extent to which the size of the industries had created special problems for the working of consultation. In practice, the inquiry could not be limited to structure because defects in working arose from many varied causes.

In spite, however, of the differences, this study of nationalized industry corroborates much of the evidence given in the fuller inquiry of the Panel on Human Factors affecting Industrial Productivity. Indeed, the very factors which, in the nationalized industries, have been responsible for the difficulties in the way of joint consultation that have hindered its development on the lines expected and have even led to its impairing instead of improving relations, arise out of neglect of the conditions for successful joint consultation stressed by the inquiry into industry in general. The unions' insistence on uniformity of treatment in the nationalized industries and their desire to apply decisions over the largest possible area, the apprehensions of management, and the over-riding tendency of management and the trade unions to treat consultation as a method of exerting power, rather than as a method of exchanging views (with all the complications and untoward consequences of these attitudes and tendencies), are at bottom due to a complete misconception of the nature of joint consultation which the contrast drawn in these industries between joint consultation and negotiation tends to accentuate.

Until that misconception is removed, the realities of the situation will not be faced and there is little hope of real progress. The report prepared by the Panel on Human Factors is a real contribution to the task of education required, and, although the data it presents are drawn from outside the nationalized industries, they are as relevant to the problems of those industries as to the problems of industry elsewhere. It is to be hoped that the report will be carefully studied by all sections of nationalized industry, and that its findings and evidence will be further interpreted and expounded in a form likely to reach those who may never read the present report.

The Acton Society Trust does not present its study of the existing structure in the nationalized industries without some positive suggestions. Five general conditions are postulated for the organization of successful joint consultation: the structure must be comprehensible to those who use it; it must be laid down in an agreement between management and the unions; it should be subject to review and amendment; it should be developed in response to local demand; and it should include adequate arrangements for reporting back the proceedings of committees to those represented. Beyond this it suggests that the structure should also be related in some way to the manner in which employees are organized into working groups. The fourth and fifth conditions are those where the position is least satisfactory, and like the itative sixth condition they demand much more ention and examination in the light of a concep- n of consultation as a continuous relationship ween groups of people which requires expression appropriate forms.

In this study, however, the main emphasis is on task of education. The most serious omission in present arrangements in the nationalized indus- es, it is urged, is the general failure to provide any chinery for passing information about the work of committees to the men they represent. As in the dy initiated for the Committee on Industrial oductivity, emphasis is laid on the need for skilled dership in the development of harmoniously work- group or committee; but the main challenge of th these inquiries is to the task of education. esh constructive thinking about joint consultation th as a technique and as a philosophy of manage- nt is needed; but the most urgent need is to secure widespread and clear understanding of what joint nsultation really is, its limitations and its possi- ities. For that task the report in particular supplies ich useful material, but the Acton Society Trust per is equally designed to stimulate the interpreta- n and exposition on which must be based an ucational campaign as it desiderates.

BOTANY FOR THE DEGREE STUDENT

xtbook of Theoretical Botany

Dr. R. C. McLean and Dr. W. R. Ivimey-Cook. l. 1. Pp. xv+1069. (London, New York and ronto: Longmans, Green and Co., Ltd., 1951.) s. net.

"THE attempt to write a textbook of Botany is an audacity which admits of no excuse but suc- ss." Few would disagree with this prefatory mark in the first volume of the new text-book of eoretical botany; all will admire the audacity, even excuses are not sought, and may, indeed, ask if it not audacity for a reviewer to attempt to criticize er so wide a field.

The authors have made no attempt at specialist eatment, but have tried to bridge the gap between e specialist books and those designed for first-year udy. Realizing that the complete work will be both stly and bulky, they have sought to arrange their xt so that it will serve for a beginner as well as for more mature general botanical student. The aim, oreover, is to place factual material in the hands the student and thus to free his teachers from the ed to use their precious lecture time for presenting aterial of this sort.

It is on this basis, therefore, that the first volume the new text-book must be judged, and the first sentials are that it shall be accurate, and lucid ough not to mislead. Mistakes could scarcely be oided in a work of this magnitude; but fundamental rors, or vague and misleading statements, are not be expected. It is on this count that the work falls ort of perfection. A few examples may be given, ough others might have been selected: p. 30, in e metaphase of meiosis, "the homologous pairs of romosomes unite, then come on to the equatorial plane and separate, so that one whole chromosome of each pair goes to one pole and one to the other"; p. 31, reference is made to the heterotypic and homotypic divisions; and p. 32, Fig. 16 illustrates "formation of chiasmata in unsplit homologous chromosomes".

In an account of the algæ, which, the algologist might perhaps complain, have been afforded less generous treatment than the fungi, matters are little better: the definition of heterogamy on p. 51 is difficult to harmonize with that on p. 59; and on p. 104 the life-cycle diagram of *Cladophora* includes reference to an antheridium and an oogonium and to an antherozoid and an oosphere, while in that of *Dictyota* (p. 127) the implication that oogonia and antheridia occur on the same plant is, at best, misleading.

Equally unhappy are statements in other sections of the book: Fig. 697 is not likely to convince even the less sceptical students that there is much difference in the pitting of the araucarian tracheid and that of other conifers; the terms alburnum and duramen (p. 897) and autumn wood (p. 903) are surely a little out of date; does hæmatoxylin oxidize to logwood (p. 898)?; the account of tension and compression wood (pp. 904–7), if correct, is not remarkable for its lucidity, while the statement that, in trees grown in an equatorial climate, growth (of the wood) is continuous, is not as cautious as one might wish.

The book contains more than a thousand illustrations, and the authors are to be congratulated on the large number which are new. Many are from original photographs; but with some, and not a few, the reader may well not feel inclined to agree that the "naturalistic quality of photographs needs no emphasis": if examples are desired, reference may be made to Fig. 30, of *Chlamydomonas*, Fig. 88 of a *Gunnera* rhizome with *Nostoc* colonies, Fig. 269 of yeast, while it is doubtful if Fig. 857 would be recognized as collenchyma. The plain fact would seem to be that a good drawing is often greatly to be preferred to a photograph, and some of these illustrations appear to furnish ample confirmation of this contention.

FRANK W. JANE

ENZYMES

The Enzymes

Chemistry and Mechanism of Action. Edited by James B. Sumner and Karl Myrbäck. Vol. 1, Part 1; pp. xvii+724; 13.50 dollars. Vol. 1, Part 2; pp. x+725–1361; 12.80 dollars. Vol. 2, Part 1; pp. xi+790; 14.80 dollars. Vol. 2, Part 2; pp. xi+791–1440; 14 dollars. (New York: Academic Press, Inc., 1950–52.)

THE publishers of these four books, two parts to each of two volumes, have printed at the front and top of the jacket the words "A new encyclopædic work". The stunned reviewer might be forgiven for doing no more than feebly murmur "Agreed, agreed"; but to do so might suggest discourtesy to editors, authors, publishers and potential readers. Despite the obvious fact, therefore, that such a treatise can scarcely more easily be reviewed than it could have been written by one person, an attempt should at least be made to indicate the scope of the work, of which the first part was published no less recently than December 1950. During the subsequent eighteen months the three remaining parts have brought the total number of pages to 2801. The two parts of each volume have been paginated continuously but separately: at the end of Vol. 1 (1362 pp.) are an author index (49 pp.) and subject index (46 pp.); the corresponding figures for Vol. 2 (1440 pp.) are 53 and 49 pp. At the foot of each page of index to Vol. 2 is repeated a statement to show on which pages Part 1 of the volume ends and Part 2 begins; unfortunately, no such convenient reminders appear in the index to Vol. 1.

In Great Britain, where divers systems of giving references pertain, scientific readers are developing an almost pathological interest in the method adopted by particular authors or editors. For their information it should be stated that in these four volumes references are indicated by serial superscript numbers, the full bibliographical details appearing at the bottom of the page of first mention. This has made necessary a procedure that is a little puzzling at first, for we find as a note to the author index of Vol. 1 the words "The numbers in parentheses are footnotes". This is explained by clearer and more extensive phraseology in a footnote to the corresponding index of Vol. 2, where it is made apparent to the probably baffled users of Vol. 1 that the bracketed numbers are, in fact, the serial reference numbers to papers mentioned on a particular page but given full descriptions on an earlier page. In this matter also, therefore, the editors have in Vol. 2 made good a defect of Vol. 1. With the textual superscripts, the description at the bottom of the individual pages and the two complete author indexes, details of a paper by a particular author can be found at a reasonable speed and one that on the average varies inversely as the author's fecundity. The same paper may, naturally, appear under two separate reference numbers in two chapters, but not in the same one.

There are altogether seventy-eight different names given in the lists of authors at the beginning of the four parts. Their national distribution is, in itself, of some interest: United States, 48; Great Britain, 9; Sweden, 8; Finland, 3; Germany, France and Denmark, 2 each; Turkey, Australia, Switzerland and Belgium, 1 each. There happen also to be just seventy-eight chapters to the combined two volumes; but this is pure coincidence, for sixty-three chapters have single names at their heads (in several instances the same names appear over at least two chapters), eleven are the result of dual authorship, and four come from a treble collaboration.

At the risk of appearing invidious by selecting particular authors for individual mention, it seems nevertheless legitimate to record those of the British contributors, Dr. E. P. Abraham (penicillinase), Dr. N. J. Berridge (milk coagulation), Prof. F. J. W. Roughton and Dr. A. M. Clark (carbonic anhydrase), Prof. Frank Dickens (anaerobic glycolysis, respiration, and the Pasteur effect), Dr. S. R. Elsden (bacterial fermentation), Prof. H. A. Krebs (oxidation of amino-acids; urea synthesis), Prof. J. R. Marrack (enzymes and immunology), Dr. E. A. Moelwyn-Hughes (physical chemistry and chemical kinetics of enzymes). These authors and their subjects are, incidentally, random samples of both, for the net of the editors has been cast so wide as to make nationality a variable independent of subject—in both senses of the word. They therefore convey a fair notion of the breadth and depth of the editors' plans and achievements; this is substantiated when we find such further names as those of Holman and Bergström (lipoxidase or unsaturated-fat oxidase Bernheim (enzymes in detoxication), Philip Cohe (transaminases; enzymatic synthesis of glutamine peptide bond synthesis), Fromageot (sulphatases desulphinase; desulphhydrases; oxidation of organ sulphur), Greenberg (arginase), R. S. Harris (th aminase), Kalckar (dephosphorylation of adenosir polyphosphates), Massart (enzyme inhibition), th late Otto Meyerhof (enolase; aldolase and isomerase Michaelis (theory of oxidation-reduction), Ocho (fumarase and aconitase; enzymatic mechanisms carbon dioxide fixation), Seegers (blood coagulation Theorell (flavin-containing enzymes; the iro containing enzymes, catalases and peroxidase "hydroperoxidases"), Umbreit (hydrogenase an hydrogenylase), Virtanen with J. Erkama (aspartas and N. Rantanen (nitrogen assimilation).

This additional, almost random, selection chapters, written by authors whose original contrib tions to the subject are known all over the world, give a further idea of the ground the editors set out t cover. They themselves contribute a foreword an the opening chapter, simply entitled "Introduction" in it they cover such various topics as definition terminology, classification, history, the chemical an general properties of enzymes and the determinatio of their activity. The anatomy of this chapte naturally differs from that of the others; but thes also show no common pattern, each author or grou of authors having—wisely, I think—been left t devise the most appropriate subdivision of subjec matter.

To the topics already enumerated above, others particular interest may be mentioned, namely, enzym specificity (Helferich), acetylcholine hydrolysis an synthesis and choline esterases and acetylas (Augustinsson), the α-D- and the β-glucosidase (Gottschalk and Veibel, respectively), pectic enzyme (Kertesz), proteolytic enzymes (E. L. Smith), pho phorylases (Hassid, Dondoroff and Barker), th fundamental physical chemistry of phosphate bond (Kaplan), the cytochromes (K.-G. Paul), luminescenc phenomena (Harvey), photosynthesis (Loomis), tumo enzymology (Greenstein and Meister) and—the las chapter of Vol. 2, Part 2—enzyme technolog (Langlykke, Smythe and Perlman). Here also w find evidence of wide scope and authoritativ treatment.

The most casual dipping into these pages, edited b Dr. J. B. Sumner (of Cornell University) and Dr. Ka Myrbäck (of the University of Stockholm), indicat what more intensive reading confirms—the extr ordinary thoroughness with which the field named i the book's sub-title has been surveyed. Despite th intensity of investigation still maintained in th field, showing no signs of abatement and involvi the publication of much new knowledge since eve the latest in date of the book's content went to pres this work must remain for many years what certainly is to-day—a cornucopia of informatic about every aspect of enzyme chemistry and actio an invaluable saver of time and energy in search through the literature, a potent stimulus to th research worker himself and an immense credit all concerned in its inception, production and pu lication. The total cost of the two volumes in fou parts is of the order of £20, and this might see formidable even to the wealthier specialists. In fac it works out at rather less than 2*d*. a page, whic perhaps puts a different complexion on the matte

A. L. BACHARACH

LUMINESCENCE OF SOLIDS

n Introduction to Luminescence of Solids

y Humboldt W. Leverenz. Pp. xv+569. (New ork: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 96s. net.

PHOSPHORS are now manufactured by hundreds of tons a year, the amount having increased n-fold with the development of fluorescent lighting. elevision and radar use quantities of the order of wenty tons a year of more exacting phosphors, and here are other uses for X-ray screens, self-luminous adioactive paints, and luminous plastics and tapes or a variety of purposes. With the increasing availability in reproducible forms, since they are difficult o make on the small scale, ingenious devices employing them are likely to increase in the future.

There are two ways of developing a theory of hosphors. One that has been very popular is to egin from the ideas used for explaining the properties f semi-conductors, which lead to generalized concepts such as 'activator centres', 'electron traps', excitons', 'phonons', etc. This method treats the rystal as a whole and is helpful in attempts to nderstand how energy can pass from the nonluminescent bulk to particular centres from which mission occurs. The other method is to emphasize the essentially atomic or molecular nature of the luminescence as shown by uranyl salts or aromatic ydrocarbons, for example, the fluorescence of which carcely changes from solid to solution, and to focus ttention more on the nature of the emitter as a hemical particle than as something irregular in the deal lattice of an 'impurity-activated' phosphor.

In early work the identification of the emitters was bscured by the fact that incredibly small amounts f impurities sometimes exerted a dominating effect; n this book Dr. H. W. Leverenz here defines ideal uminescence purity' as 99·9999 per cent and spectroscopic purity' as 99·999 per cent. There are ow signs, however, that the fashion is changing, as n other fields, with a swing away from communal lectronic physical theories to individualistic chemical nterpretations, where considerations of atomic olume and variable valency are significant.

The book is the fruit of twenty years of experience n the preparation of phosphors of all types. The uthor is an outstanding authority, well conversant with every side of physics and chemistry related to he subject, cautious, accurate and systematic. He tates, "During the alchemical infancy and haphazard rowth of the phosphor art, the resultant desultory nd greatly dispersed literature on luminescence of olids has become cluttered with confused terminologies, incorrect data, and baneful misconceptions. As an antidote this book seeks to be objective, to provide a rational terminology, and to furnish a ritical guide to the literature". In seeking for ccuracy of definitions and statement, the author has llowed his style to become somewhat ponderous. He first builds up a massive apparatus of physical heory, only to show in the end to what little quantitative purpose it can be put. After advanced considerations of energy-levels in imperfect crystals, he dismisses the simpler concept of potential energy urves as "artistically stimulating; some may incorporate verity, but they have yet to achieve practical ignificance". Finally, after all the elaborations of physical theory, he states: "At present, in the bsence of a satisfactory compilation of phosphors nd phosphor properties, it is usually necessary to enlist the aid of a phosphor expert *with broad experience* in order to assure obtention of the best available phosphor for a particular purpose".

This is an extremely valuable book for all workers on luminescence, containing matter, not obtainable elsewhere, on every aspect of theory, methods of phosphor manufacture, different types of phosphor and their detailed uses, modes of excitation, decay characteristics, etc., with a multitude of precise definitions and physical data. Although entitled an "Introduction" and therefore expressing only a fraction of the author's own knowledge and experience, it is, in fact, a very extensive and detailed account which will absorb the full attention of one coming newly to the subject. E. J. Bowen

WORLD POPULATION AND FOOD

Geography of Hunger

By Josué de Castro. Pp. 288. (London: Victor Gollancz, Ltd., 1952.) 18s. net.

OF the three historic checks on population growth —war, famine and pestilence—the last-named is being dramatically curtailed by modern techniques. The ensuing population increase is both sudden and immense, and it is presenting the world with one of the biggest problems it has ever had to face, that of providing food (and other necessities) for this rapidly increasing multitude.

The author of this book believes firmly that enough food could be produced and that only the will is lacking. He cites examples from all parts of the world to show that malnutrition and frank hunger are widespread even now; but he lays the blame for this squarely at the door of Western European civilization with its domination over the 'backward areas'. Much of his criticism is valid; but the exploitation of man by man is by no means the only factor which limits the world's food supply, and no one should read this book without also reading Vogt's "Road to Survival" and Cook's "Human Fertility".

The author dismisses as "alarmist" those who press the need for a voluntary control of population increase to replace the harsh, natural checks; but he has the grace to remind his readers that "the United States of America, using fertilizers on a scale without precedent in the history of agriculture, has already exhausted 100 million acres of land in less than two centuries of cultivation".

There can be little doubt but that many apparently successful measures merely postpone the day of reckoning while adding to the bill to be paid, and it is unfortunate that this book has been published at a time when its author is chairman of the executive of the Food and Agriculture Organization, as this gives it an air of quite unwarranted authority. (It is not, of course, in any way an official publication.) The evidence presented has been collected by means of "a widespread correspondence" and "talks with strategically placed personalities" and, inevitably, not all of it rings true. Few countries are fully documented with regard to their vital statistics, food production, economic resources, etc., and many of the figures which the author uses are, at best, no more than informed guesses; they provide a very insecure base for the rather fantastic edifice he builds upon them; but the general reader may not realize this, and false beliefs and false hopes will be engendered.

The early chapters are spoilt by a florid style of writing, of which two examples will suffice. About vitamin D, it is said that, "the sun . . . pours forth this vitamin like a divine manna from the cornucopia of the heavens", and scurvy is described as "one of the more vivid of human miseries, gaudy with blood from the hæmorrhages of its victims, the strange bruised appearance of their purple skins and the ghastly stench of their rotting gums".

The issues dealt with in this book are, as Lord Boyd-Orr says, "of the first magnitude". They are urgent and immense, and they call for care and wisdom from both men of science and politicians, if they are to be solved. The emotional approach of this book does little to help. M. W. Grant

ON GROWING OLD

Commentary on Age

By Kenneth Walker. Pp. 192. (London: Jonathan Cape, Ltd., 1952.) 12*s*. 6*d*. net.

Dr. Kenneth Walker is a distinguished surgeon; his book is part philosophy, part science and part common sense. The philosophy is philosophical in the good old-fashioned sense: it is a reflexion on the conduct of life, in one of its epochs, and the dispositions that must be made to meet its enemies, with special reference to the last enemy of all. Dr. Walker writes simply, and sometimes movingly, of the rewards and sadnesses of growing old, and skilfully dissects the inevitable disabilities of ageing from those which, arising from unpreparedness, are the punishment for an earlier spiritual improvidence. He has not much new to say, it is true, and the title of his book makes no such claim for it; but wide reading and a genial eclecticism make what is true seem manifestly true, and to do that is the chief business of the commentator. What Dr. Walker says of our ageing population and the provision that must be made for the elderly is all good sense, and with such reasonable and even-tempered advocacy it may not be too long before opinion becomes policy, and policy becomes practice.

The reader must be warned, however, that the part of the book that purports to be scientific scarcely deserves to be so described. Ominous minor errors such as the mis-spellings of the names of Ebeling, McCay and Korenchevsky, the confusion of Bogomolets *père* with *fils* and of Jacques with Leo Loeb make it all too clear that Dr. Walker is not too familiar with his original sources. It is not simply a matter of minor misconceptions, such as the suggestion that elephants may live for two hundred years, or the mayfly for but a few hours, or of the uncritical acceptance of the importance of senile dehydration, the sexual rejuvenation of *Paramecium*, or the beguiling metaphor of 'physiological time'. It is mainly that the entire treatment is in a multitude of ways inexpert and unanalytic; there is no real grasp of the problem of measuring senescence, of the importance of studying the expectation of life of wild animals in the wild, or of the degree to which the senile state is one which only domesticated animals are spared to display. More serious still, one gets the feeling that Dr. Walker is inclined to equate the analysis of the scientific problem of ageing with *ad hoc* researches into the prolongation of life.

This is harsh criticism, which may be more than half countered by the retort that the book is not addressed to a professional audience and that, except in one respect, the man of science is not likely to use it as a work of reference. The exception is Dr. Walker's appraisal of the clinical value of testicular grafting, as it had been practised by Voronoff to revive the flagging energies of the elderly. He finds that even homoio-transplants of human testes are rapidly absorbed, and is highly sceptical of Voronoff's claim to have succeeded with heterografts of testes from chimpanzees. This is useful evidence on a subject on which Dr. Walker writes with personal authority. P. B. Medawar

A FAUNA OF FARM ANIMALS

A World Dictionary of Breeds, Types and Varieties of Livestock

By I. L. Mason. (Commonwealth Bureau of Animal Breeding and Genetics, Technical Communication No. 8.) Pp. 272. (Farnham Royal: Commonwealth Agricultural Bureaux, 1951.) 30*s*.

Although complete lists and descriptions of wild animals, birds and even insects exist, no world list of the different breeds, types and varieties of farm animals has been available. The first part of this book attempts to supply this.

As mentioned in the introduction, this list requires supplementing with maps and illustrations of the breeds, and it is hoped that these may be forthcoming at a later date. It is comparatively easy to find details for improved breeds which have a herdbook; but there are a large number of native breeds in Asia and Africa about which knowledge is sadly lacking. This is required if production in the backward areas of the world is to be improved. As the title indicates, the book is a dictionary to be consulted and not one to be read; references are given, however, to papers which contain descriptions of the breed in question. The second part of the book, which gives livestock numbers and breeds by countries, together with references to publications concerning the breeds of these countries, should prove most useful to those who require a bird's-eye view of the livestock production of any area. For the temperate zones and the more highly developed areas of the world, a very good picture is presented; but, through no fault of the author, the information given for the tropical zones of the world is lamentably small, consisting of, in many cases, a catalogue of breeds only. Possibly steps already taken by the United Nations Food and Agriculture Organization to collect information for those areas may soon bring our knowledge of domestic animals on a par with our knowledge about wild species. New breeds with improved production qualities suitable for tropical areas, such as the Santa Gertrudis cattle (3/8 zebu, 5/8 shorthorn), are now being formed, and may before long drive many of the primitive breeds to extinction, as has occurred with improved breeds in Great Britain. Before this is done, these primitive breeds require study for qualities suiting them to their habitat, so that some of them at any rate may be preserved and the valuable genes they contain retained for use in the future.

The species dealt with are the horse, ass, cattle, buffalo, sheep, goat and pig. The first part gives some four thousand entries, listing the various names which have been used, and for each breed mentioned it recommends an English name. Some information about breed characters, origin and relationship to other breeds is given. John Hammond

ENGINEERING, BIOPHYSICS AND PHYSICS AT KING'S COLLEGE, LONDON

NEW BUILDING

THE new physics and engineering laboratories at King's College, University of London, were pened formally by Lord Cherwell on June 27. These iboratories have been built in the only place availble, below ground, in the space previously occupied y vaults which had been broken open by bombs uring the Second World War. The proximity of omerset House prevents any part of the building rom projecting above ground-level, and the height f the water-table determined by the neighbouring 'hames limits extension downwards. Between these vels a two-story building has been constructed, the resence of which would scarcely be suspected by nyone who, entering King's College from the Strand, rives or walks over the asphalt surface of the quadangle which forms the roof of the building. However, he laboratories are extensive and, being decorated nside in bright colours and lit by fluorescent lighting nd by a surprisingly large amount of daylight enterng from large windows on one side, suffer relatively ttle from their subterranean condition.

Both physics and engineering at King's College re distinguished by the antiquity of their foundation. 'he first professor of natural and experimental hilosophy was appointed in 1831. Charles Wheattone was made professor of experimental philosophy 1 1834 and developed the celebrated Wheatstone ridge. The College can claim to be the oldest cademic institution in England to teach experiental physics, as the Clarendon Laboratory at xford and the Cavendish at Cambridge were ounded respectively in 1868 and 1871. Later, Clerk axwell was a professor, and the high traditions of he department were maintained by H. A. Wilson, . G. Barkla, Sir Owen Richardson, Sir Edward ppleton and Sir Charles Ellis, three of whom became obel laureates.

The Faculty of Engineering, which dates from 1838, the oldest university engineering school in Great ritain and Ireland, the first professor (William osking) having been appointed in 1840, three weeks efore Lewis Gordon became professor in Glasgow.

Department of Engineering

In its beginning, the Department of Engineering t King's College included in its teaching architecture nd metallurgy. To-day, undergraduate study covers ivil, mechanical and electrical engineering, which re continued in postgraduate work together with hemical engineering. The heads of these departments re, respectively, Prof. A. D. Ross, Prof. S. J. Davies, rof. J. Greig and Mr. S. B. Watkins. It is of interest hat King's College Engineering Society, an underraduate body, is the oldest engineering society of ny kind in Britain and was founded in 1847, six ays before the Institution of Mechanical Engineers.

Most of the space for engineering in the new buildng is devoted to teaching, and comprises a new rawing office, a library, laboratories for soil mechnics and for the study of structures and mechanical ibrations, and for certain branches of electrical ngineering. The space in the old building made vailable through the provision of the new drawing office is now reconstructed as a laboratory for concrete technology.

On the electrical engineering side there are two new teaching laboratories, one for machines and one for light-current work. A new research laboratory is being equipped mainly for work on automatic control systems, and a new workshop and additional photographic facilities have been provided. The research interests of the department lie mainly in the field of electrical measurements, in particular in relation to non-linear phenomena of magnetic origin. The new laboratories include a standards room in which much of the equipment will be associated with this work.

In the Engineering Faculty the research activities are distributed throughout the individual specialist laboratories and will not be concentrated in the new building.

Physics Department : Wheatstone Laboratory

Biophysics Research. The department, under Prof. J. T. Randall, is, of course, responsible for the teaching and research in physics ; but a large part of the research is biophysical, and is concerned essentially with the solution of biological problems. To understand the nature of such biophysical research, which is somewhat unusual in a physics department, it is useful to consider its character and origin. Organization of science (for example, in university departments) naturally requires much modification in order to meet the needs of these new trends.

The increasing size of the body of scientific knowledge and lack of linkage by common theory between its parts has naturally resulted in the separation of science into various subjects, each studied in the universities by specialists in independent departments. Biology, in particular, has developed independently of physics. However, the process of the sciences separating is reversed, and re-integration becomes possible, when an all-embracing fundamental theory is developed. Such theoretical development has enabled chemistry and physics to fuse with parts of biology, thus producing the new subjects of biochemistry and biophysics, which have the complementary aspects of being both new specializations and syntheses of science. Biochemistry is a coherent subject ; but biophysics is heterogeneous and exists in many aspects and more as a trend in certain aspects of biology than as a subject in itself.

The theory behind this biophysical trend is mainly the electron theory of molecular structure, which, having already reduced much of chemistry to physical terms, now, by way of biochemistry, begins to describe and explain in terms of electrons and molecules the properties of living matter and the nature of biological processes. Application of such fundamental theory makes possible the explanation and linkage of phenomena in many fields, and, as a result, it should become easier for a scientific worker to have a measure of real understanding of several branches of science. The effect on the research worker, therefore, is to enable him to return in some ways to the comprehensive view of the natural or experimental philosopher. In fact, progress in biophysics depends largely on the development of such research workers who will have a broad approach resulting from synthesis of the traditions of physics and biology.

Physics finds application in biology, not only in the theoretical approach but also in the use of many new physical techniques. Perfected physical tools (for example, the ordinary compound microscope) may be operated by biologists, but collaboration with physicists is desirable when the information obtained by the method is essentially physical in nature as well as biological; or when the development and operation of the technique requires much physical insight. The aid that physicists can give biologists by providing new techniques is an important aspect of biophysics; but elucidation of biological phenomena in terms of molecular theory has ultimately greater significance.

These trends in certain aspects of biology have developed during the past thirty years—in most cases not under the name of biophysics—in university departments of chemistry, biochemistry, physiology, etc. It has also often been necessary to create new departments of biophysics, research units and research institutes.

Owing to the complicated nature of biophysical problems, it is generally desirable to approach the same subject from many different angles and by use of a wide range of techniques. This is best achieved by mutually sympathetic and understanding specialist biologists, biochemists, physicists and hybrid scientists working in one laboratory and allowing their efforts to unite. A biophysics laboratory will tend to be large because it must contain both a large personnel and an exceptionally wide range of facilities.

To expand a physics department in a biological direction it is necessary to go outside the normal university departmental framework. Biology graduates can scarcely hold posts as teachers of physics, or *vice versa*. At King's College this difficulty is overcome by the inclusion in the Physics Department of a Medical Research Council Biophysics Research Unit, which contains scientists and technicians other than physicists. Apparatus has been provided by King's College, the Medical Research Council, the University Grants Committee and the Rockefeller Foundation. Further staff and apparatus have been provided for by research fellowships and grants from the Nuffield Foundation, the British Empire Cancer Campaign, the Rockefeller Foundation, and Imperial Chemical Industries, Ltd. Research students are physics graduates and biologists, and biophysics is a recognized subject in the University of London for postgraduate study. When physics graduates become research students in biophysics, they are required to attend courses in biology. In order that biophysicists should preserve a rigorous approach to the main branch of science in which they have graduated, the research workers who are not on the physics teaching staff of King's College usually contribute to the teaching in other appropriate departments of the College.

The biophysics research at present involves about twenty-four graduates, including four biologists and two chemists, and there are twenty-seven technicians, both biological and physical. Dr. Honor B. Fell, director of the Strangeways Laboratory, Cambridge, acts as senior biological adviser to the Medical Research Council Unit.

One aspect of the biophysical research of the Department is concerned with the structure and function of various biological fibrous molecula systems. Collagen provides a favourable opportunit of studying the structure of protein in relation to it function and mode of formation. Connective tissu composed of collagen grows with a quasi-crystallin structure from smaller protein units in solution, an the resulting fibres have a very great tensile strengt correlated with a highly oriented system of chemica bonds.

The fibrous molecule of deoxyribonucleic acid i often supposed to have a special function in relatio to protein synthesis. It has been found possible t crystallize the pure substance in the form of fibre and then to determine, by X-ray diffraction, man of its structural characteristics, which can also b shown to exist in living sperm cells and in the nucle of growing cells. The structural relation of protei to nucleic acid is also being elucidated, and this ma cast light on the mutual role of nucleic acid and protein in growth, and the relation of these molecula patterns to specific chemical differences associate with gene action.

The other main aspect of the biophysical researc is the development and application of physica methods to determine the distribution of chemica substances in growing cells. Ultra-violet, infra-re and interference microscopes are used to measur the concentrations of nucleic acid, protein and othe substances. Thus, from the cytochemical side, th functional relationship of nucleic acid and protein i studied, and this connects with the molecula structure approach to the same question. Th development (by use of a microscope interferometer of successful reflecting microscopes for this work ha involved much physical study.

On the biological side, the department has all usua facilities, including an animal room and tissue-cultur laboratories. There are two time-lapse phase ciné microscopes in 'hot-boxes'; a 35-mm. camera on eac biologist's microscope; cytological freeze-dryin equipment; several ultra-violet microscopes; a high power ultrasonic generator; and a flying-spot microscope.

On the more physical side, there are two electron microscopes and a 400-kV. instrument nearin completion. Three ultra-violet and two infra-re microspectrometers together with five reflectin microscopes are at present in use. A semi-fine-focu X-ray tube and two fine-focus tubes are used i conjunction with several microcameras and a long spacing diffraction camera.

Biochemical facilities include cold rooms at 0° C and −20° C.; an ultracentrifuge; electrophoresi apparatus; and a 12-litre centrifuge, ultra-viole spectrophotometers, etc.

Theoretical Physics. A strong theoretical grou of about twelve workers has been engaged unde the direction of Prof. C. A. Coulson on applications of wave mechanics and statistical mechanic The theory of the chemical bond has been develope and applied to questions of the chemical reactivit of molecules, the stability of crystal structures, biological properties of molecules such as cancer producing chemical compounds, electrical and magnetic properties of metals, etc. A second aspec of the work concerns properties of electrolytes an colloidal solutions, including the theory of electrophoresis. The activity of the theoretical physic group at King's College may be judged from th fact that more than one hundred papers have bee published during the past five years.

Experimental Physics. Apart from biophysics, there e several distinct physics research groups in the heatstone Laboratory.

One group is studying effects produced by clear radiations and light on various crystalline sulators such as diamond. Variations in the texture diamonds have been shown to cause wide changes some of their physical properties. This work has e dual purpose of developing radiation detectors nich utilize such effects, and of increasing knowdge of how energy is transported and converted in sulators and semi-conductors.

Another group is concerned with the temporary stortions produced in the earth's electric field due thundercloud disturbances. The relation of the opagation of this field distortion, the wave-form, d its frequency analysis are studied by means of ulti-tube cathode-ray wave-form recorders and dio spectrometers installed on the roof of the College.

An electronics group is concerned with the development of high-speed electronic-analogue computing chniques and their applications to a variety of ysical and biophysical problems. Two high-speed mputing instruments have been built. Techniques e also being developed for the study of the central ervous system from the point of view of information eory.

In connexion with biophysical applications of ectroscopy, investigations of the fundamental relaon of optical properties to molecular structure are eing made by a spectroscopic group. The ultra-violet d infra-red absorption of small molecules and ystals of known structure is being measured by eans of high-dispersion equipment using polarizers, flecting microscopes and automatic recorders. undamental studies in the vacuum ultra-violet are so in progress.

M. H. F. Wilkins

LONG ASHTON RESEARCH STATION

OPEN DAY

AT the University of Bristol Agricultural and Horticultural Research Station's Open Day on uly 15, several items of particular scientific interest ere demonstrated. In the Pomology Section, Dr. . C. Luckwill dealt with fruit-thinning sprays conaining α-naphthalene acetic acid. These, applied to pples within three or four weeks of petal-fall, induce ed abortion, and consequently an increased drop of oung fruits. The concentration required to give atisfactory thinning is affected by the variety, the itial set of fruitlets and the stage of development t the time of spraying. The method, therefore, annot yet be safely recommended in commercial pple growing.

Paper chromatography is being employed at Long shton in the study of the natural auxins controlling ruit development. An exhibit showed some of the iological tests employed for locating the position of he auxins on the chromatograms. These include a odification of the coleoptile cylinder test and the *oleus* petiole abscission test.

In the plant nutrient investigations under the irection of Dr. E. J. Hewitt, specific visual symptoms n the cauliflower plant were used to demonstrate its olybdenum requirements in the presence of nitrogen pplied respectively as nitrate, nitrite, ammonium or urea. Nitrate consistently induced a characteristic mottling, absent from plants given the other treatments.

A survey of the copper, zinc and molybdenum requirements of large-seeded legumes demonstrated that the seed reserves in dwarf, runner and broad beans and in peas could provide sufficient molybdenum for one year's growth but rarely for two. Seed reserves of these crops also mitigated the effects of copper and zinc deficiencies. In comparative trials of water purification methods in the study of molybdenum, copper and zinc requirements, the behaviour of test crops showed that rainwater demineralized by a suitable ion-exchange resin was similar to glass-distilled water.

Iron deficiency was induced in sugar-beet by excess of copper, zinc or manganese. The degree of chlorosis produced was increased by extra molybdenum and, outstandingly, by copper.

The exhibits dealing with insecticides included a demonstration by Mr. S. H. Bennett (working in collaboration with Dr. W. D. E. Thomas) of biological methods using chrysanthemum plants infested with *Macrosiphoniella sanborni* for tracing the movement of octamethyl pyrophosphoramide (schradan) through the plant. This method used in conjunction with radioactive tracer techniques permitted accurate study of the translocation of the insecticide.

Dr. R. J. W. Byrde, of the Mycology Section, demonstrated the effect of winter spray treatments in inhibiting sporulation by *Nectria galligena* (causing apple canker) and *Sclerotinia fructigena*, the brown rot fungus. The effect on *Nectria galligena* was sufficient to reduce subsequent leaf scar infections; but in *S. fructigena* the supply of spore inoculum could be built up sufficiently quickly to outweigh the effect of the winter treatment.

In an exhibit illustrating improvements in spray nozzles, Mr. N. G. Morgan and Dr. H. G. H. Kearns showed two standardized designs. The first was a light-weight all-purpose ¼-in. B.S.P. nozzle, with interchangeable parts for high- or low-volume spraying at low pressures (30–75 lb./sq. in.), suitable for light lances, ground-crop booms or air-flow machines. The second was a ⅜-in. B.S.P. nozzle intended mainly for high-pressure (200–400 lb./sq. in.) spraying of fruit trees by means of hand lances or spray masts.

The exhibits of the Cider and Fruit Juices Section (under the direction of Dr. A. Pollard) were concerned both with the practical aspects and with some of the more fundamental work at present being undertaken on cider and apple juice production. In an exhibit emphasizing the microbiology of cider making, photomicrographs illustrated the yeasts and bacteria capable of giving rise to disorders of cider. The latter included 'sickness' bacteria and lactic rods responsible for the condition known as 'ropiness'. The use of acetic bacteria in the production of cider vinegar was the subject of a practical demonstration.

An exhibit of unfermented apple juices illustrated oxidation phenomena during processing and storage. The addition of small amounts of sulphur dioxide at the time of milling the fruit was shown to inhibit the initial rapid oxidation of polyphenolic components which normally occur, the amount required exhibiting wide variation according to fruit variety. Adequate exclusion of oxygen from the bottled and pasteurized product was shown to inhibit the slower oxidative changes which occur on storage.

The result of field trials with selected varieties of cider apples grown as bush trees was illustrated by

Dr. Luckwill and Mr. R. R. Williams. Average annual yields over a period of three years have ranged from less than one to over thirteen tons per acre, depending chiefly on the variety. These intensive methods of cider fruit production have brought their problems of pollination, and work is in progress to determine the self- and cross-fertility of the recommended varieties. A provisional list of the triploid varieties of cider apples was displayed. R. W. Marsh

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STRUCTURE OF ELASTIC TISSUE

By Dr. D. A. HALL, Dr. R. REED* and Prof. R. E. TUNBRIDGE, O.B.E.

Departments of Medicine and of Leather Industries, University of Leeds

ELASTIC fibres are described in standard histological texts as being yellow in colour, highly refractile and as exhibiting considerable elasticity[1]. The fibres run singly, branch freely and anastomose with one another and can be differentiated by selective stains such as acid orcein and resorcinol fuchsin. They form the major component of the elastic tissue of aortic media and ox ligamentum nuchæ. It has been shown[2] that the apparent increase in elastic staining in certain pathological conditions of the skin may not necessarily be associated with similar increases of elastic fibres, as identified under the electron microscope, but may be due to the presence of altered collagen. Such anomalies in the basic criteria for the identification of elastic fibres and elastin led us to study the morphological and chemical characterization of elastic fibres, and the present communication summarizes our observations of human aortæ and ox ligamentum nuchæ.

Histological examination has confirmed the findings of Benninghoff[3] that there are in the media of human aorta two components, fibrils and lamellæ, to which the name elastin could be given on the basis of their staining properties. By contrast ox ligamentum nuchæ consists solely of large fibrils running parallel to the long axis of the fibres. Morphological differences are also evident under the electron microscope. Disregarding the fibrils of collagen which are a characteristic and easily definable component of all elastic tissue, the aortic media contains ill-defined branching fibres, some of which are apparently made up of still smaller fibres embedded in an amorphous matrix. The large lamellæ observed under the light microscope contain similar elements. On the other hand, ox ligamentum nuchæ consists solely of dense broad fibres of circular cross-section arranged in parallel formation and exhibiting no branching.

Both tissues react similarly when treated with pancreatic elastase. Some of the cementing matrix is first digested, the fibres becoming less opaque and collapsing, revealing an array of fine fibrils, lying roughly parallel to the long axis. These fibrils are quickly broken down into small particulate material. Thus the action of elastase points to a morphological similarity between the two tissues, although under the light microscope considerable differences are apparent.

The chemical evidence is similarly confusing. The majority of data previously available had been obtained from studies on ox ligament and had shown that elastin differed from most albuminoids in the it was remarkably insoluble in the normal solvent for proteins, while those reagents capable of dissolvin it apparently did so only with considerable degrada tion. Total analyses have been made by Richar and Gies[4], and amino-acid analyses of preparation believed to be pure elastin have also been made b Stein and Miller[5] and by Neuman[6]. Stein and Mille used either boiling 40 per cent urea solution fo protracted periods or short treatment with water t remove associated proteins, and reported that th analyses of the materials remaining were identica Later workers have used the simpler method o preparation to minimize degradation of the protein but it has recently been reported by one of us (Hall[7] that treatment of human elastic tissue with hot wate or acetic acid, although previously presumed adequat for the removal of collagen, does not free th preparation from all proteins other than the elasti of Stein and Miller. A fraction remains resemblin collagen on analysis, having both basic amino-acid and hydroxyproline in excess of the accepted value for ox ligament elastin, but having neither th striated structure nor the solubility properties o collagen. Hence all analyses of tissue for elasti content based on the separation of elastin as fraction insoluble in water or acetic acid[8,9] will giv erroneously high values in tissues such as huma aorta where the extra component appears to b present. The acetic-acid-resistant protein can be removed from elastin by prolonged treatment with dilute solutions of urea, hence the method of Neuma and Logan[10] should give more reliable results wit human tissue. The material remaining after the removal of collagen and the extra component has an amino-acid analysis identical with elastin preparations obtained from ox ligament by the action of acetic acid alone. This is further evidence of the complexity of human elastic tissue as compared with that from ox ligamentum nuchæ and, at the same time, of the possible existence of a common component.

The insolubility of elastin in boiling 40 per cent urea solutions, as claimed by Stein and Miller[5], has been shown by Hall[7] to be relative and dependent only on the ratio of urea to elastin. The product of such a reaction with urea is a soluble protein which from preliminary ultracentrifuge and osmometry observations appears to be of low molecular weight and which from electrophoretic data migrates as a single peak over a pH range of 2–10. Further, no free amino-acids have been identified in the dialysate; but, most significantly, polysaccharide and acid are released during solution. This protein species is also reversibly denatured by heat, the temperature at which this is brought about varying with pH and ionic strength of the environment and being lowest (14° C.) at pH 2·8 and at an ionic strength of μ–0·2. This soluble protein, therefore, is similar in some respects to that reported by Adair, Davis and Partridge[11] as being produced from elastin by the action of 0·25 M oxalic acid. Their protein was a mixture of two fractions, one with a molecular weight of 84,000 showing thermal denaturation and the other of much lower molecular weight and not denatured by heat. A further significant difference is the short duration of the oxalic acid reaction and the reported presence of acidic amino-acids in the dialysate, phenomena which Adair *et al.* attribute to incipient hydrolysis of the elastin molecule. Recently, Wood[12] has demonstrated that other methods, such as prolonged boiling with 0·1 N sodium hydroxide or eatment with performic acid at 18° C., can be used r the production of similar soluble proteins and at, in addition, polysaccharide and sulphuric acid e liberated.

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* The electron microscopic studies were carried out while Dr. Reed was on the staff of the Department of Biomolecular Structure of this University, and the authors would like to thank Prof. W. T. Astbury for the facilities provided.

Elastin can be digested by the enzyme elastase[13]. ur initial observations appeared to preclude the istence of a component common to all elastic tissue nce there was a gross difference between the susptibility of human aorta and ox ligamentum nuchæ attack by the enzyme. Little, if any, of the gament was dissolved at pH 10·3 and under the nditions described as optimum by Balo and Banga[14]. e have shown that this phenomenon is due to adequate buffering. Appreciable quantities of lphuric acid are liberated by the action of elastase human tissue, especially at high pH values, hereas over a similar range of pH the amount of id released from ox ligament is much less. Given lequate buffering, it has been shown that elastase as the same shape of pH sensitivity curve for both ibstrates with an optimum pH value of 8·55. The nount of acid liberated from aortic tissue under nditions of inadequate buffering at an initial pH 10·3 was sufficient to lower the pH to the optimal alue of 8·55, whereas with the ligament an initial H of as low as 9·5 was needed before the required epression could be attained. The quantity of acid berated was directly proportional to the amount of astin passing into solution during the dissolution of e first half of the tissue. At this point, however, e whole of the acid had been released and the maining protein passed into solution without any rther lowering of pH.

Collagen-free human elastin preparations, treated ith urea to remove the extra component, show rogressively increasing susceptibility to enzyme ttack. With a concentration of urea suboptimal for lution it is possible to remove the extra component ithout affecting the solubility of the remaining lastin. Material which has been completely taken ito solution by means of urea, and then reprecipated from solution by acetone, shows a far greater ate of dissolution under the action of elastase and a arked increase in its degree of solubility in buffer lution. Ox ligament, which dissolves in urea lution over a much shorter time range, shows little icrease in susceptibility to elastase until final lution occurs.

Before discussing the possible structure of elastic bres we would direct attention to the following bservations:

(1) The soluble proteins obtained from elastic issue by all the chemical methods show the property f reversible heat denaturation; but the soluble rotein produced by the action of elastase does not.

(2) Amino-acid analysis of the proteins obtained om both aortic and ligament tissues, either by reatment with urea or oxalic acid, are similar to the reviously accepted values for 'elastin'.

(3) Urea solutions of elastic tissue contain no free mino-acids, but such compounds are present in xalic acid solutions.

(4) Polysaccharide and sulphuric acid are liberated y the action of those reagents which produce the oluble protein material.

(5) The action of elastase on human aortic tissue nd on ox ligamentum nuchæ is similar from a norphological point of view. Fine fibrils are embedded n an amorphous cement substance in both tissues, nd removal of the latter results in the collapse of he structure.

(6) Solutions of elastic tissue in urea show low viscosity and no streaming birefringence, hence they may contain a corpuscular unit similar to the G-elastin postulated by Banga[15].

(7) The total amount of polysaccharide in the tissues is small, approximately 2 per cent in aorta and 0·5 per cent in the ligamentum nuchæ.

It is therefore reasonable to suppose that part at least of the elastin system is made up of linear aggregates of a corpuscular protein unit of low molecular weight. To this extent we agree with Banga[15], who considers that fibrils of elastin (*F*-elastin) are built up from repeating units of *G*-elastin, entirely analogous to the *G*–*F* transformation of the muscle protein actin; but so far there is no evidence to identify the hypothetical *G*-elastin with the units we have observed. Moreover, Banga's concept of *G*- and *F*-elastin precludes the involvement of such units in mixed mucoprotein chains (see below), and therefore we think it inadvisable to use the name *G*-elastin for these structural units. On the other hand, to use the name elastin would be equally confusing, since the word has a different meaning for the chemists and for the histologists. We suggest as a temporary expedient that these corpuscular units should be proelastin, analogous to procollagen[16], the soluble protein derived from collagenous tissues. There is, however, as yet no evidence that proelastin exists in the free state in elastic tissue.

The main difference between our observations and those of previous workers is the finding that polysaccharide and sulphuric acid are intimately associated with protein in elastic tissue. It is significant that polysaccharide is liberated simultaneously with protein whenever the tissue is degraded, and this points to the association of acid, polysaccharide and the proelastin as being a necessary condition for tissue stability. To postulate linear chains of polysaccharide arranged in parallel association with aggregates of proelastin would be more in accord with present knowledge of muco-protein systems; but it is difficult to see how such an arrangement could bring about the high degree of stabilization observed. As a possible explanation we would suggest the presence of mixed mucoprotein chains each of which is formed by proelastin units joined by polysaccharide molecules and that these chains are essentially the stabilizing cement material surrounding chains of linearly aggregated proelastin. A suitable name for this species would be elastomucin. In our view, therefore, elastic staining tissue consists of linear aggregates of proelastin protected by material consisting of similar units held together by union with polysaccharide. The ratio of polysaccharide to proelastin has not yet been determined accurately, but five moles of acid including both sulphuric and possibly uronic acids are associated with each proelastin unit.

The dual nature of elastin seems to follow from the fact that during the action of elastase all the acid is liberated during the dissolution of only half the protein. It also accounts for the presence of amorphous and fibrous material as revealed by the electron microscope.

The doubt expressed by Banga[15] as to the function of elastase is substantiated by our observations. We suggest that elastase is not a proteolytic enzyme, but rather a mucase. It would therefore attack only the elastomucin chains liberating the proelastin therefrom. Once the stabilizing effect of this elastomucin is removed, however, the remaining proelastin would be released by direct solvation from the chains containing no polysaccharide. This mechanism would account for the liberation of all the acid during the first half of the enzyme reaction and, if the fine fibrils observed in the electron microscope during the initial stages are aggregates of pure proelastin, would also explain their rapid disintegration. Proteolytic enzymes such as trypsin which have been shown to digest elastic tissue after prolonged treatment must be assumed to attack the proelastin units themselves.

The proposed structure would also account for the liberation of protein units of similar properties by the prolonged action of reagents such as alkali and performic acid, capable of disrupting the polysaccharide, since similar units of proelastin could originate from both the cement material and the fibrils. A reagent favouring polypeptide hydrolysis such as oxalic acid would be expected to have a different action, as indeed is the case. Chemical reagents might be more drastic in their removal of polysaccharide than the enzyme, and the retention of sugar residues masking the ends of the proelastin from the cement material, in the case of protein solutions prepared by elastase, could preclude the thermal denaturation of the whole preparation.

Thus we suggest that there is considerable evidence in favour of the existence of two common entities in the elastic staining fibres of human aorta and of ox ligament.

The polysaccharide—elastomucin—content of aorta is higher than that of ox ligamentum nuchæ, and this finding is supported by the presence in the aorta of sheets of amorphous material at the e.m. level and of the lamellæ at the light microscope level. The smaller concentration of elastomucin in ligament would explain the more rapid rate at which this tissue finally passes into solution, since little mass would be dissolved during the earlier removal of the cement substance. Schultz[17] in 1922 suggested that the staining capacity of elastic tissue was due to the impregnation of elastin by mucin, which he identified as the 'chromatropic ground substance' present in many tissues. Our proposed structure gives a rational foundation for these deductions which were based solely on histological observations.

Whether any enzyme function is associated with the linear aggregation of proelastin, as is the case with actin, is unknown. It is significant, however, that Banga and Nowotny[18] have reported the presence in aortic tissue of an ATP-ase different from the muscle enzyme and which falls in amount as the elastin content of the aortic media decreases with increasing severity of arteriosclerosis.

A knowledge of the structure of elastic tissue is essential for an understanding of clinical problems. Balo and Banga[19] have applied their studies of elastase action to the problem of arteriosclerosis and have suggested that the degeneration of human elastic tissue is brought about by the enzyme elastase, which they had shown to be present in beef pancreas. Further, the enzyme was thought to be controlled by an inhibitor present in the sera of normal persons, but absent from those of patients with vascular degeneration. We have been unable to obtain elastase from normal human pancreas processed in an identical fashion to the hog and beef pancreas used for the routine preparation of the enzyme. This observation has been confirmed by a personal communication from Mr. E. Levin, of the Viobin Corporation, from whom the hog pancreas used in this work was obtained. It may be that, in the human, elastase is secreted in organs other than the pancreas, but it is more likely that the whole question of elastomucin involvement in arteriosclerosis is far more complex than that of a simple enzyme/inhibitor system, and more studies are needed, especially into the mucoid/protein interrelationship, in order to assess the changes involved in vascular degeneration. Again, in the present communication we have ignored the possible participation of lipoid as a tissue stabilizer, but in view of the changes associated with arteriosclerosis, no hypothesis would be adequate that ignored so important a factor.

We would like to register our indebtedness to Mr. T. J. Bowen for physical observations and to Dr. F. Wewalka, of the 1st Medical Clinic, Vienna, for help in some of the initial observations on the elastase reactions; also to Messrs. A. Millard and G. D. Coulson and Misses I. Rennie and B. Stannard for technical assistance. We also wish to acknowledge the gift of samples of elastase of high purity from Prof. I. Banga, Budapest.

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OBITUARY

Dr. J. C. James

John Charles James was born at Harrow in 1920. He passed through Harrow County School to Queen Mary College, London, where he took first-class honours in chemistry in 1940. After a period in the laboratories of the London Passenger Transport Board, he became a research student under C. W. Davies at Battersea Polytechnic (where he was made lecturer in 1945), and was awarded the Ph.D. degree by the University of London in 1947. Since 1948 he had been a lecturer in chemistry in the University of Glasgow.

Deriving from his training at Battersea, his earlie work, and most of his published work, involved the accurate measurement of electrolytic conductivities from which were elucidated various ionic interactions in solution. During the past two years he had become interested in the polarography of non-aqueous media and in the double-layer capacity at electrode surfaces he and his students were opening up several very promising lines of research in these related fields James was an able and industrious experimentalist ingenious in adapting electronic techniques to the tudy of electrochemical problems. He had also ecently collaborated in the first reliable determination of the dielectric constant of anhydrous sulphuric acid, proving this important quantity to be not much higher than that of water. Only the first-fruits of all his later work have yet been published.

Though of a quiet disposition, James was a good and witty lecturer, very popular with his students, and well liked by his colleagues. He was unmarried. His untimely death in a mountaineering accident in the Jotunheim, Norway, on July 9 is a great loss to electrochemistry in Britain. J. C. SPEAKMAN

NEWS and VIEWS

Parliamentary and Scientific Committee: Deputation to the Lord President of the Council

A DEPUTATION from the Parliamentary and Scientific Committee, including Lord Samuel (president), Lord Waverley (past-president), Sir Ralph Glyn (deputy-chairman) and Mr. M. Philips Price (vice-president), which waited on Lord Woolton, the Lord President of the Council, on July 28, while welcoming the indications in the speeches of Lord Woolton and Lord Cherwell in the debate in the House of Lords on June 11 that the Government recognizes the urgent importance of exploiting discovery and research as rapidly as possible and of a much closer liaison between science and industry, asked for further information as to the specific action the Government proposed to take in the immediate future, especially in so far as such action would make a valuable contribution to productivity and the balance of payments crisis. Further information was also requested as to the action the Government proposes to take to meet the very serious criticism of the last report of the Advisory Council for Scientific and Industrial Research, especially in regard to the recruitment of staff and the execution of the Department's Building Programme. In this connexion the Parliamentary and Scientific Committee urged that it was false economy to hold up essential developments in the country's scientific and technical resources. Research must be based on reasonably firm budgetary expectations for several years ahead, and sudden and unexpected limitations or cuts caused more than a proportionate retrenchment. The deputation also urged the extension of the co-operative research scheme to research in veterinary medicine and agriculture and asked for further information as to the steps to be taken to build up a technological institution of university rank and to increase the financial assistance available for selected technical colleges.

The deputation also indicated the Committee's strong endorsement of the main conclusions in regard to scientific man-power of the last report of the Advisory Council on Scientific Policy, and also represented to Lord Woolton that the facilities for the publication of original papers and abstracts in the field of chemical sciences also called for inquiry and action by the Government. Some replies received in reply to a question as to the extent to which industry made effective use of the results of scientific research and any obstacles to the utilization thereof, included in a questionnaire circulated by the Committee prior to the House of Lords debate, suggested that the absence in Britain of an efficient abstracting journal or journals was a major obstacle and that there was a case for further support from the Government for scientific publication generally. Defective liaison services, the lack of trained men both on boards of directors as well as in production, difficulties experienced in obtaining licences and delivery of items of plant, financial problems arising out of plant obsolescence and taxation policy were also contributory factors, as well as the general backwardness of some industries. Lord Woolton expressed his keen interest in the points raised and promised to give them careful consideration.

Wool Industry Research Levy

AN Order increasing the wool industry research levy was approved by the House of Commons on July 24. The amount of the levy depends on both the employment in the industry and its consumption of raw material. Both have declined, and the increase has been requested by both sides of the industry, by the Wool Textile Delegation and by the National Association of Unions in the Textile Trade, and it was estimated by the Parliamentary Secretary to the Board of Trade that the amended rate would have yielded £70,000 in place of the £48,000 actually collected during the first six months of this year or the £114,000 produced by the first year of the levy approved in October 1950. Of the £48,000 collected this year, £31,000 was based on the employment unit and £17,000 on the supply and consumption of fibre. The Parliamentary Secretary expressed himself as satisfied with the programme of research conducted by the Research Association and stated that the £100,000 required to qualify for the grant from the Department of Scientific and Industrial Research was regarded as adequate for the programme in mind. Some concern as to the value of that programme was expressed in the debate, notably by Mr. Mikardo, who urged that the most forward-looking and imaginative research was being done not in the Research Association establishments but in industry. He questioned whether the research association was devoting sufficient attention to what he called the fundamental problems of the industry, and asked whether the distribution of expenditure on research between the research association, the universities and the technical colleges was that most appropriate to enable the industry to make the best use of scientific knowledge. Mr. Mikardo was as concerned as other speakers in the debate that there should be adequate expenditure on research and the fullest possible utilization of its results by the industry. The distribution of research effort is not a matter for the Board of Trade, however, and Mr. Mikardo scarcely made his case sufficiently specific to warrant the Department of Scientific and Industrial Research setting up a further survey panel from what he said alone.

United Nations Resolution on Indigent Aliens and Refugees

ON August 9, 1951, at its thirteenth session, the Economic and Social Council of the United Nations adopted a resolution directing attention to the report on assistance to indigent aliens prepared by the Secretary-General at the Council's request and re-affirming its recommendation that governments should not expel or deport aliens solely on the grounds of indigency or becoming public charges. The resolution recommended governments to accord to aliens lawfully in their territory the same measures of public assistance as are accorded to their own nationals and to give effect to the principles enunciated in the Secretary-General's report in any legislation or administrative action required. The Department of Social Affairs of the United Nations has now issued a pamphlet entitled "Study on Assistance to Indigent Aliens" (pp. 81. New York: United Nations. London: H.M.S.O., 1952. 50 cents or 3*s.* 9*d.*), and this publication embodies the analysis and conclusions contained in the Secretary-General's report as well as some current data and information. Besides the general conclusions drawn from the survey, which led to the resolution already quoted, those reached by the Social Commission and the Economic and Social Council are also indicated. Appended are the texts of some existing conventions or agreements, including the Model Convention on Assistance to Indigent Aliens approved by the Council of the League of Nations in May 1938, the Convention which was concluded between Denmark, Finland, Iceland, Norway and Sweden in January 1951, and that on the Status of Refugees adopted by a United Nations conference on July 25, 1951.

Survey of Physiology in the United States

THE American Physiological Society, under contract by the National Science Foundation, is undertaking a study to determine the present status in the United States of research and education in physiology, including an inventory of available scientific workers, facilities, and institutional and communication problems, and an appraisal of how progress in physiological research relates to other scientific fields and the national welfare. The project has been sponsored by the Foundation, partly because of the central importance of physiological research to all sciences, but primarily to test the value of such a survey-inventory in assisting the Foundation in developing a national policy for science and research in the United States. The contract will be administered for the Foundation by Mr. John Field, assistant director for biological sciences. The survey-inventory will be conducted in two parts, the first being a pilot study, which has already begun and is expected to last for seven to nine months, and from this will be developed the pattern for a more detailed full-scale investigation, which, it is anticipated, will last for an additional eighteen months. The full-scale study will include such problems as the historic development of physiology as a science, present conditions and trends, research and educational facilities and personnel, and the policy for the dissemination of information, communication and publication in physiological work. The pilot phase of the study, costing 33,500 dollars, is under the direction of an honorary central committee, appointed by the American Physiological Society, and the committee has appointed Dr. Orr E. Reynolds, on leave of absence from the Office of Naval Research, to serve as executive director on the pilot project.

Moving a Factory

MR. ROY LEWIS, joint author of the recently published highly successful book "The English Middle Classes", has written a fascinating account of the resettlement of a factory and its workers in the first of Britain's new towns. The factory, Sunvic Controls, Ltd., was formerly housed in a "warren of workshops" in Long Acre, Covent Garden, and was rapidly developing the highly skilled business of producing instruments for temperature, electrical and other forms of control. With the rearmament programme, expansion of facilities became essential and urgent in the nation's interest. A new factory was needed; but it was essential to keep at least a nucleus of the skilled staff together. In Harlow new town the requirements were ideally met; the Development Corporation was glad to get a rapidly developing business for its industrial estate. The directors of Sunvic wished to move the whole factory from Long Acre to Harlow, and put the proposition to the staff. Despite many obstacles about 70 per cent of them elected to move and, in his booklet, Lewis describes how these and unexpected difficulties were overcome, how personal problems were resolved and a new team spirit at Harlow was created. The booklet, which may be obtained from Sunvic Controls, Ltd., No. 1 Factory, Harlow, Essex, admirably describes a sociological experiment which is of the greatest significance in the re-distribution of urban populations from over-crowded cities.

Aslib: Report for 1951

THE annual report of the work of Aslib for the year ended December 31, 1951 (pp. 22; London: Aslib, 1952), records an increase in membership from 1,038 in 1950 to 1,219, the largest percentage increase—thirty—being in the industrial and commercial membership. Besides the annual conference at Ashorne Hill in October, for which many applicants had to be refused, a successful conference was arranged by the Scottish Branch in May, and one arranged by the Northern Branch at Birmingham in June led to the inauguration of a Midlands Branch in September. The Northern Branch also arranged a successful meeting at Leicester, and six London meetings were held during the year. A number of special groups were also established during the year, covering aeronautical engineering, textiles, economics, and food and agriculture. The report includes an extended analysis of the work of the Information Bureau and Library, which handled 3,521 inquiries during the year, an increase of 33 per cent on 1950, apart from 1,236 loans from the Aslib library. Of these inquiries, 1,255 were requests for inter-library loans; and, of the 1,690 telephone inquiries, 464 were for complete bibliographical references of published works and 379 for locations, not necessarily for loans. Of 576 postal inquiries, the most numerous were for complete bibliographical references of published works or references on a specific subject (129 each) and for special library routines, training, etc. (106). By the end of the year, 3,500 translations had been recorded in the index of unpublished translations.

Petroleum Consumption and Refinery Production in Great Britain during 1951

THE Petroleum Information Bureau (on behalf of the United Kingdom Petroleum Industry Advisory Committee) has released statistics of oil consumption and refinery production in Great Britain during 1951, which show an increase in total consumption of all products of 1,611,137 tons above that of the previous year. When it comes to output of finished products from the refineries, the figures are even more impressive: 16,430,025 tons in 1951, as against 9,283,752 tons in 1950. This actually reveals the intensive development of refinery capacity which has aken place in the past twelve months or more in ccordance with the refinery expansion programme Great Britain. Production of aviation and motor pirit was 2,923,181 tons as against 1,477,955 tons in 950; again, nearly half the output of refinery roducts was fuel oil—7,649,982 tons during 1951 nd 3,805,198 tons during 1950. The refineries are rocessing almost entirely Middle East crude oil, hus saving dollar currency, and, in any event, the ncreased output represents a substantial saving in ost of the finished products.

rchæology in Greece and Cyprus during the Year 1950–51

THE survey, "Archæology in Greece, 1950–51", by . M. Cook, to which is appended "Archæology in yprus, 1951", by A. H. S. Megaw, is published both n the annual report for the session 1950–51 of the ritish School of Archæology at Athens (pp. 60; rom 9–13 George Street, London, W.1; 1952) nd in *Journal of Hellenic Studies*, 52 (1952). The econd World War and its consequences have had ne good effect in classical archæology, namely, hat there has been less excavation and more study f what had already been excavated. Hence these wo surveys, which are limited to field-work and nds of objects, are less sensational than sometimes n the past. The energetic Orlandos is repairing and estoring ancient and medieval buildings in many arts of Greece. The Americans continue their model xploration of the Agora (or public centre) of ancient thens, the greatest and most solidly productive ndertaking of classical archæology; it now seems hat there is below the Agora a large cemetery of the ate Bronze Age. Of other excavations the most seful is that of Old Smyrna, where the Turks and ritish have found remains going back to the Early ron Age; this is important for the date and nature f the Greek colonization of the coast of Asia Minor. lsewhere, expeditions have produced finds interesting in themselves, but of less general relevance. There still a tendency to excavate without good reasons; erhaps, in this respect, rising costs will prove a lessing.

olonial Service: Recent Appointments

THE following appointments have recently been ade in the Colonial Service: P. Adames (agricultural fficer, Sierra Leone), principal agricultural officer, ierra Leone; E. G. Giglioli (assistant agricultural uperintendent, British Guiana), agricultural superntendent, British Guiana; T. S. Jones (agricultural fficer, Sierra Leone), senior agricultural officer, ierra Leone; C. H. B. Williams (deputy director of griculture (crop husbandry), Trinidad), director of griculture, Trinidad; A. Cawley (deputy director, eological Survey, Nigeria), director, Geological urvey, Uganda; C. E. W. Hoar (pathologist, igeria), pathologist, Uganda; R. E. Alvares ssistant pathologist, Hong Kong), pathologist, ong Kong; J. P. Henderson (meteorologist, East frican High Commission), assistant director, East frican Meteorological Department; P. I. R. acLaren (fisheries officer, Nigeria), fisheries officer, ame and Tsetse Fly Department, Northern hodesia; Ong Chin Ghee (senior agriculture ssistant, Sarawak), senior assistant agricultural fficer, Sarawak; D. W. A. Peters (laboratory techician, Medical Department, Somaliland Protectorate), aboratory superintendent, Virus Research Institute, igeria; A. McCallum, agricultural officer, Tanganyika; A. J. Ouseley-Smith, agricultural officer, Uganda; Dr. H. J. F. Cairns, medical research officer, grade 3, Virus Research Institute, Uganda; P. J. Byrne, veterinary officer, Tanganyika; R. F. Apps, scientific officer, Royal Observatory, Hong Kong; J. A. C. Davies, agricultural officer, Sierra Leone; H. S. Deans, assistant conservator of forests, Jamaica; R. Good, educational psychologist, Northern Rhodesia; J. G. Halcrow, entomologist, Colonial Insecticides Research Unit, Mauritius; R. C. Jones, hydrologist, Public Works Department, Kenya; R. M. Mabon, laboratory assistant, Veterinary Department, Tanganyika; Hon. P. L. A. O'Brien, geologist, Northern Rhodesia; Miss J. M. Slow, scientific officer, Maize and Produce Organization, Kenya; Dr. L. A. Whelan, soil chemist, Agricultural Department, Kenya.

The Behaviour of Bower-birds

DR. L. HARRISON MATTHEWS writes: "The article on 'The Behaviour of Bower-birds' that appeared in *Nature* of July 19, p. 110, is based on a review by Prof. Evelyn Hutchinson, of Yale University, that appeared in the *American Scientist* (40, No. 1). The writer of the article in *Nature* does not make it clear that this is a review by Prof. Hutchinson of original work published by Dr. A. J. Marshall at various times in *Nature* and the *Proceedings of the Zoological Society of London*. Prof. Hutchinson gives due credit to the author of the papers which he reviews, but it should also be made clear to readers of *Nature* that the original work was done, not by Prof. Hutchinson, but by Dr. Marshall".

The writer of the article did mention that it was based on Prof. Hutchinson's review; but we regret that no reference was made to the original work by Dr. A. J. Marshall.

Announcements

DR. H. A. B. SIMONS has been appointed to the readership in physics tenable at the Royal Free Hospital School of Medicine, London, from October 1.

THE United States Government and the Institute of International Education are offering grants or supplements to existing grants for graduate study in an American university during the year 1953–54. Applicants must be citizens of the United Kingdom or the British Colonies, less than thirty years old, and must possess a bachelor's degree or its equivalent. Application forms (to be completed by November 1) can be obtained from Mrs. D. R. Dalton, Universities Department, English-Speaking Union, 37 Charles Street, Berkeley Square, London, W.1. Applicants from the British Commonwealth, other than those in the above category, should apply to the respective United States embassy in their own country for information on similar grants.

ERRATUM.—Mr. W. D. Furneaux writes that in his communication to *Nature* of July 5, p. 37, entitled "Some Speed, Error and Difficulty Relationships within a Problem-solving Situation", he has inadvertently omitted a t from equations (1) and (2), which should therefore read as follows:

$$P_S = \int_0^t \frac{1}{\sigma_S t\sqrt{2\pi}} \exp - (\log t - mD + S)^2 / 2\sigma_S{}^2 dt \quad (1)$$

$$P_C = 1 - \int_0^t \frac{1}{\sigma_C t\sqrt{2\pi}} \exp (\log t - C)^2 / 2\sigma_C{}^2 dt \quad (2)$$

LABORATORIES FOR CEMENT RESEARCH

THE new research laboratories of the Associated Portland Cement Manufacturers, Ltd., at Stone, in Kent, were opened on July 11 by the Minister of Works, the Right Hon. D. McA. Eccles. These laboratories, together with general offices, form a pleasant building, and the architects, Messrs. Westwood, Sons and Harrison, are to be congratulated on the effect of modestly decorating a functional building with Tyrolean and coloured finishes and by the occasional use of Kentish rag-stone.

In these laboratories and offices, a large staff of well-qualified scientific men and technicians will work towards the improvement of the quality of cement, the cheapening of production, and the introduction of new products, in addition to dealing with specific problems which continually arise. Engineering research in connexion with cement-making plant will form an important part of the work, as well as fundamental research in the chemistry and physics of cement manufacture, and its behaviour in the making and curing of concrete and many allied materials. The development and improvement of methods of manufacturing burnt clay, sulphate-resisting and low-heat cement are also important objects.

The laboratories are well equipped. The lay-out of the chemical laboratories is of particular interest. Artificial ventilation effectively disposes of fumes, and subsidiary side-rooms are provided to house such equipment as muffles, furnaces, hot plates, water-baths and additional fume cupboards, etc. The Physical Testing Department has the usual equipment for cement and concrete testing, including temperature- and humidity-controlled curing rooms. It is evident from results that when testing is carried out under rigorously controlled conditions the uniformity of strength of cubes is as good as can be desired when made from the same batches of cement.

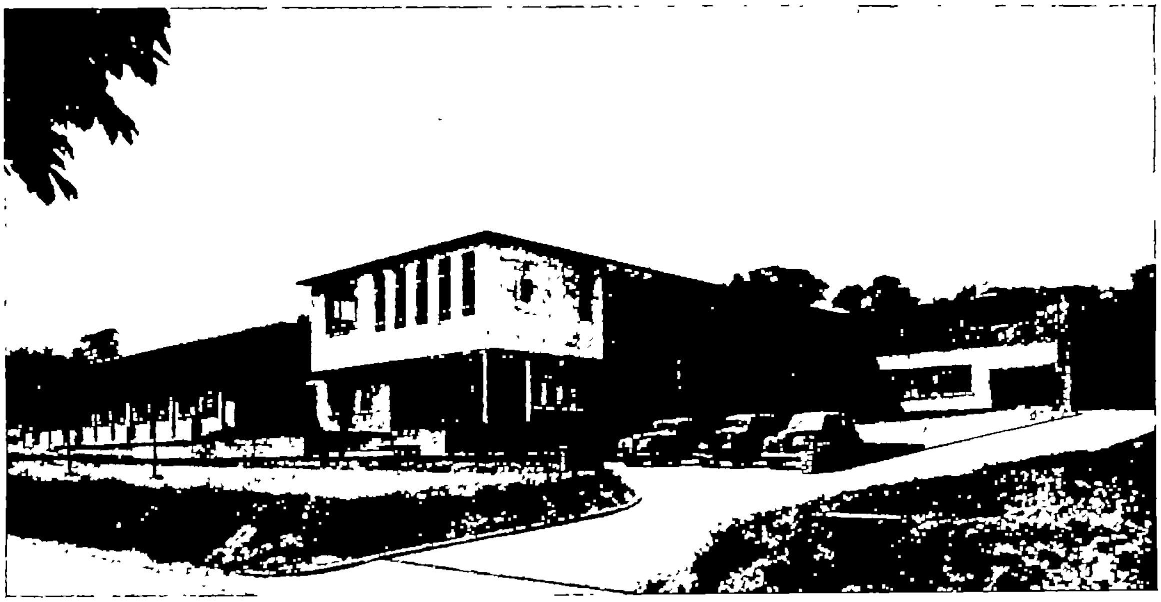

Fig. 1. Research Laboratories of the Associated Portland Cement Manufacturers, Ltd., at Stone

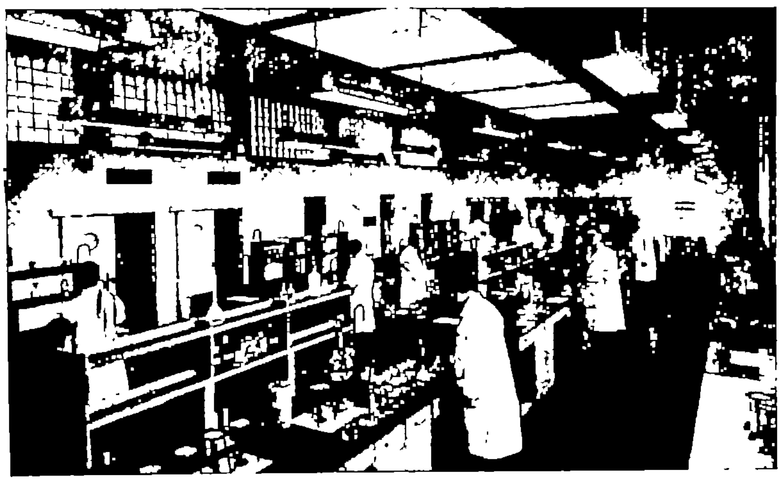

Fig. 2 Chemical Laboratories

It would take too much space to describe in detail all departments but it should be mentioned that in the laboratories there is a Kilns and Mills Division, and a Raw Materials Section, both well equipped and doing important work. There is a Microscopic Department, and a Library is beginning to accumulate. There is a lecture room in which instruction is given to personnel undergoing training in cement technology. This activity is considered to be one of the most important functions of the laboratory. A large and pleasant canteen has been rovided ; in fact, the visitor receives the impression hat every aspect of planning has been well conidered.

The staff of the laboratory will no doubt contribute greatly in the future towards improvements in the ement industry, and so give further help towards he solution of some of our economic problems, to which the cement industry has already contributed much.

GERMAN SOCIETY FOR ELECTRON MICROSCOPY

FOURTH ANNUAL CONFERENCE

THE fourth annual conference of the German Society for Electron Microscopy took place this year at Tubingen during June 6–9. The increasing interest evoked by this event, both inside and outside Germany, may be judged by the attendance at the conference of more than two hundred electron microscopists, many of whom came from abroad. Although this was not an international conference, eight European countries were, in fact, represented. A high standard was maintained both in the papers presented and in the discussions. It was felt, however, that the total number of eighty papers was rather large considering the limited time available. It is only possible to mention a few of the papers here, and these have been chosen so far as possible to indicate the general scope of the conference.

The chairman of the Society, Prof. U. Hofmann, delivered the opening lecture, choosing as his subject "The Electron-Microscope in the Treatment of Problems in Inorganic Chemistry". The electron microscope, he said, has made its contribution to organic chemistry largely by virtue of its ability to resolve fine structures, particularly those of crystals. It has been used, for example, for determining the structure of graphite crystals in connexion with problems of lubrication. Similarly, with its aid, progress has been made in the chemistry of soils and clays and in the selection of suitable fillers for rubbers. Although the resolving power of the electron microscope is not yet sufficient to resolve atomic structure, it is often possible to use the instrument for obtaining an estimate of surface area and crystal size, thus obtaining a valuable check on X-ray determinations from line-broadening measurements.

Several papers were devoted to the imaging properties of electron lenses. H. Bremmer developed a simple approximate formula for the axial field distribution in a magnetic lens in terms of the lens excitation and pole-piece geometry. S. Leisegang presented a theoretical paper on the form of the caustics arising in lenses suffering from astigmatism. Previous work by W. Glaser and E. Regenstreif was reviewed, and a number of caustic cross-sections were shown arising from different types of field asymmetry. By observing such caustics in a lens provided with a suitable correcting device, it is possible in principle to compensate the lens astigmatism.

F. Lenz and M. Hahn showed how this could be done experimentally. Electrons are arranged to travel through an astigmatic lens in slightly under-telescopic ray-paths. The emerging electrons strike a distant fluorescent screen forming a pattern there, consisting of an astroid surrounded by a circle. Using Sturrock's theory of the astigmatic lens, Lenz and Hahn have correlated quantitatively the dimensions of this pattern with the asymmetries of the pole-piece system. Experimental results were shown for a particular magnetic lens in which the astigmatic difference of foci goes through a minimum value as the lens excitation is increased from zero to the maximum value available.

B. Von Borries, F. Lenz and G. Opfer described some experimental work undertaken to resolve a discrepancy amounting to 10 per cent between the focal lengths of a magnetic objective lens as calculated by Lenz and those measured by E. Ruska. Ruska's measurements were repeated and found correct. Further experiments on the magnetic circuit showed that, due to the design of the iron casing of the lens and to the B/H properties of the iron used, a loss of magnetomotive force of 5 per cent occurred, causing an increase in focal length of 10 per cent above the calculated value. This accounted for the discrepancy.

R. Seeliger reported progress in the attempts to construct an electron microscope in which the primary spherical aberration is eliminated using correction methods proposed by Scherzer. The mechanical and electrical stability of the instrument has been considerably improved, and the complete correction of primary spherical aberration has been realized. There are, however, many practical difficulties still to be overcome in connexion with the stability of the specimen, etc., before the greatly increased theoretical resolving power of the lens system can be fully attained.

A new approach to the problem of reflexion specimens for the electron microscope was put forward by G. Mollenstedt and H. Duker. Measurements of the velocity distribution of secondary electrons leaving a surface which is subjected to ion bombardment showed that the energy spread was only 3 eV. In the new microscope a metal specimen is placed at right angles to the optical axis and is bombarded with low-voltage ions by means of an ion source mounted at an angle of 45° to the specimen. The resulting secondary electrons are imaged at the fluorescent screen by an electrostatic lens placed immediately below the specimen. An accelerating voltage of 30 kV. is employed. The image has the appearance of that due to a shadowed specimen owing to the inclination of the ion source, thus facilitating the interpretation of the pictures. The resolution is at present about 1000 A. ; but it is believed that this can be improved considerably. The defects associated with previous systems employing glancing incidence at the specimen, namely, gross distortion of the field and high chromatic aberration, are avoided.

L. Wegmann outlined the design of a new Trub-Täuber electron microscope which embodies several novel constructional features. An electrostatic objective and first projector lens are used, only the final projector being magnetic. The lenses are mounted on a hinged door provided with a vacuum seal. This construction makes the lenses readily accessible. In addition, the projector lenses are mounted on bearings so that they may be swung out of the path of the beam when a direct diffraction pattern is required. Two ranges of magnification are provided : 800–4,000 for comparison work with the optical microscope, and 8,000–14,000. A focusing aid is incorporated which causes three images of each object point to appear when the instrument is incorrectly focused. This is achieved by providing two extra-axial holes in the condenser aperture in addition to the normal central one. In ordinary use the illuminating beam passes through the central hole only; but, by switching in an A.C. deflexion system, the illuminating beam traverses the outer holes as well, giving rise to three images on the screen when the objective lens is defocused.

E. Kinder discussed the design of small microscopes. He gave his opinion that there is a place for a small microscope with a resolution of 100 A. and a magnification of 3,000. It should be provided with a transparent screen and pocket magnifier. The cost should be one-fifth of the price of an instrument having a resolution of 20 A.

The fluorescent screen received its share of attention. H. Arend, E. Ruska and I. Broser described quantitative measurements on the resolving power and light-conversion efficiency of a number of fluorescent screens. Their apparatus allows eight fluorescent screens to be viewed consecutively by either an optical microscope or a photomultiplier, without breaking the vacuum. A series of curves showed the effect of grain size and screen thickness on light output for both reflexion and transmission screens.

Dealing with the subject of electron diffraction, A. Boettcher and R. Thun described a dynamic electron diffraction apparatus in which phase changes in a specimen can be recorded on a single photographic plate. The instrument resembles the ordinary diffraction apparatus but is provided with a slit in front of the camera. This slit selects part of the ring diffraction pattern across a diameter. The specimen is heated up and the plate is traversed horizontally, thus producing a set of diffraction patterns corresponding to a given range of temperature. In this way, phase changes occurring in as short a time as fifteen seconds have been recorded. By using specially prepared alloy specimens, phase diagrams can also be obtained for simple alloy systems.

In connexion with the use of the electron diffraction camera, O. Radczewski outlined recent progress in interpreting the patterns obtained when investigating the structure of minerals.

Among many papers on the application of the electron microscope, only a few can be mentioned here. M. Fahnenbrock and W. Liese have investigated the mechanism of liquid flow control in the pores of certain conifers, using a 'Perspex' replica method with silicon monoxide shadowing. They have succeeded in building up a fairly complete picture of both the fine and gross structure of these pores which are several microns in overall size. These pores contain a central membrane carrying a central torus. In order to resolve the fine structure an electron microscope is needed. This paper was typical of many in which the higher resolving power of the electron microscope is used for building up a complete picture of comparatively large structures previously investigated with the optical microscope.

At the conference considerable importance was attached to the question of the falsification of object detail introduced by the preparation technique. E. Perner and G. Pfefferkorn described critical comparisons they had made on the effect of methods of specimen preparation for the electron microscope on plant chondriosomes. Micrograms obtained in the electron microscope were compared with those obtained directly using an optical phase-contrast microscope. Considerable differences in shape and structure were apparent. The authors concluded that this was due to the homogenizing and fixation technique, and were of the opinion that preparation methods which had proved successful for animal structure could not be applied to botanical material.

Of no less importance are the changes that occur in the specimen material due to the electron bombardment. A. Brookes, M. Knoch and H. König reported further measurements on the variations that occur when polystyrene latex and nitrocellulose are bombarded with electrons. It was stated that an electron 'dosage' of only 1×10^{-4} coulombs/cm.^{2} is sufficient for detectable changes to occur in nitrocellulose, 4×10^{-3} coulombs/cm.^{2} being the corresponding dosage for polystyrene latex. This corresponds roughly to only one or two electrons per square angstrom at the specimen.

L. Wegmann showed examples of specimen damage by comparing micrograms taken with object loadings of 2,000 and 10,000 W./cm.^{2} respectively. The use of beam-limiting apertures was suggested to limit the area of the specimen being irradiated.

It may be remarked here that the question of specimen contamination, that is, the formation of a visible deposit on the specimen at somewhat higher dosages, received very little attention in comparison with the variations that occur in organic material.

Several speakers dealt with the detection of defects which frequently occur in crystals. R. Bernard and E. Pernoux gave examples of the *Schlieren* effects that arise in the imaging of very thin crystals in the electron microscope. G. Möllenstedt, and also O. Rang, showed how the size and position of cavities and other defects in crystals can be determined by correlating a particular electron diffraction pattern quantitatively with the corresponding area of the specimen. This is done by selecting a particular ray from the diffraction pattern, by means of an aperture, and using it to form a focused image of the corresponding area of the specimen.

The advantages of stereoscopic methods were emphasized by R. Rühle and E. Zehender. The special object-holder employed in the Bosch electron microscope enables the operator to rotate the specimen through 25° without appreciable transverse object movement. In this way a good idea can be gained of the surface contour of the specimen before a photograph is taken. A short film was shown of the appearance of the image as the object is rotated.

J. Helmcke and B. Jahn demonstrated by means of stereoscopic projection the structure of the dentine canals in human teeth.

V. C. Dalitz and J. A. Schuchmann reported on their work in developing the 'carbon' skin replica method described at last year's conference by Konig. J. Helmcke had used a somewhat similar technique to investigate the fine structure in thick membrane films.

Other speakers dealt with the preparation of textural components in steels and the application of the point emission microscope to metallurgical problems. Papers were given on the investigation of colloidal fractions of the soil, methods of preparation of bacteriophage, and the examination of plant cells with the aid of the microtome.

Electron microscopy in the U.S.S.R. was reviewed by F. Lenz. He stated that most of our information is based on the proceedings of a conference on electron microscopy held in Moscow in 1950. There are more than a hundred Russian-built electron microscopes in the Soviet Union using magnetic lenses. The design follows closely that of the Siemens instrument. There are also a number of electrostatic instruments.

fost of these instruments are operated on behalf of he electrical industry. Research is being carried out n the imaging properties of electron lenses, and the roduction of high voltages using high-frequency scillators. Investigations are being pursued into the cattering properties of electrons and the interaction f electrons and the photographic plate.

An exhibition of photomicrographs was held llustrating the topics dealt with at the conference, nd interesting large-scale demonstrations of optical iffraction effects were given by Prof. Kossel.

T. MULVEY

PRIMITIVE MEDICINE AT THE WELLCOME HISTORICAL MUSEUM

ON July 18 the new exhibition at the Wellcome Historical Medical Museum, 28 Portman Square, ondon, W.1, which bears the title "The Medicine of he Aboriginal Peoples in the British Commonwealth", vas officially opened, and on that occasion Lord Vebb-Johnson delivered an address. In his intro-uctory remarks the director of the Museum, Dr. shworth Underwood, explained that the scope of he exhibition has been restricted to the primitive aces in the Commonwealth in order to enable the ubject to be covered in the limited space available; his arrangement nevertheless allows of a cross-ection of the world to be illustrated.

The exhibition is divided into a number of sections vhich lead from general primitive conceptions, hrough ideas regarding the nature of disease, to its reatment by non-rational and by rational methods. he sequence then follows the detailed methods used n treatment, and the practices which are employed r the protection of the individual, both against isease and danger in general, and also against specific ilments.

In the section dealing with general knowledge arious fine carvings, such as a genealogical stave, hould be mentioned. In the section dealing with the ause of disease, attention should be directed to the ne series of sago-pith effigies from Borneo, to the arious memorial heads, the finely carved soul-atchers, and to the unique exhibit illustrating the ult of the god of smallpox in the Yoruba mythology. he practice of the medicine man himself is well lustrated, and the very complete outfits actually sed by certain individual medicine-men will be of he greatest interest. This section contains a number f fine carvings, especially the spirit-masks and the ront-pieces of ceremonial head-dresses.

In the section dealing with treatment, attention hould be directed to the outfit actually used by the ersonal medicine man to Cetewayo, which contains number of horns used for cupping purposes. The arious instruments and operations shown in the ection on surgery illustrate the ingenuity of primitive eoples in making very simple instruments serve a pecific purpose. The practice of artificial deformation s illustrated by some most interesting specimens, ncluding a rare preserved head showing the practice f elaborate facial tattooing which, among the Maori, vas reserved for chiefs and other important persons.

The ritual background on which primitive medicine ests is shown by a number of most interesting arvings, some of which are used as masks in the eremonies of various secret societies. These exhibits cannot be easily described; but attention should be directed to the very fine carved elephant's tusk from Benin which epitomizes so much of the background of African ritual and legend.

All the exhibits in this exhibition are selected from the collections in the Museum. The exhibition deals with subjects which are little known, and the detailed catalogue includes the fruits of extensive research. The catalogue is published by the Oxford University Press* on behalf of the Museum.

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* "Catalogue of an Exhibition illustrating the Medicine of the Aboriginal Peoples in the British Commonwealth." Pp. xviii+68+6 plates. (Published by the Wellcome Historical Medical Museum by Geoffrey Cumberlege, Oxford University Press.) 3s. 6d.

SOUTH-WESTERN NATURALISTS' UNION

CONFERENCE AT PLYMOUTH

THE South-Western Naturalists' Union held its annual Whitsuntide conference during May 30–June 2 at Plymouth, at the invitation of the Plymouth and District Field Club and the Plymouth Institution. Some eighty members attended.

On May 30, the Mayor of Plymouth (Alderman H. Wright) received the delegates and members at the City Art Gallery. Afterwards Mr. H. G. Hussell showed a series of films illustrating the animal and plant life of the neighbourhood.

Most of Saturday, May 31, was taken up by a river excursion up the Tamar as far as Calstock. Mr. G. M. Spooner pointed out features of interest along the route; in the afternoon Cotehele House, formerly owned by the Earl of Edgecombe and now in the possession of the National Trust, was visited.

In the evening, Mr. Mervyn G. Palmer gave his presidential address; his subject was "Lundy". In his comprehensive survey of the island, he dealt with the geology, topography and history of Lundy and with its animal and plant life, paying particular attention to the birds.

A coach tour across the southern part of Dartmoor occupied most of June 1, and the hut circles at Grimspound and the stone avenue and menhirs at Merrivale were visited. Mr. Spooner again acted as leader.

The annual general meeting, following a meeting of the Council of the Association, was held on June 2. In his report, the honorary secretary, Dr. Stanley Smith, stated that at the present time the Union embraces twenty-two societies, one institution and one private member. A letter from the honorary secretary of the Ilfracombe Field Club inviting the South-Western Naturalists' Union to hold its next conference at Ilfracombe was then read, and the invitation accepted. Mr. Mervyn Palmer agreed to continue in office as president for another year, and the other officers were all re-elected: *Hon. Secretary*, Dr. Stanley Smith (University, Bristol, 8); *Hon. Assistant Secretary*, Miss Elizabeth Fleure; *Hon. Treasurer*, Mr. H. W. Turner; and *Hon. Auditor*, Dr. F. S. Wallis, Mr. G. M. Spooner, Mr. G. Tipper and Mr. O. G. Watkins were added to the Council.

On behalf of everyone present, Mr. Palmer thanked the Plymouth societies for their hospitality and all individual members of the Plymouth and District Field Club and Plymouth Institution who had contributed to the success of the conference. He particularly mentioned Mr. O. G. Watkins, who had carried out the duties of local secretary, and Mr. Spooner, who acted as leader in the field.

Members had the choice of one of three excursions on the afternoon of June 2: a visit to the Aquarium and Laboratory of the Marine Biological Association; Buckland Abbey; and Plympton Castle.

SOVIET FAMILY LEGISLATION

CONSIDERING the concept of the family in Soviet life Dr. R. A. J. Schlesinger suggests that the U.S.S.R. does not just represent an attempt at the application of socialist theories in a modern industrial society. In considering any matter in the U.S.S.R. it should be realized that it is not a country but a continent; at the time of the Bolshevik revolution Russia comprised a greater variety of civilizations than it does at present, after a systematic process of industrialization (*Health Educ. J.*, 10, No. 2; April 1952).

In some areas until quite recently millions of peasant homes in Russia were man-dominated in the most brutal sense of the term, and women's condition deteriorated, at least in the poor peasant's home when the economic differentiation in the village increased its dependence on the richer neighbour. Of the Islamic regions some—especially the Volga Tartars—were fairly advanced; but most of them (especially Central Asia) belonged to the most backward provinces of the Islamic world. There were large areas over which a primitive tribal organization was still in operation. As late as 1936 the Government struggle against blood-feud was just in its concluding stage. Large sections of the penal codes of the Republics concerned dealt with paying bride-price, abducting women, polygamy, marriage of minors and similar "offences originating from tribal custom", some of which (for example, marriage of minors) came under heavy penal sanctions only if they were caused by local custom which the legislator wished to repress in the interest of the emancipation of women.

Confronted with the initiation of a revolution in human relations against the prejudices of primitive custom, the Soviet state has firmly kept to the Marxist concept that undesirable phenomena in family life should, and can, be overcome by the removal of their economic causes. In 1935 Stalin hailed the Labour Day as the great emancipator of peasant women because it granted them an income independent of that of their menfolk. To-day the Soviet Government is attempting to construct a modern industrial society in which its policies aim at stabilizing family relationships in such a society.

Before this were possible, however, certain 'house-cleaning' had to be concluded. In the 'house-cleaning' programme the first enactments of the revolutionary Government did not exceed measures current in modern legislation elsewhere. They were revolutionary only in comparison with Tsarist Russian legislation and consisted of such measures as the transfer of marriage and divorce from the Church to the registrar's office, admission of divorce on the joint petition of both parties, or by court decision on the petition of only one party, the decision being left to the judge's discretion.

Much confusion about the real social situation has been created and is still being created by exaggerated emphasis on some literary pronouncements. Even in statements by authors who must be regarded as characteristic of the Soviet outlook, concepts of an eventual withering away of the family played a predominant part. The withering process, however always referred to the family as an economic unit o consumption and as the main place of education, and not as a normally permanent union of man and wife To some extent this may have been due to the impact of the more Utopian elements of Marxist ideology to some extent to exaggerated estimates of the potentialities of some measures which are clearly necessary in order to enable women to take their share in production, such as crèches, pre-schoo education and public canteens.

This view has now completely changed and, in al Soviet publications since 1936, the family is described with great fervour as "the primary unit of our Sovie society". The Ministry of Education publishes a special monthly, *Family and School*, to promote collaboration between home and school and the activities of parents' committees. Great emphasis i laid upon the responsibilities, not only of parents towards their children, but also of the younger members of the family towards the aged ones. The reasons for this change are political as well as economic.

After having passed its revolutionary period—which, *a posteriori*, is explained by the consideration that it was necessary in order to break up some millions of unfree relationships and to establish the principle of equality of the sexes—Soviet legislation as enacted in the period 1936–45, has come to conclusions very similar to those current in other advanced industrial countries. Most of the differences may be explained by the absence of traditional prejudice; the Soviet State can leave the decision upon whether a divorce should be granted or not to the judge's common sense, without binding him by enumerating grounds for divorce, the presence of which gives a claim to, and the absence of which excludes, granting of a divorce. It can also encourage marriage without paying tribute to the concept that being an unmarried mother is morally wrong.

In essence, however, the conclusions arrived at are the same: marriage is the normal way to motherhood; the family home is the ordinary, though not the only, place to rear the new generation; men and women have equal rights within the family as well as in professional life. The real problems of th Soviet approach to the family arise less from th consummation of the permanent results of th feminist movement than from the potential contradiction between the recognition of the family hom as one centre in the education of the future citizen and the demand for the access of women, not only in theory, but also in practice, to all professions for which they are physically fitted.

INHIBITION OF ŒSTRUS BY CULTIVATED GROMWELL

By DR. B. P. WIESNER and PROF. JOHN YUDKIN
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IN one settlement of the Shoshone Indians, infusion of the roots of *Lithospermum ruderale*, Dougl. taken orally, were believed to have contraceptiv properties[1]. Prompted by this, Cranston[2] administered fluid extracts of the herb to mice in their food She observed inhibition of œstrus and fertility during treatment, without any evidence of general toxicity

Other workers confirmed these findings and also xtended them by showing, for example, an inhibition f certain mammary tumours[3,4]. We have observed a omplete inhibition of œstrus in mice of the *C3H* train by aqueous extracts of *Lithospermum ruderale* administered daily for four weeks.

Lithospermum ruderale is not readily available and batches of this plant vary greatly in activity. However, we have found that English gromwell (*L. fficinale* Linn.), which can be cultivated, yields œstrus-inhibiting extracts.

Cultivation. Seeds of wild gromwell were sown in February under glass, pricked off in 3-in. pots at the end of April, and planted out in May in open limed beds. Plants, including roots, were harvested in October.

Stabilization. We found that delay in processing or slow drying of wild plants tends to result in loss of activity. The cultivated plants were therefore dried at 60° C. immediately after harvesting. This procedure effected stabilization.

Preparation of extracts. The dried plants are finely ground and the powder is extracted with cold distilled water for 45 min. After filtration, the residue s re-extracted with water at 60° C. The second extract is cooled, combined with the first and freeze-dried, since there appears to be loss of activity in aqueous solutions even when they are stored in the cold.

Administration to mice. Tests were made on mature female mice of the *C3H* strain with high œstrous frequency, established by daily vaginal smears during a preliminary period of at least seven weeks. They received daily, by stomach tube, freshly made aqueous solutions of the freeze-dried extract. After preliminary experiments with herb-diet mixtures, this method of administration was adopted because of the uniformity of dosage and the avoidance of complicating factors such as reduced food-intake[4] and inactivation on standing. Smears were taken daily and showed that the equivalent of 1 gm. of the ground dried herb inhibited œstrus, cornification remaining in abeyance from the third day after beginning of treatment until four to five days after its cessation. There is, however, considerable variation in the dosage response; for example, reduction of the initial dose of 1 gm. to 0·5 gm. herb-equivalent daily may maintain inhibition of œstrus. No toxic or other side-effects were noted. After termination of treatment, the œstrus rhythm returned to normal within three days.

Administration to human subjects. Although gromwell has long been used as a medicament and for preparing a popular beverage, no ill-effects have been reported. The observations in mice also suggested that experiments in human subjects were permissible. Preliminary experiments were thus made with the small quantities of extracts available.

(*a*) Single doses of active aqueous extract corresponding to 10 gm. of dried herb per day evoked no subjective effects or obvious objective effects in three subjects (two women, one man).

(*b*) A nulliparous woman aged thirty-four consumed, from the first day to the seventh day of the menstrual cycle, freeze-dried extract, equivalent to about 20 gm. dry herb per day; from the eighth day of the cycle until menstruation the daily dose was doubled. Indices of ovarian function, both œstrogenic and luteal, were recorded before, during and after treatment. These included vaginal cell content, characteristics of cervical secretion, waking temperature and endometrial differentiation. There was no manifest change in the œstrogen response, but during treatment the ovulatory rise in the waking temperature was small compared with previous and subsequent records, and the progestational development of the endometrium was less than in the proceding and subsequent cycles. There were no other subjective or objective effects; for example, no changes in blood picture, urinary findings or pulse-rate. It would appear, therefore, that daily doses of roughly 20–40 mouse units did not inhibit œstrogenic secretion in the subject, but may have reduced the level of luteal secretion. The occurrence of luteinization is, of course, not incompatible with the suppression of ovulation. No risks of conception were taken by the subject during the treatment.

Our thanks are due to: Mr. W. W. Binns and Miss B. P. Jackson for pharmacognostic advice and preparation of extracts; Mr. John Gilmour and Mr. F. Hanger for collecting and cultivating *Lithospermum officinale*; Messrs. Ayerst, McKenna and Harrison, Ltd., for supplying extract of *L. ruderale*; Mr. E. C. Moran for presenting dried *L. ruderale*; Dr. Mary Barton for collecting specimens from the experimental subjects; Dr. E. N. Brand for carrying out bacteriological and other examinations; Mrs. E. N. Blacker and Miss Mary Jewell for technical assistance. The cost of these investigations was borne in part by a grant from Messrs. Kylon, Ltd. [March 25.

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REVERSAL OF THE MOLECULAR SET IN KERATIN

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THE stability of α-type proteins is due to the combined effect of hydrogen bonds and cystine cross-linkages. Thus proteins with a low cystine content, for example, myosin, are very labile under conditions favouring heat denaturation[1]; they show supercontraction in hot water, and their crystallites are transformed into the β-configuration; but this crystallographic transformation can be reversed simply by treatment in saturated urea solution[2].

Having a much higher cystine content, animal hairs are, under similar conditions, extremely stable. Even prolonged treatment in water at 90° C. (for example, for periods up to twelve days) is ineffective in producing supercontraction. Such treatments may, indeed, lead to the appearance in the X-ray photograph of the first traces of the equatorial reflexion of spacing 4·65 A.; but concurrently there is a loss of cystine sulphur[3]. In order to produce supercontraction in the presence of water alone, it is necessary to resort to high-pressure steam[4] (in which case hydrolysis of the main chain occurs) or to make use of the results of stress relaxation in stretched fibres[5].

Stability in hot water is not an exclusive property of the α-form; it is also induced in the β-form, when extended fibres (the crystallites of which are in the β-configuration) are exposed to the action of steam; this effect is generally recognized as being the cause of the 'setting' properties of keratin fibres[4].

A study of the stability of steam-set β-keratin is thus of considerable importance. In particular, a demonstration of the possibility of reversal of set β-keratin to the original α-configuration would serve two purposes: (1) from the character of the reagents capable of producing the effect it might be possible to assess the importance of the various types of molecular interaction which have been suggested as being responsible for the stability of set β-keratin; and (2) a study of the reconstituted α-keratin might throw further light on the problem of the long-range elasticity of keratin fibres.

With reference to the first point, Rudall has shown that saturated urea solutions at room temperature can reconvert set β-crystallites to the α-form, if the time of setting is restricted to a few minutes[2]. He concluded that hydrogen bonds must be responsible for the setting properties of keratin. I have obtained similar results when I treated fibres, which had been set in boiling water under tension for five minutes, in 0·15 *N* sodium hydroxide or 75 per cent lithium bromide solutions at room temperature, but only partial reconversion in 98–100 per cent formic acid. In all these reagents the degree of reversal was decreased when the time of setting was increased, and with fibres set for five hours no effect whatsoever was observed in saturated urea and only a partial effect in the other reagents. These results lend strong support to Speakman's conclusion[7], based on experiments in which the contraction of set fibres in various reagents is compared with that of normal fibres, that dimensional set is due in part to linkages other than hydrogen bonds.

Since the above reagents, chosen because of their probable effect on hydrogen bonds, are, in the main, ineffective in eliminating completely the set in the crystallites of keratin, efforts were made to find other reagents which would have the desired action. The only one which I have found to be effective is cuprammonium hydroxide. When fibres which had been set in boiling water at 50 per cent extension were immersed in solutions of this reagent, and afterwards in dilute sulphuric acid in order to remove the absorbed copper, they were left in a condition such that the X-ray photograph showed only the α-form whatever the time of the initial setting. Similar reconversion was observed in fibres set in steam at 100 per cent extension, and in fibres which had supercontracted after treatment in steam at high pressure. The degree of reconversion in such experiments depends on the time of treatment in the cuprammonium hydroxide solution, and for complete reversal to the α-form it is essential that the fibres should absorb enough copper to ensure the disappearance of the X-ray photograph[8].

Fibres in which the crystalline set had been eliminated in the way described still showed the normal reversible α ⇌ β transformation on stretching and release in water, although higher extensions than usual were necessary to produce the complete transformation. The fibres could also be set again in boiling water; the set β-crystallites were again stable except in cuprammonium hydroxide, which caused a complete reconversion to the α-configuration as before. In fact, the cycle, α → set β → α, could be gone through repeatedly with the same fibres. In all these respects the fibres behaved very much like normal fibres; but that there had nevertheless been a considerable change in the properties was shown by their behaviour when exposed without constraint to the action of water at high temperatures, for such treatment produced the supercontraction and spontaneous appearance of the β-form which is, as mentioned above, characteristic of the more labile proteins. Since normal fibres are not affected in this way by the action of cuprammonium hydroxide and sulphuric acid, the linkages—or some of them—responsible for the stability of the α-form must be broken during the relaxation of tension in water at high temperatures. We may also conclude that, if the setting phenomenon is due in part to reformation of cross-linkages, their effect is not powerful enough to produce stability in cuprammonium hydroxide solution. The action of cuprammonium hydroxide solution may be either to reduce the number of such reformed linkages, a possibility which is unlikely on chemical grounds[9], or to induce refolding by a co-ordination mechanism similar to that proposed by Whewell and Woods[8] to account for the supercontraction of unstrained virgin wool fibres in cuprammonium hydroxide solutions. Even then, however, we must postulate that some of the linkages responsible for the set have actually been eliminated by the cuprammonium hydroxide, for the fibres do not revert to the β-configuration after removal of copper.

I wish to thank Mr. H. J. Woods for his advice, and Prof. J. B. Speakman and Dr. C. S. Whewell for the benefit of many discussions; I am also indebted to the International Wool Secretariat for grants in aid of these investigations. [Feb. 7.

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CARBOHYDRATIC FERMENTATION OF BACTERIAL ISOLATES FROM ZYGOPHYLLACEOUS AND LEGUMINOUS ROOT-NODULES

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So far, the previous work done on zygophyllaceous root nodules[1,2] has dealt with the following problems: (*a*) effect of soil sterilization on growth response of *Zygophyllum coccineum* and on its nodular formation; (*b*) the capacities of zygophyllaceous bacterial isolates to produce nodules in some members of Leguminosae; (*c*) the growth response and stimulation of nodular formation in *Zygophyllum coccineum* either to its own specific bacterial isolate or to those isolated from *Tribulus alatus* and *Fagonia arabica*. In the present work, attempts have been made to elucidate the physiological identities of some zygophyllaceous and leguminous bacterial isolates in ms of their fermentation potentialities on various rbohydratic sources. Two zygophyllaceous nodular cterial strains, namely, those isolated from *Zygo-yllum coccineum* and *Tribulus alatus*, are compared th a *Rhizobium* strain isolated from root nodules a leguminous plant (that is, *Arachis hypogæa*).

The medium used was that suggested by Baldwin d Fred[3], with the variation of the carbon source follows: (1) *monosaccharides:* xylose, glucose, vulose and D-galactose, and (2) *disaccharides:* crose, maltose and lactose. Since some sugars were und to break down during autoclaving, the medium for each experimental carbon source—is divided to two portions: one portion was sterilized by toclaving, and the other was cold-sterilized by enon's technique[4]. The latter involves the trans-rence of the medium into an ice chest and left r twenty-four hours, heated for ten minutes at ° C., and then returned back again to the ice est; the whole process was repeated three con-cutive times.

For expressing the bacterial fermentation poten-alities, the following criteria have been determined:) relative growth; (2) pH variation; (3) gas oduction.

Comparisons of fermentation characteristics of rious monosaccharides, as induced by different cterial isolates from zygophyllaceous and legum-ous root nodules, have been made after six weeks cubation. In both xylose and glucose, incubation as carried out at 37° C., while it was at 32° C. in vulose and D-galactose. Concerning the relative owths of the three bacterial isolates, as influenced the nature of the experimental monosaccharide, ose from *Zygophyllum coccineum* and *Arachis pogæa* show that xylose is the most favourable, llowed by glucose and levulose, while D-galactose the least favourable. Except in D-galactose, on hich both *Zygophyllum* and *Arachis* bacterial olates show a very slight growth, *Arachis rhizobium* rain shows—on the whole—a comparatively more gorous growth than that of *Zygophyllum* on the her experimental monosaccharides. On the other nd, glucose is the most favourable for *Tribulus* cterial isolate, followed by levulose, while both lose and D-galactose are the least favourable. The ree bacterial isolates tend to lower the pH value both xylose and glucose; it does not change preciably, however, on either levulose or D-galactose. ey differ with regard to gas production; the sults can be summarized as follows.

(1) The *Arachis rhizobium* strain does not produce y gas. In a similar manner, Fred, Baldwin and cCory[5] stated that the evolution of gas in liquid ltures of *Rhizobia* is not rapid enough to form gas bbles.

(2) Except on autoclaved glucose medium, where ere is gas production, *Zygophyllum* bacterial olate behaves in a similar manner to *Rhizobia* in e non-production of gas.

(3) *Tribulus* bacterial isolate differs, however, in at gas production takes place on both autoclaved vulose and D-galactose media. The restriction of s-production to autoclaved monosaccharide media ay be due to the effect of hydrolysis during auto-aving, which enables the bacterial isolate to initiate fermentative potentiality.

In a similar manner, comparisons have been made on different disaccharides—after six weeks incubation at 20° C. A study of the relative growths of the three bacterial isolates shows that the most favourable one is maltose. *Tribulus* bacterial isolate continues to grow equally well, to some extent, on both lactose and glucose media. On the other hand, *Arachis* strain differs from that of *Tribulus* in exhibiting a very slight growth on different treatments of either lactose or sucrose media. Similarly, *Zygophyllum* strain shows a very slight growth on autoclaved lactose and sucrose media; its growth becomes, however, comparatively greater on the two latter disaccharides when the media are cold-sterilized by Menon's technique instead of being autoclaved. Except on lactose medium, the three bacterial isolates are found to be acid producers; they tend to lower the pH value. This tendency is comparatively greater with *Arachis* strain on both sucrose and maltose media. The fermentative potentiality, as expressed by gas production, is a constant and prominent feature of *Tribulus* bacterial isolate on the differently treated experimental disaccharide media. On the other hand, both *Zygophyllum* and *Arachis* strains agree in their feeble fermentative potentialities; gas production can only be detected either when *Zygophyllum* bacterial strain grows on cold-sterilized lactose or when that of *Arachis* grows on autoclaved maltose.

Thus, according to fermentation characteristics on different monosaccharides and disaccharides, the three bacterial isolates can roughly fall into two categories: one category includes the two bacterial isolates from root nodules of *Zygophyllum coccineum* and *Arachis hypogæa*, and the other contains only *Tribulus* bacterial strain which stands rather physiologically distinct. The similarity of *Zygophyllum* and *Arachis* bacterial isolates manifests itself in the following behaviours: (1) the most favourable monosaccharide for growth is xylose, followed by glucose and levulose, while the least favourable is D-galactose; (2) the feeble or non-production of gas on most monosaccharide and disaccharide media; (3) the most favourable disaccharide for growth is maltose, while there is a very slight growth on autoclaved lactose and sucrose media. *Tribulus* bacterial isolate differs, however, with regard to its relative growth on different monosaccharide and disaccharide media and with regard to its fermentative potentialities. It produces gas on all differently treated disaccharide media, as well as on two autoclaved monosaccharide media (namely, levulose and D-galactose).

This work indicates that the two zygophyllaceous bacterial strains, namely, those isolated from root nodules of *Zygophyllum coccineum* and *Tribulus alatus*, are physiologically distinct in respect to their relative growths and to their fermentation potentialities. *Zygophyllum coccineum* bacterial isolate behaves even more similarly to leguminous *Arachis rhizobium* strain than to that of its zygophyllaceous colleague isolated from *Tribulus alatus*. Further work on the fermentation potentialities of the three bacterial nodular isolates, on different polysaccharides and nitrogen sources, are still in progress.

I wish to express my gratitude to Mr. Z. Mahmoud for his continual assistance. [June 12.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Stereochemistry of the Tropane Alkaloids

THE respective C$_3$-configurations of the epimeric N-acyl-nortropins have been recently established from the different behaviour of the epimers[1] in acyl migration, N → O. Naturally occurring psi-tropine derivatives seem on this basis to contain a hydroxyl group *syn*-placed to the ring-nitrogen. Atropine, hyoscyamine, convolamine, being hydrolysable to tropine or nortropine, appear, therefore, to represent *anti*-3-tropanol structures.

These investigations have now been extended to ecgonine (I *b*) and psi-ecgonine (II *b*), and to two cocaine-epimers.

Ecgonine and psi-ecgonine are C$_2$-epimers[2]. In alkaline medium ecgonine is converted[3] into psi-ecgonine, in analogy to the tropine (*anti*-tropanol) → psi-(*syn*)-tropine conversion, which indicates identical C$_3$-configuration for tropine and ecgonine, and the respective epimeric configurations for the corresponding ψ-derivatives.

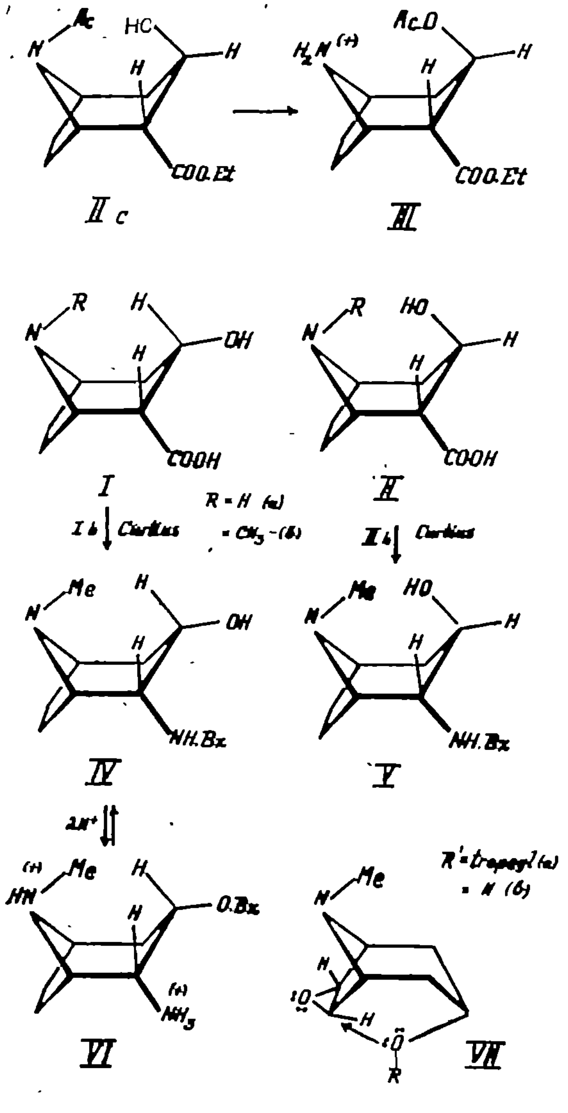
This inference has now been confirmed experimentally. Hydrogen chloride in dioxane converts N-acetyl-nor-ψ-ecgonine ethyl-ester (m.p. 112°) (II *c*) to O-acetyl-nor-ψ-ecgonine ethyl-ester hydrochloride (m.p. 226°; $[\alpha]_D = +23 \cdot 6°$) (III), while under strictly identical conditions no amino ester was obtained from the epimeric nor-ecgonine derivative (II *a*). In ψ-nor-ecgonine and its derivatives, the C$_3$-hydroxyl seems, therefore, to be *syn*-placed to the nitrogen, the opposite following for nor-ecgonine and cocaine.

These results did not permit any statement to be made on the position of the C$_2$-carboxylic group of the *syn* and *anti* ecgonine epimers with respect to the C$_3$-hydroxyl. No generally applicable methods being available for the determination of the configuration of beta-hydroxy-carboxylic acids[4], an attempt was made to overcome this difficulty by converting the two ecgonine C$_2$-epimers to the corresponding 2-amino-tropanol-3-epimers and subsequent comparison of the respective N-benzoyl derivatives (IV and V). In this conversion the migrating group would—just as in the Curtius reaction—be assumed to retain its configuration[5], which then makes it possible to determine the steric position of the amino-group in respect to the carboxylic group and, by inference, the configuration of the carboxyl in the original ecgonine epimers.

2-Benzamido-3-*anti*-tropanol (m.p. 163°, $[\alpha]_D = -6°$; IV), prepared from *anti*-ecgonine, was converted by absolute ethanolic hydrogen chloride quantitatively into 2-amino-3-*anti*-benzoyloxy-tropane *bis*-hydrochloride (m.p. 214–216°; $[\alpha]_D = -22°$; VI). Under identical conditions, 2-benzamido-*syn*-3-tropanol (V; m.p. 205°) affords only the monohydrochloride of (V), that is, in the latter case no acyl migration N → O is taking place. Thus the amino and hydroxyl groups are shown to be *cis* in the 2-amino-*anti*-tropanol, and *trans* in the *syn*-tropanol epimer. Obviously, in ecgonine and in cocaine the carboxylic and C$_3$-hydroxyl groups occupy the same corresponding positions. Hence, cocaine is (−) 2-*cis*-carbomethoxy 3-*anti*-benzoyloxy-tropane. As another approach t the problem, the two ecgoninol C$_3$-epimers were pre pared by reduction of the methyl esters of (I) an (II) with lithium aluminium hydride, which conver sion leaves the asymmetrical carbon atoms intac These epimers will be compared in other stereo specific reactions at some later date.

These results admit the following interpretation c previous findings of earlier authors. It is well known[3] that (I *b*) is more readily converted into anhydrc ecgonine than (II *b*). This dehydration appears t involve a *trans*-elimination[7], and is evidence that, i ecgonine, C$_2$—H and C$_3$—OH are *trans* (polar, polar[8]) situated. It follows, then, that in (*anti*)-ecgonine th relative positions of the carboxyl and hydroxyl ar *cis*, the reverse being true for *syn*-(ψ)-ecgonine, whic is in complete agreement with the results of th above acyl migration experiments.

It is intended to investigate the configuration o the "third racemate"[2] of ecgonine and that of the ye unknown fourth epimer by the same methods. Th third racemate cannot be epimerized, and, bein readily dehydratable, appears to have C$_3$—OH an C$_2$—H in the *trans* configuration (polar, polar). There



re, the C_3—OH would be predicted to be *sym* placed respect of the nitrogen. For the fourth racemate, erefore, the structure of a 2-*trans*-carboxy-3-*anti*-opanol seems to be valid.

Our experiments also point to the fact that opolamine and scopine (VII *a* and *b*) can only be rivatives of tropine (*anti*-3-tropanol), as they are adily converted[9,10] into the tetrahydrofurane deriva-ve scopoline. The rupture of the epoxide ring of opolamine can only be attributed to the rearward icleophilic attack of the C_6-oxygen. Accordingly, e *trans* position of the epoxide ring of scopolamine, well as that of the C_6-hydroxyl group of scopoline relation to the C_3-oxygen, appears to be likewise oved. It is intended to establish these predictions experimental investigation of the existing con-gurative correlations between scopolamine, valeroi-ne and tropine.

Experimental details will be submitted to the *urnal of the Chemical Society*.

Note (*March* 28).—Ecgoninol can be converted in e presence of benzenesulphonic acid to the cyclic nzylidene acetal, whereas ψ-ecgoninol remains ichanged under the same conditions.

Ecgonine (I) and ψ-ecgonine (II) fail to form loralids, (I) undergoing dehydration to anhydro-gonine and (II) remaining unchanged.

These findings support the configuration ascribed oove to the ecgonine epimers.

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Use of *n*-Butanol – Formic Acid – Water Mixture in the Paper Chromatography of Amino-Acids and Sugars

DURING the course of a systematic investigation of ne amino-acids of the sugar cane, it became desirable o record simultaneously the amino-acid distribution n material from several sources. Two-dimensional hromatograms developed by Consden, Gordon and lartin[1], although effecting excellent resolution of the onstituents of a mixture, suffer from the disadvantage hat only one sample can be mapped at a time. loreover, the application of controls necessitates the reparation of separate maps. On the other hand, he single-dimensional 'strip chromatogram' offers a nuch more rapid method of analysing mixtures of mino-acids; but the use of phenol-aqueous mmonia as solvent was found to give rather poor eparation of individual amino-acids. Under tropical conditions, darkening of the solvent was an added difficulty.

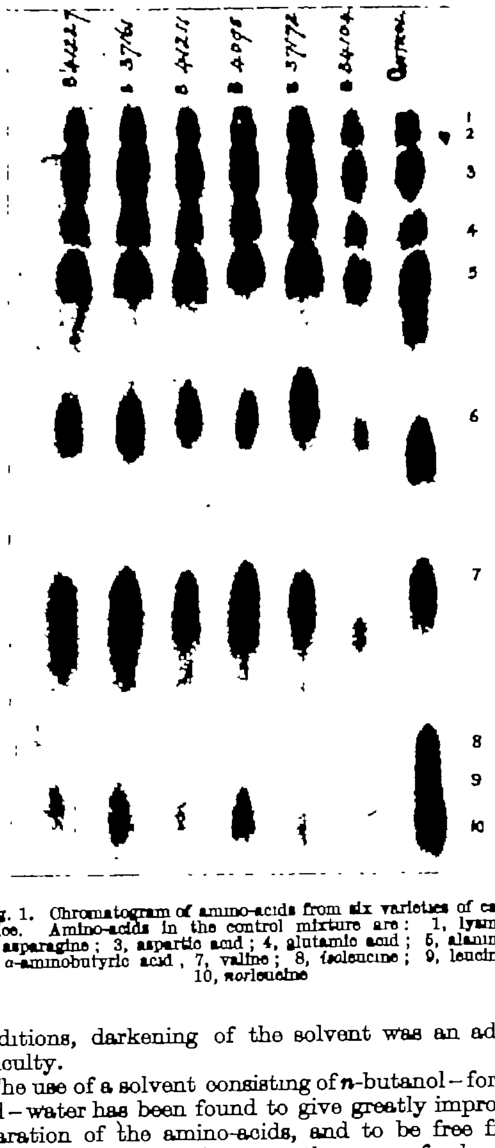

Fig. 1. Chromatogram of amino-acids from six varieties of cane juice. Amino-acids in the control mixture are: 1, lysine, 2, asparagine; 3, aspartic acid; 4, glutamic acid; 5, alanine, 6, α-aminobutyric acid, 7, valine; 8, *iso*leucine; 9, leucine; 10, *nor*leucine

The use of a solvent consisting of *n*-butanol – formic acid – water has been found to give greatly improved separation of the amino-acids, and to be free from the numerous objections to the use of phenolic solvents. The solvent was prepared by refluxing for an hour a mixture of formic acid (90 per cent, 50 c.c.), *n*-butanol (600 c.c.) and water (50 c.c.). A further 300 c.c. of water was then added and the mixture shaken from time to time during cooling. After being kept for twenty-four hours, the upper solvent layer was separated and was then ready for use.

Fig. 1 is a photograph of a typical chromatogram obtained for the amino-acids of the juice of six varieties of mature sugar cane. These cane varieties, all derived from the Cane Breeding Station in Barbados, were grown in Trinidad concurrently and were harvested at the same time. The amino-acids were obtained from the fresh juice by adsorption on columns of 'Amberlite IR 120', followed by washing with water and elution with dilute ammonia. After concentration *in vacuo*, the extracts were chromatographed on Whatman No. 1 filter paper in the usual manner for forty hours in the above solvent. The chromatograms were developed by spraying with ninhydrin (0·4 per cent) and cobalt chloride (0·2 per cent) in *iso*propyl alcohol, and heating at 110° C. for ten minutes. The amino-acids showed up as

Fig. 2. Chromatogram of a sugar mixture in formic acid-n-butanol-water solvent. The sugars shown are: 1, raffinose; 2, sucrose; 3, glucose; 4, fructose; 5, xylose; 6, rhamnose

salmon-coloured spots rapidly turning bright magenta red.

The six varieties of sugar cane examined all show a very similar amino-acid pattern, as can be seen from the photograph, which also indicates the identity of the individual spots shown on the chromatogram. An interesting point is that, in the solvent used, asparagine has a smaller R_F value than aspartic acid (the sequence of amino-acids in the control mixture was previously determined by running them separately), whereas in phenol the reverse is true. Similarly, lysine, which has a large R_F value in phenol, has a very small R_F value in the solvent here described.

A full account of the qualitative and quantitative examination of the amino-acids of sugar cane will be published elsewhere.

The solvent described above can also be used satisfactorily for the chromatographic separation of sugars. Fig. 2 is a photograph of a chromatogram obtained in a 40-hr. run from a mixture of glucose, fructose, sucrose, xylose, rhamnose and raffinose, after development of the chromatogram with aniline phosphate in butanol, a reagent which, as found by Bryson and Mitchell[2], showed up all the sugars satisfactorily.

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Plasma Thromboplastin

WHEN whole normal blood clots in a glass tube, the generation of thrombin can be observed by removing 0·1-ml. amounts at intervals and adding these to fibrinogen. The clotting times of the fibrinogen samples will record the amount of thrombin present. When this is done, it is found that there is a phase lasting 3–4 min. in which no thrombin can be detected. Thereafter an extremely rapid formation of thrombin occurs, and all the prothrombin is converted to thrombin in 2 or 3 min. This separation of thrombin formation into two phases suggests that there is a powerful intrinsic thromboplastic activity of blood, but that 3–4 min. are required for its formation.

The plasma of a patient deficient in prothrombin but apparently lacking in no other factors was useful for the demonstration of plasma thromboplastin activity. A 1/5 dilution of the patient's plasma was mixed with washed platelets from normal plasma and calcium chloride. At intervals samples were remove from this incubation mixture and added to norm plasma made platelet-deficient by centrifuging, an the mixtures were immediately recalcified. Th clotting times of the normal plasma mixtures ar shown in Table 1. In this experiment the clottin of the substrate plasma samples certainly cannot b attributed to thrombin transferred from the incubation mixture because very little thrombin was formed The potency of this thromboplastin requires littl emphasis. A 1/5 dilution of plasma mixed wit platelets formed a thromboplastin comparable i strength to undiluted brain emulsions.

Table 1. FORMATION OF THROMBOPLASTIN IN PROTHROMBIN-DEFICIEN PLASMA

0·3 ml. of 1/5 plasma was mixed with 0·3 ml. platelet suspensio (318,000 per c.mm.) and 0·3 ml. of *M*/40 $CaCl_2$. At intervals 0·1 m of this incubation mixture was added to 0·1 ml. of normal plasm and the mixture immediately recalcified with 0·1 ml. of *M*/40 CaC The clotting times are recorded in seconds. The fibrinogen clotti times give an indication of the amounts of thrombin transferred fro the incubation mixture.

Incubation mixture	Substrate	Time intervals in minutes for withdrawal of samples from the incubation mixture								
		½	1	2	3	4	6	8	16	32
Equal parts of: (1) Prothrombin-deficient plasma 1/5	Recalcified normal plasma	37	24	18	16	16	15	15	17	21
(2) Platelets (3) *M*/40 $CaCl_2$	Fibrinogen	660	163	300	460	570	960	1,800+		

The factors required for the formation of thromboplastin are platelets, the 'antihæmophilic globulin and factor VII[1]. Factor VII is probably identica with serum prothrombin conversion accelerator[2] convertin[3], and co-thromboplastin[4]. The formation o this thromboplastin in the factors isolated fron normal plasma and serum is shown in Table 2.

Table 2. FORMATION OF THROMBOPLASTIN FROM FACTORS ISOLATE FROM NORMAL PLASMA AND SERUM

'Antihæmophilic globulin'. The fraction precipitated by 33 per cen saturation with $(NH_4)_2SO_4$ from normal plasma previously treate with $Al(OH)_3$ to remove prothrombin.

Factor VII. The fraction of serum prepared by $Al(OH)_3$ adsorptio and subsequent elution with phosphate buffer at pH 8.

Platelets: 700,000 c.mm. prepared from normal plasma.

0·2 ml. amounts of antihæmophilic globulin, factor VII, platele and *M*/40 $CaCl_2$ were mixed, and at intervals 0·1 ml. of the incubatio mixture was added to 0·1 ml. of normal plasma and the mixtu immediately recalcified with 0·1 ml of *M*/40 $CaCl_2$.

The clotting times were recorded in seconds.

Incubation mixture	Substrate	Time intervals in minutes for the withdrawal of samples from the incubation mixture					
		1	2	4	8	16	32
Equal parts of 'antihæmophilic globulin', factor VII, platelets, *M*/40 $CaCl_2$	Recalcified normal plasma	53	51	25	18	13	14

It appears that platelets are the main quantitativ precursor of thromboplastin, and that the anti hæmophilic globulin and factor VII are required i relatively small amounts. This work will be reporte in detail elsewhere.

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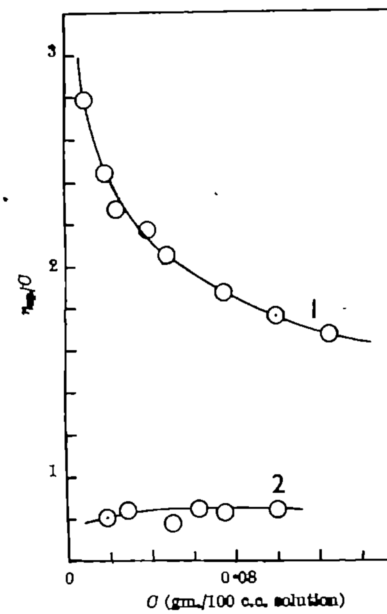
Viscosity of Sodium Salt of Polyuronide Hemicellulose from Jute

IT has been observed by Fuoss and Strauss[1] that e viscosity behaviour of a polymer such as poly- ylbutyl pyridonium bromide, containing ionizable oups, in water is not the same as that of a neutral lymer. The reduced viscosity (η_{sp}/C) of the former polyelectrolyte), unlike that of a neutral polymer, creases on dilution. A similar behaviour has been ted by Pals and Hermans[2] in the case of sodium otinate. Basu[3] has studied the viscosity of sodium ymonucleate, which also behaves as a polyelectro- te. The present communication describes the scosity measurements of the sodium salt of methyl- onic acid – xylan complex[4] (a jute hemicellulose ction). As this uronic acid is believed to occur in chain molecule, it was thought that the sodium lt of the complex in aqueous solution might also have as a polyelectrolyte. This does not appear have been studied hitherto.

The results of viscosity determinations are shown aphically ; curve 1 shows that the reduced viscosity tually increases on dilution. In the presence of 1 *N* sodium chloride solution, the sodium salt behaves a neutral polymer. These facts may be readily ex- ained by the conception of polyelectrolytes put rward by Fuoss and Strauss[1]. Viscosities were easured in an Ostwald viscometer with an efflux time r water of about 165 sec. at 32° C.



Reduced viscosity of (1) sodium salt of methyluronic acid – xylan complex, (2) same in presence of sodium chloride

Defatted jute was delignified with 'Textone'[5] ; the r-dry holocellulose thus obtained was treated with ·3 per cent caustic soda solution (w/w) at room mperature for two hours and filtered through a ntered-glass filter. The filtrate was acidified with lacial acetic acid, and an equal volume of absolute thyl alcohol was then added. The precipitate was ltered off and washed free from acetate with queous ethyl alcohol (1 : 1). The sodium salt of emicellulose (acetic acid is too weak to decompose) thus obtained was purified by dissolving in per cent caustic soda solution at room temperature, filtering and washing the precipitate first with aqueous ethyl alcohol (50 per cent) and then with absolute alcohol. This was dried in a vacuum desiccator over concentrated sulphuric acid.

My thanks are due to Dr. P. B. Sarkar, director of the Technological Research Laboratories, Indian Central Jute Committee, for his interest in this work.

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Biological Activity of some Enteramine-related Substances

THE action of enteramine on various biological test objects has been established in previous investigations[1].

The present communication represents a preliminary contribution to the comparative study of the actions developed, on some of the most important and significant biological reactives of enteramine, by a number of enteramine-related indole derivatives.

The results obtained with indol- and hydroxyindolalkylamines on the diuresis of hydrated rats (antidiuretic action), on the blood pressure of the spinal cat (hypertensive action), as well as on the isolated oestrus-uterus of the rat, and the *in situ* urinary bladder of the dog (stimulant action), are summarized in the accompanying table.

The activity of enteramine is arbitrarily taken as 100 ; the activity of the other substances is expressed in percentage.

	Hydrated rats' diuresis	Rat oestrus-uterus	Dog urinary bladder	Spinal cat blood pressure
Enteramine	100	100	100	100
Bufotenine	6–7	10	5–10	50
Bufotenidine	<0·3	0	?	400–600
Bufothionine	0	0	0	0
Dehydrobufotenine	0	0	0	0
Tryptamine	0·3–0·5	1–1·5	1·5	12–16
1-Methyltryptamine	0·1–0·2	1–3	1–1·5	10–12
N-Methyltryptamine	<0·3	<0·5	<0·5	10
N,N-Dimethyltryptamine	<0·3	<0·5	<0·5	6–8
5-Methoxytryptamine	25–40	25–30	30–35	30–50
Adrenaline	diuretic action	inhibition	inhibition	2,000–3,000

The following compounds have proved wholly inactive on all the above biological reactives : indole, skatole, 5-methoxyindole, β-(indole-3)-acetic acid, β-(indole-3)-propionic acid, γ-(indole-3)-*n*-butyric acid, tryptophane, tryptophanol, hypophorine.

From the data in the table and from the study of numerous records, the following conclusions may be drawn.

(*a*) Among the indolalkylamines hitherto tested, enteramine possesses the most powerful action on the diuresis and the uterus of the rat, and on the urinary bladder of the dog. Moreover, the biological reactives are in no way damaged by the substance, as shown by the easily repeatable pharmacological response, and, when working with isolated organs, by the prompt reversibility of this response, however intense it may be, after washing out.

This by no means occurs with bufotenine or with the methyltryptamines, which, on the contrary, may greatly damage the smooth muscle.

(*b*) 5-Methoxytryptamine is the product which most closely approaches to enteramine, both qualitatively and quantitatively; bufotenine (= N,N-dimethylenteramine) does it to a much lesser degree.

It seems, therefore, that for the appearance of the specific antidiuretic and uterus-stimulating actions the peculiar structure of the lateral chain of enteramine (chain with two carbon atoms, with a primary amino-group attached to the terminal carbon atom) is as important as the presence of a free phenolic hydroxy group in position 5.

(*c*) A satisfactory agreement exists between the antidiuretic action of the different substances and their uterus- and bladder-stimulating action. No relationship exists, on the contrary, between the antidiuretic action and the hypertensive action in the spinal cat.

I wish to thank Prof. R. H. Manske for the methyltryptamines.

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A Bacterial Growth-Factor Synthesized by a Soil Bacterium

Earlier studies in this laboratory[1] have indicated the presence in soil of bacteria dependent upon growth-factors provided by soil extract but not by yeast extract nor by combinations of amino-acids and vitamins (not including B_{12}). More recently it was shown[2,3] that for many of the indigenous soil bacteria dependent upon essential growth-factors supplied by soil extract, the nutrilite effect of the latter could be replaced by vitamin B_{12}. Other micro-organisms, however, remained dependent upon unidentified growth-promoting substances in soil.

In a study of the growth requirements of certain bacterial strains for the nutrition of which vitamin B_{12} was unable to replace soil extract, it was found that a number of bacteria isolated from soil and having simple nutritional needs were able to synthesize a factor nutritionally equivalent to soil extract. Using a selected test organism requiring the growth-factor (No. 88) and one capable of synthesizing it (No. *B*89), both pleomorphic bacteria of the 'soil diphtheroid' type and apparently undescribed species, more detailed study was made. With a basal medium of inorganic salts, sugar and yeast extract ('Difco'), the test organism gave no response to the addition of any of the following: thiamine, riboflavin, niacin, pyridoxin, pyridoxal, pyridoxamine, pantothenic acid, biotin, folic acid, vitamin B_{12}, *p*-aminobenzoic acid, inositol, choline, combinations of B vitamins, cytosine, thymine, uracil, adenine, guanine, xanthine, cystine, β-alanine, ribonucleic acid, desoxyribonucleic acid, oleic acid, tomato juice filtrate, casamino-acids, enzymatic casein digest and soil extract ash. On the other hand, growth resulted from additions of small amounts of the culture filtrate of organism No. *B*89, grown in a simple nutrient medium containing only inorganic salts and sugar (see accompanying table). Partially purified material from the metabolic liquid gave observable growth response at approximate 0·1 p.p.m. concentration.

Growth Response of Organism No. 88 (Washed Cells)

Addenda to basal medium*	Optical density (aver. of 4 tests)
None	0·005
Soil extract	0·132
B vitamins, purines and pyrimidines	0·005
0·00001 ml. culture filtrate *B*89/ml.	0·007
0·00002 ,, ,, ,, ,,	0·014
0·00003 ,, ,, ,, ,,	0·044
0·00004 ,, ,, ,, ,,	0·083
0·00005 ,, ,, ,, ,,	0·105
0·00007 ,, ,, ,, ,,	0·149
0·00010 ,, ,, ,, ,,	0·180
0·001 ,, ,, ,, ,,	0·196
Liver extract (0·37 mμ gm. B_{12}/ml.)	0·007
,, ,, (3·75 ,, ,,)	0·075
,, ,, (37·5 ,, ,,)	0·228
,, ,, (75·0 ,, ,,)	0·194
Crystalline vitamin B_{12}, 0·37 mμ gm./ml.	0·003
,, ,, 3·75 ,,	0·003
,, ,, 37·5 ,,	0·004
,, ,, 75·0 ,,	0·003

* Salts, glucose and yeast extract.

It was further found that a growth-factor effe equivalent to that given by filtrate *B*89 was obtaine on addition of injectable "15 unit" liver extract. Th effect was not attributable to vitamin B_{12} as indicate in the table, showing results with different amoun of liver extract and equivalent concentrations c crystalline vitamin B_{12}. Growth stimulation c *Lactobacillus leichmannii* by a factor in liver extra which promotes growth in excess of that attributab to vitamin B_{12} has been reported[4], while concentrat from liver have been found[5] to contain a factor r quired by *Leuconostoc citrovorum* which appears t be identical with 'folinic acid'[6]. Since these facto were reported to be present in yeast or yeast extrac there is reason for assuming that the factor produce by organism *B*89 is a different substance. Th latter is believed to represent a nutrilite require for the growth of a group of indigenous soil bacter and to contribute to the growth-promoting properti of soil extract. It is considered a matter of intere that it is nutritionally equivalent (for the te bacterium) to a factor in liver extract and that is a product of microbial synthesis.

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Inhibitors of Hyaluronidase

An unsolved problem in the study of rheumat diseases is whether or not hyaluronidase plays an part in the typical changes in the connective tissu particularly of the interfibrillar cement substanc which is believed to contain hyaluronic acid. Guerra for example, claimed that sodium salicylate si nificantly inhibits the spreading power of hya uronidase injected into the skin, and therefo ascribed the value of salicylate in rheumatic fever t an action of the drug on the hyaluronidase–hyaluron id system of the body. Meyer[2] and Dorfman *et al.*[3] nfirmed these observations, but gave no experi-ental data. Later, Meyer and Ragan[4] argued that e effect claimed by Guerra was due not to the sali-late but to gentisate, a supposed metabolic product salicylate. Further research has since shown that erapeutic concentrations of salicylate[5,6] or gent-ate[7] are too weak to inhibit hyaluronidase *in vitro*. oreover, Swyer[6], Dalgaard-Mikkelsen[8] and Jones[9] iled to find any demonstrable effect of salicylate i the spreading activity of hyaluronidase injected to the rabbit's skin. The evidence is thus contra-ctory and too weak to ascribe the value of salicylate rheumatic fever to an inhibition of hyaluronidase.

In an endeavour to clear up this problem, an vestigation was started at this laboratory in 1948. ne purposes of the investigation were to find potent, n-toxic inhibitors of hyaluronidase, and to ascer-in: (*a*) whether any such inhibitors are capable influencing the course of pathological changes in e ground substance of mesenchymal tissue; and) whether they are of value in the prophylactic or erapeutic treatment of diseases secondary to in-ctions with bacteria producing hyaluronidase, aluronidase being known to increase the permeabil-y of the tissue and thereby presumably to favour e invasion of the tissues by other micro-organisms.

Numerous organic compounds were tested viscosi-etrically for hyaluronidase-inhibiting properties. ighly purified testis hyaluronidase was mixed with e substance to be tested. Thirty minutes later the ixture was added to a 0·2 per cent solution of hyal-ronic acid from umbilical cord, which was adjusted a *p*H of 7 by means of phosphate. Readings were ken at 37° C. after different intervals. The investiga-on will be reported in detail elsewhere[10]. Certain lycondensation products built up of substituted iphenylmethane units proved powerful inhibitors of stis hyaluronidase. These compounds were obtained y allowing dihydroxy- or trihydroxy-benzoic acids react with formaldehyde under conditions favour-g the formation of condensation products of fairly gh molecular weight. Substitution in the methylene roups of these compounds by monohydroxy- or olyhydroxy-carboxyphenyl radicals produced still ronger inhibitors. These compounds were syn-esized by oxidizing polycondensed diphenylmethane erivatives with nitrous acid in the presence of suit-ble phenol derivatives. The inhibitory activity i *vitro* of some polycondensed diphenyl- and tri-henyl-methane derivatives and the acute oral oxicity of the compounds in mice are summarized i the accompanying table, which, for purposes of comparison, includes also corresponding values for salicylic acid and gentisic acid.

Compound		Inhibitory action on hyaluronidase (relative units · resorcinol = 1)	Acute oral toxicity (LD_{50} in mgm./100 gm.)
Polycondensed methylenedigentisic acid	7*P*	2,000	1,000
Polycondensed methylenedi-γ-resorcylic acid	24	1,850	400
Polycondensed hexahydroxytricarboxytriphenylmethane ('trigentisic acid')	21*P*	2,485	> 1,500
Polycondensed heptahydroxytricarboxytriphenylmethane ('di-β-resorcylic-gallic acid')	16*P*	1 300	540
Polycondensed heptahydroxytricarboxytriphenylmethane ('digentisic-gallic acid')	30	2,275	1,250
Salicylic acid		0·2	100
Gentisic acid		0 8	300

Of the diphenylmethane derivatives, it was a high-molecular weight condensation product of methylene-digentisic acid that showed the highest *in vitro* activity. The inhibitory activity of the triphenyl-methane derivatives synthesized by the reaction of polycondensed digentisic acid with gentisic acid or gallic acid was even stronger. The toxicity of the diphenylmethane and triphenylmethane derivatives tested is low (see accompanying table). The strong inhibitory action of these compounds was confirmed by experiments *in vivo*.

Reports[11,12] of these *in vivo* experiments and of clinical trials with the new inhibitors will be published in due course.

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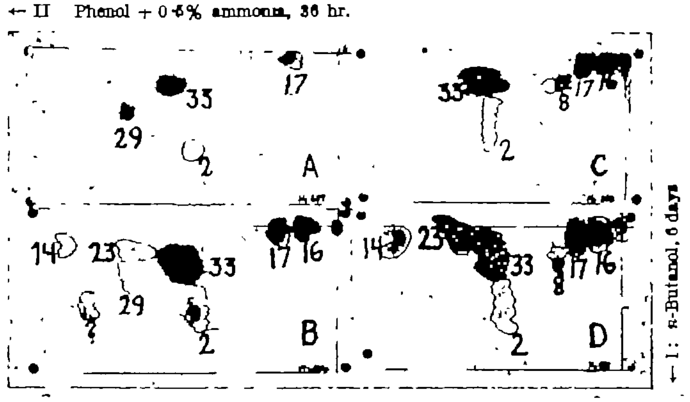
Free Amino-Acids in the Leaves, Roots and Root Nodules of the Alder (*Alnus*)

AN intensive fixation of atmospheric nitrogen takes place not only in the root nodules of leguminous plants but also in those of the alder[1]. For example, in a quartz sand culture of *Alnus glutinosa* with no combined nitrogen the growth was 261 cm. in length and the increase of nitrogen in the plant about 6·5 gm. in the second year (Virtanen and Saubert-v. Hausen). In order to gain information on the mechanism of the atmospheric nitrogen fixation and the nitrogen metabolism in general we have examined the seasonal occurrence of free amino-acids in the different parts of *A. glutinosa* and *A. incana*.

The free amino-acids were extracted by aqueous ethanol (70 per cent by weight) and the extracts were examined by two-dimensional paper chromatography (Fig. 1). Quantitative determinations were made by visual comparisons with a known series of dilutions. This method gives an accuracy of about 20–30 per cent. The method was controlled in respect to citrulline photometrically by diacetyl monoxime reaction[2].

The free amino-acid found most abundantly in the roots and nodules of the alder is L(+)-citrulline. In this respect alder differs distinctly from the leguminous plants, for example, *Pisum* and soya bean, in the roots and nodules of which asparagine and glutamine are found in abundance, but no citrulline[3,4]. Asparagine and glutamine are not found in the roots nor in the nodules of alder. The citrulline content of the nodules of both *Alnus* spp. increases greatly in the



Paper chromatograms of alcoholic (70 per cent by wt.) extracts from alder roots and nodules. Paper: Whatman No. 1, development by ninhydrin. *A*, nodules of *A. incana*, *B*, nodules of *A. glutinosa*, *C*, unnodulated roots of *A. glutinosa*; *D*, nodulated roots of *A. glutinosa*. 2 = alanine, 8 = serine, 14 = arginine, 16 = aspartic acid, 17 = glutamic acid, 23 = ornithine, 29 = γ-amino-butyric acid, 33 = citrulline

autumn, rising from about 0·2–0·3 per cent in the summer time to about 1–2 per cent of the dry weight of the tissue.

To confirm the identity of citrulline, it was isolated from the nodules of *A. incana* as the difficultly soluble copper salt, m.p. 266–268° C., which was in every respect identical with the authentic Cu-L(+)-citrullinate. The yield was 0·6 per cent of the dry weight. The nodules were harvested in October.

The nodules of *A. incana* (samples taken from Nature in August and October) contain, in addition to citrulline, appreciable quantities of γ-amino-butyric acid (*c.* 0·2 per cent of dry weight) with smaller amounts of alanine and glutamic acid but no other free amino-acids (Fig. 1,*A*).

The nodules of *A. glutinosa* (from laboratory cultures in January and May) differ from those of *A. incana* mainly by containing only traces of γ-amino-butyric acid (Fig. 1,*B*). In addition, they contain some aspartic acid and small amounts of arginine and ornithine. The roots of *A. glutinosa* (from laboratory culture in January) differ from the nodules taken from the same plant by containing somewhat less citrulline but much more arginine and ornithine (*c.* 0·1–0·2 per cent of dry weight) (Fig. 1,*D*). Those parts of the roots which are nearest to the nodules possess considerably higher concentrations of free amino-acids than do the more remote parts, but there is no qualitative difference. The leaves of *A. glutinosa* differed from the roots and nodules of the same plant mainly by containing less citrulline.

To ascertain whether the occurrence of citrulline in the nodules of the alder is possibly due to nitrogen-fixation taking place in the nodules or to nitrogen-metabolism, the free amino-acids of unnodulated alder roots were also examined. These alders were grown in sand and water cultures with combined nitrogen: nitrate, ammonium, aspartic acid–nitrogen. It was found that such roots, too, contain citrulline (Fig. 1,*C*), although considerably less than the nodulated roots (*c.* 0·1 per cent in winter). The presence of citrulline in the roots of alder is thus no consequence of the fixation of molecular nitrogen.

Other two-dimensional paper chromatograms were sprayed by *p*-dimethylamino-benzaldehyde reagent[5], which reacts with urea and ureides on paper, giving yellow spots. Intense citrulline spots were obtained from all the root and nodule extracts; but a detectable amount of urea was present only in the extract from the unnodulated roots (less than 0·0 per cent of dry weight).

So far as we know, citrulline has not bee found in the higher plants except in wate melon (*Citrullus vulgaris*), from which it wa originally isolated by Wada in 1930[6]. I is probably produced in alder roots by th Krebs–Henseleit cycle[7] from ornithine as i the animal organism, although there is n direct proof of this so far. It is noteworth that in winter the concentration of fre arginine and ornithine is high in the root near to the nodules but not in the nodule Borsook and Dubnoff[8] have shown tha citrulline reacts with glutamic or asparti acid while it is converted to arginine.

The great accumulation of citrulline i the nodules in the autumn suggests tha citrulline in the alder may have the role c a nitrogen store similar to that envisage for glutamine and asparagine in the legum inous plants.

A detailed description of this work will be publishe later.

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A New Method for Isolating Members of the Acrasieæ from Soil Samples

METHODS for isolating members of the Acrasieæ which are slime moulds producing pseudoplasmodi and inhabiting soil, have been reported by variou workers[1–3]. The usual procedure is to inoculat directly on special media soil crumbs or soil/wate suspensions from samples being tested. The bacteri from the soil develop colonies which in turn becom the food source for the feeding myxamœbæ of th slime moulds.

The objection to these methods is that the fruitin phase of the Acrasieæ is often sparse and also over grown by various mould members of the fungi. Thi latter objection is true in part even on the nutrien 'lean' soil agar[4], which does delimit the growth of th unwanted forms. For these reasons a means wa sought of isolating members of the Acrasieæ whic would make it less difficult and cumbersome to sub culture the organism into 'pure-mixed' cultures[5] o *Escherichia coli*.

The new technique described here is simpler t operate and is more efficient. It tests larger quan tities of soil and still eliminates the contaminatin growth of other fungi almost completely. It als gives a view of the organisms under investigation mor nearly as they would appear *in vivo* in soil. The ne approach consists simply in first smear-inoculatin nutrient agar plates with *Escherichia coli*, ensuring heavy growth. Then with a sterile inoculating wir e growth is skimmed off the agar surface after -hr. incubation and suspended in sterile water.

The soil samples to be tested were previously pre- ared and placed in 25-c.c. specimen bottles. These ere sprinkled liberally with the bacteria in water ispension, enough to moisten the soil, not inundating . I find the 25-c.c. specimen bottles used by many f the biological supply houses are more than adequate r this purpose. The soil samples were loosely ulverized before being placed in the sterile 25-c.c. r to the level of one-half full. The loose-fitting etal cover completes the incubating chamber, which allowed to stand at room temperatures varying ithin limits of 20° to 23° C. After two days, pseudo- asmodia are visible, and after three days numerous uiting bodies will appear if the organisms were iginally present in the soil samples.

It is interesting to note that perhaps the appear- ice of the fruiting bodies on these cultures is more ke what it must appear to be in Nature, inasmuch they are on their natural substrate.

Escherichia coli was used as the bacterial food supply, nce past reports, and also my own experience, show at it is most suitable. Also this bacterium makes excellent food source for the Acrasieæ in 'pure- ixed' culture. Sub-culturing from the isolation als is a simple step of transferring a sorus to agar ntaining a 24-hr. old streak of *Escherichia coli*.

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Nerve Impulses Originating from the Compound Eye of the Locust

ELECTRICAL changes in response to illumination of e insect eye have been studied previously[1]. These ve been related mainly to relatively slow potential riations, of the nature of retinal potentials, recorded om the eye itself. In addition, impulses in the rcum-œsophageal commissures of *Locusta migratoria* rrelated with changes of illumination have been ported[2].

We have found that similar or identical impulses, hich are of large amplitude and rapid conduction, ay be detected in the ventral nerve cord of the sect, as far caudally as the last thoracic ganglion, it not farther. The impulse discharges, which were ways in the form of short bursts, were found to be lated to two types of stimulus: (*a*) switching the ht on and off (constant illumination gave no dis- arge); (*b*) movement of an illuminated object the field of vision. The 'on' and 'off' discharges em to correspond with the 'on' and 'off' responses hich occur in vertebrate eyes, with the distinction at in our experiments these responses were detected the central nervous system of the insect, at some stance from the eyes. The responses to movement,), may be simply related to (*a*), in that a shift of umination from one ommatidium to another may be expected to give rise to an 'off' response, immediately followed by, or merging into, the succeeding 'on'. Hence single rapid movements of small extent are accompanied by single bursts of impulses. On this supposition, therefore, the smallest detectable shift of a light/dark boundary in the visual field would be referable to an angular movement corresponding to the angle subtended between the axes of two adjacent ommatidia, or a lesser angle.

Our experimental results have so far supported this view. With the insect firmly secured, the ventral nerve cord was exposed and placed on the recording electrodes. Responses to movement of a small light source in the visual field of one eye were studied. It was soon found that the response to any particular movement could only be elicited repeatedly if a sufficient interval were allowed between successive tests; the preparation became refractory to further stimulation for a period of 5–10 sec. after the first movement was made. Afterwards, test movements were made at 10-sec. intervals, and we report only on movements in a vertical plane.

It was found that consistent responses to movement were obtained until the angular movement of the source, referred to the eye of the insect, was reduced to approximately 1°. For smaller angles, responses were obtained in less than 100 per cent of trials, and for very small angles there was no response at all. Thus the minimum angular movement which gave 100 per cent responses was approximately 1°, which agrees very closely with the angular separation of the ommatidia of the eye measured by independent means.

These results are similar to those found for perception of vertical stripes by *Carausius*[3], and for moving stripes in the honey bee[4] and *Drosophila*[5]. An acuity of perception of movement by the insect eye of the same order as the ommatidial separation thus seems well established. The responses we obtained to smaller movements (down to ¼° in some cases) are difficult to explain, if we regard the ommatidium as a single functional unit. We are at present investigating these minimal responses on the assumption that they occur when the light source is moved just across the projected boundary between two ommatidia.

The preparation as a whole offers a ready means of studying a number of visual responses, for example, spectral sensitivity of the eye, reactions to changes of light intensity, extent of visual field and variations in response of different regions of the compound eye.

We think that the biological significance of the impulse discharges described lies in relation to the jumping habit of the insect, the impulses giving an effector response in the muscle of the jumping legs (last thoracic segment). We could find no similar responses in *Carausius*.

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Heterozygosity, Environmental Variation and Heterosis

When a wild strain of *Drosophila melanogaster* is inbred under optimum conditions, the phenotypic variance of body-size is reduced by not much more than 50 per cent[1]. This suggests that nearly half the variance of the original strain was due to the effects of uncontrollable environmental variations within the culture. But highly inbred lines tend to have a much higher variance than crosses between them, so that the environmental variance in such quantitative characters is not constant for all genotypes and tends to be smaller in heterozygotes than homozygotes. This is illustrated in Table 1 for six highly inbred lines and the crosses between them. The lines came from two unrelated wild stocks, Nettlebed and Edinburgh, and include two lines selected for long wings (*LN* and *LE*), two selected for short wings (*SN* and *SE*) and two unselected lines (*UN* and *UE*). Wing-length is closely correlated with body-size, and variance is expressed as squared coefficient of variation, since this measure eliminates most of the effect of differences in absolute size.

Table 1. Phenotypic Variance of Inbred Lines and Crosses. Variance of wing-length in squared coefficients of variation

Strains crossed	Parental average	F_1	
LN × *SN*	1·79	1·37	females only
LE × *SE*	1·44	0·52	males only
UN × *UE*	2·27	1·11	sexes combined
SN × *UN*	2·85	1·88	,,
SE × *UE*	1·78	0·55	,,
SN × *SE*	4·00	2·00	,,
Average	2·35	1·24	

The inbred lines have, on the average, almost double the phenotypic variance of the crosses between them, and the same tendency is shown by crosses involving large, small and unselected lines. There are probably also differences in variance between the different inbred lines; but part of the differences between the parental averages for the six comparisons must be attributed to environmental differences between the experiments in which they were tested.

The relation between heterozygosity and environmental variance has been further analysed by preparing genotypes containing specific combinations of the three major chromosomes from inbred lines *SE* and *UE*, using methods which will be described elsewhere. If these genotypes are grouped according to the numbers of heterozygous pairs of chromosomes they carry, we find that the average variance of wing-length declines progressively with increase of heterozygosity (Table 2), so that the environmental variance of a particular genotype appears to be intimately related to the degree of heterozygosity.

A partial analysis of the *SN* × *UN* cross by the same technique shows the same general trend for size, and in view of the differences in variance between inbred lines and their crosses, it is likely to be a general phenomenon. The same general relationship also appears to hold for rate of egg production, both in comparisons between inbred lines and their crosses and in comparisons between the specific genotypes of differing heterozygosity referred to above. But problems of scaling make interpretation of these figures difficult, since the heterozygotes tend to have a much greater output than homozygotes. It seems probable that many quantitative characters in different animals and plants will show the same tendency for environmental variability, under given conditions to decrease as heterozygosity increases. It is not to be expected, of course, that the same rule would hold good when one is dealing with individual genes with large effects.

Table 2. Variance and Heterozygosity in *SE*/*UE* Genotypes

No. of major chromosome pairs heterozygous	No. of genotypes tested	Average variance of wing-length
Females		
0	5	2·54
1	9	2·23
2	5	1·44
3	1	1·20
Males		
0	5	1·64
1	7	1·31
2	2	1·19

Size in *Drosophila* shows the same phenomena of decline under inbreeding and heterosis in crosses between inbred lines as other quantitative characters. This suggests that heterosis, or increased size, vigour, etc., and reduced susceptibility to environmental variations are both manifestations of the same phenomenon of heterozygosity. There may be a general explanation for this relationship: the more heterozygous individuals will carry a greater diversity of alleles, and these are likely to endow them with a greater biochemical versatility in development. This will lead to heterosis, because of the more efficient use of the materials available in the environment, and also to a reduced sensitivity to environmental variations, since there will be more ways of overcoming the obstacles which such variations put in the way of normal development.

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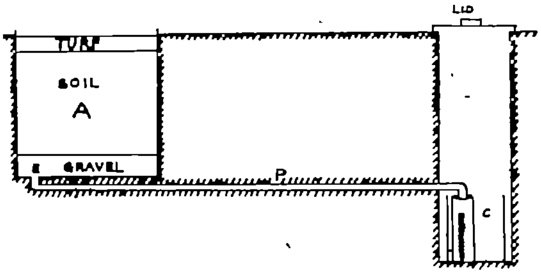
A Simple Apparatus for Measuring Potential Evapotranspiration

The combined process of evaporation from the soi and transpiration from plants is known as 'evapotranspiration'. The amount of moisture so used varies from place to place and depends mainly on climate (especially temperature and precipitation and the closeness of the vegetative cover. 'Potentia evapotranspiration', on the other hand, refers to th amount of moisture which would be utilized if supplie were unlimited and vegetative cover complete. It value, therefore, alters irrespective of precipitation and vegetation and is a function mainly of length of day and temperature[1].

Potential evapotranspiration can be measured simply and cheaply by an apparatus (see diagram made of oil drums, some lead piping and a suitably graduated jar. A 44-gallon drum (*A*) is cut down to a height of about 55 cm. From this a right-angled elbow (*E*) is led to a piece of ½-in. lead piping (*F* which drains into a container (*C*), where there is a graduated jar into which the overflow drip directly. There should be a protective shaft for thi container, which must be covered to stop the rain getting in.



A layer of gravel is put at the bottom of the apotranspirometer' (A) and the outlet (E) is ered by a small-meshed copper screen. Soil of a ht, friable nature, which permits free drainage and ter circulation, is placed in the tank (A) where, for eral purposes, grass should be grown. A suitable cedure is to install the apparatus in a level field grass so that the sod removed during installation n be replaced in the tank after the soil there has d time to settle. The area immediately surrounding apparatus should be kept well watered so that micro-climate above the tank and its surroundgs is as nearly similar as possible.

I installed an apparatus of this type in July 1951 the Johns Hopkins Laboratory of Climatology, abrook, New Jersey. It measures potential evapoanspiration by a very simple process. A known ount of water is applied to tank (A) and the ainage is collected in the overflow (C). Potential apotranspiration thus equals the amount of water plied plus precipitation, less the amount collected the overflow. The amount of water applied to the k and collected in the overflow can be converted sily to inches or millimetres of 'precipitation' as quired. This principle is the same as that used for more elaborate installations already at Seabrook, ainst which the new apparatus has been tested th satisfactory results. It can be read like a rainuge and, if erected at existing climate stations in ferent parts of the world, would add very little expense or observational time, since only one read- a day is required. In this way it could be used many areas to provide an indication of a climatic tor well worth more attention.

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e various articles by C. W. Thornthwaite, especially "An Approach towards a Rational Classification of Climate", *Geog. Rev.*, 38, No. 1, 55 (Jan. 1948) and "Climate and Moisture Conservation", *Ann. Assoc. Amer. Geog.*, 37, No. 2, 87 (June 1947).

A New Serological Division of *Staphylococcus aureus* Bacteriophages: Group *G*

THE bacteriophages lysing *Staphylococcus aureus* ve been divided by Rountree[1] into five serological oups, designated A, B, C, D and F. Phages of oups A, B and F were isolated from lysogenic phylococci from human sources.

Three phages have been received in this Laboratory at are not neutralized by anti-sera of any of untree's groups. Each of these three phages is utralized by an anti-serum prepared against one the three, and this anti-serum fails to neutralize phages of the groups A–F. We refer to this new serological group as Group G.

The three phages are numbered 65, 66 and 68 in our collection. The first two were isolated by Dr. Wallmark of Stockholm using the cross-culture technique of Fisk[2], and are referred to as 155 and 166 by him[3]. The third phage, known as 68, was received from Dr. Wahl of Paris, and had appeared as a variant of one of the phages, $44A$, used for the routine typing of staphylococci[4].

Like the phages of groups A, B and F, these three phages lyse only coagulase-positive staphylococci; but they differ from these groups in lysing a greater variety of strains. Undiluted filtrates of all three lyse most coagulase-positive staphylococci; at their routine test dilutions the phages lyse about 40 per cent of a mixed group of strains, including strains of all the three major groups defined in routine phage typing and some strains not lysed by any of the typing phages. Because of the number of strains lysed, the group G phages are not used for phage-typing in this laboratory.

The plaque-size of these phages is often variable on a single culture; small clear, or indistinct, plaques may be mixed with larger plaques that are often surrounded by a halo. When picked and plated the phages giving these different plaques do not generally breed true.

Phages of group G may be readily propagated to high titre on nutrient agar, or in broth. In this respect, and in their wide lytic range, they resemble the phages of serological group D.

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Nupserha bicolor Thoms., subsp. *postbrunnea* Breun.: a New Pest on Jute (*Corchorus olitorius* Linn.)

DAS[1] recently compiled a list of insect and mite pests of the two cultivated species of jute, namely, *Corchorus capsularis* and *Corchorus olitorius*. A pest, hitherto unrecorded in India, was detected in *olitorius* jute during 1949 on the farm of the Jute Agricultural Research Institute, and was identified by the Commonwealth Institute of Entomology, London, as *Nupserha bicolor* Thoms., subsp. *postbrunnea* Breun. The pest has since been found to be an important one for all the varieties of *C. olitorius*, while the *capsularis* varieties show resistance to it.

The pest has special economic importance, as it causes an immediate loss of a considerable portion of the stem. The ovipositing female cuts two rings around the stem with its sharp mandibles at two different levels, 0·7–2·7 cm. apart, with highest frequency between 1·0–1·4 cm. A slit is cut between the rings down to the pith tissue for oviposition. This causes withering and ultimate death of the apical plant region above the lower ring.

From our observations, it is presumed that the seat of oviposition chosen has a direct relation to the ratio of the length of mandibles of the laying female and the diameter of the stem. No oviposition has been recorded in stems outside the diameter range of 0·2–0·4 cm.; rings may be cut on stems of diameter up to 0·5 cm., but these do not generally exceed 0·4 per cent of the total. This clearly indicates the role of mandibles in the selection of diameter of stem for oviposition, and consequent susceptibility to damage.

Loss of plant height is therefore regulated by the actual seat of oviposition in the stem within the range of susceptible diameter. Frequencies of occurrence of height classes lost with susceptible diameter classes at the level of the lower ring show that the highest frequency lies in the height range 10–20 cm. and stem diameter 0·26–0·3 cm.

With susceptibility restricted to the apical part of the stem, loss of fibres becomes insignificant with older crops. It has been estimated that, in the young crop, loss of stem may be up to 30·02 per cent; in older crops, it is 6·32 per cent on the average.

Pre-ovipositing operations and feeding on the veins of the leaves by the adults, leaving the softer tissues intact, produce symptoms so specific that they may be taken as a field key for identification.

Crotalaria juncea, *C. saltiana*, *Hibiscus cannabinus*, *Aeschynomene aspera* and *Sesbania aegyptiaca* have been recorded as alternative host plants.

Fuller details will be published later. Thanks are due to Dr. B. C. Kundu, director of the Institute, for his helpful suggestions.

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Bacterial Invasion

Let it be assumed that: (*a*) each organism invading a host has a chance λ of reaching a favourable site, and of afterwards undergoing a sequence of events which enable it to proliferate and result in the death (or infection) of the host; (*b*) each organism acts independently; (*c*) c inhaled organisms are necessary to produce the death (or infection) of 0·5 of the total of exposed animals; (*d*) the experimental animal population is large and homogeneous. Then the proportion S of animals remaining uninfected after the intake of n organisms each is given by:

$$S = (1 - \lambda)^n,$$

and by definition $0\cdot5 = (1 - \lambda)^c$.

Expressing n in units of c, that is, $n = fc$,

$$S = (1 - \lambda)^{fc} = 0\cdot5^f.$$

Where invasion by pathogens is through the respiratory system, these conditions might well apply. The argument is not invalidated by consideration of the case of many organisms grouped in one particle, since once the particle is deposited on a moist surface the cluster usually disintegrates and each organism has an independent subsequent history.

For the purpose of comparison with existing data on experimental respiratory infection available to me, the curve $S = 0\cdot5^f$ was plotted on the conventional probit–log dose plane. The curve shows a slight upward concavity, but is almost straight between the ED$_{25}$ and ED$_{75}$ values, having a mean slope approximately 1·9. Tables 1 and 2 show expe mental values of slopes for comparison.

Table 1. Slopes Obtained by Exposure of Animals to Clouds
Anthrax Spores (Ref. 1)

Animal	Size of particle inhaled	Slope ± 2σ range
Guinea pig	Single spore	1·26–2·13–3·0
,,	3·5 μ	1·31–2·44–3·57
,,	4·5 μ	0·59–1·26–1·93
,,	8 μ	1·67–2·54–3·41
,,	12 μ	0·72–1·25–1·78
Monkey	Single spore	1·45–3·19–4·93
,,	12 μ	0·32–1·17–2·02

Table 2. Slopes Obtained by Exposure of Guinea Pigs to Clo
of Single Organisms of the *Brucella* Group (Ref. 2)

Organism	Slope ± 2σ range
Br. suis	0·26–1·17–2·08
,,	1·64–2·86–4·08
,,	1·47–2·61–3·75
,,	1·41–2·54–3·67
Br. melitensis	0·99–1·76–2·53
,,	0·51–1·54–2·57

It will be observed that in twelve of the thirte results quoted, the slope value of 1·9 given by t theoretical curve lies within the 2σ range of t experimental results.

If the hypothesis outlined be true, it follows th the infection or mortality among a batch of anima exposed to a given bacterial cloud depends upon t total number of organisms deposited in the respirato tract of the host, and not upon the time taken deposit them. This, of course, will not be true if t time of exposure is made sufficiently long for i munity processes stimulated by the early depositio of organisms to influence the fate of those deposit later. Thus for a batch of animals exposed to bacterial cloud, it would be expected that a consta mortality or infectivity would be obtained if t aerosol concentration (C) × time of exposure (t) constant.

Results supporting this conclusion have bee quoted by Goldberg and Watkins[3] using *Streptococc zooepidemicus* and *Klebsiella pneumoniae*, while value of $C^{(1\cdot1\pm0\cdot05)}t$ = const. has been obtaine for *B. anthracis* spores and guinea pigs by workers[1] i this department.

Expressed in its logarithmic form, the equatio becomes:

$$\log S = -0\cdot301\,f.$$

It is suggested that bacteriologists, particularly i the field of respiratory infection, might consid whether a simple plot of log survival against do might provide adequate linear representation of the results, as was found to be true for the results t slopes of which are given in Tables 1 and 2.

I am indebted to Dr. D. W. Henderson and M S. Peto for help and advice, and to the Chief Scienti of the Ministry of Supply for permission to publis this communication.

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[2] Elberg, S. S., and Henderson, D. W., *J. Inf. Dis.*, 82, 302 (1948)

[3] Goldberg, L. J., and Watkins, H. M. S., *Bact. Proc., Soc. Am. Bac* 74 (1952).

Wave Velocities in the Outer Part of the Earth's Mantle

IITHERTO, wave velocities V in the earth's interior 'e been calculated from the travel times t of earth- ıke waves in shallow shocks computed as a function the epicentral distances Δ. This procedure fails ,t any depth the velocity V decreases with depth ı rate in excess of $dV/dr = V/r$, where r is distance m the centre. In this case a portion of the travel- ıe curve is formed by the arrival of diffracted ves; if these are misinterpreted as direct waves, orrect velocities are found not only for the low- ocity layer, but also (with decreasing errors) for deeper layers. Moreover, discontinuities may be rred when none actually exists.

n 1914, in a different form, the following equation s developed by S. Mohorovičić[1]: $V = V^* r/R$, where s radius of the earth, V is velocity at the depth $h =$ $-r$ of the focus, and V^* is apparent velocity ($d\Delta/dt$) he point of inflexion (distance Δ^*) of the travel-time ve for longitudinal (P) or transverse (S) waves a given shock. Apparently it has not been realized t this equation can be used to calculate the vel- ties of the two waves at a depth corresponding h the focal depth. Neither the time of origin of shock nor the distance Δ^* enters the calculations. e focal depth h of the shock must be known, and a ficient number of reliable time-observations at tance from about 500 km. less to 500 km. greater n Δ^* must be available for finding V^*.

About eighty earthquakes were found listed in the ernational Seismological Summary for which the essary conditions for application of the method fulfilled. Most of them occurred in the Japanese a between 1930 and 1940 at depths from 20 km. 600 km. For years later than 1940 the Summary not yet been issued. Data for a few shocks in eastern and central Mediterranean (depths ween 100 km. and 300 km.), in Roumania (150± ı.) and in the Hindu Kush (250± km.) do not licate any appreciable regional differences in ocity at the depths involved. Average velocities V ngitudinal) and v (transverse) in km./sec., and lues of Poisson's ratio σ at the depths h in km. as follows:

50	100	150	200	250	300	400	500	600
8·0	<7·8	<7·9	8·1	8·3	8·5	9·0	9·6	10·2
4·45	<4·4	<4·35	<4·4	4·45	4·6	4·95	5·3	5·65
0·26	0·27	0·27	0·28	0·29	0·29	0·29	0·29	0·29

These new values agree well with those which had en found by application of the older method to nes of travel of shallow shocks; but they bring t much more prominently the low-velocity layer depths near 100 km. This had been indicated eviously by observations of amplitudes, especially adow zones'[2], at epicentral distances of about 00 km. The new velocity data do not indicate y discontinuity within the range of depth given ove. A sudden increase in velocity at a depth of out 400 km. has been assumed by some to explain e so-called 20°-discontinuity in the travel-time rve. However, this discontinuity is a consequence 'ray optics' produced by the low-velocity layer. e actual velocities in the low-velocity layer may somewhat smaller than those given in the table, ce the resulting decreases in V and v possibly ceed the critical rates of 0·13 and 0·07 km./sec. r 100 km. respectively. Local temperature or other atively small differences at the depths involved may result in a decrease of velocity less than the critical rate in one area and in excess of it in another. Thus P or S or both may show 'shadow zones' of different extent (including zero) depending on the region, and even noticeable differences in time of travel. This could explain the appreciable local differences in the observed amplitudes of P, and S in recorded shocks of a given magnitude at epicentral distances between 500 km. and 2,000 km., even when the velocities at the depths involved are practically the same in all such regions.

B. GUTENBERG

Seismological Laboratory,
Division of the Earth's Sciences,
California Institute of Technology,
Pasadena, California.
June 20.

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[1] Mohorovičić, S., *Gerlands Beitr. z. Geophys.*, 13, 225 (1914).

[2] Gutenberg, B., *Bull. Seis. Soc. Amer.*, 38, 121 (1948).

Band Spectrum of AsH

IN a letter to *Nature*, Kimball and Bates[1] stated that they have succeeded in obtaining the band spectrum of AsH. The spectrum was excited in a carbon arc run in an atmosphere of hydrogen. The lower electrode formed the cathode of the arc and contained the arsenic. Two bands with origins at 32,380·2 cm.$^{-1}$ and 31,639·9 cm.$^{-1}$ were observed and attributed to AsH. The lines of the band at 32,380·2 cm.$^{-1}$ are represented by the formula

$$\gamma = 32{,}380 \cdot 18 - 11 \cdot 186\, m - 4 \cdot 47\, m^2 + 0 \cdot 0485\, m^3 + 0 \cdot 01027\, m^4.$$

We have tried to photograph the bands mentioned by Kimball and Bates but without success, although a large range of excitation conditions has been used.

It seems probable that Kimball and Bates have been confused by the P and R branches of the $^2\Sigma - {}^2\Pi$ system of CH. Using the frequencies of the lines for the R_1 and R_2 branches of the (0,0) CH band, as listed by Heimer[2], a close fit of the alternate lines is obtained with the lines calculated from the formula given by Kimball and Bates. This is illustrated in the table for a number of lines.

COMPARISON OF THE AsH LINES WITH ALTERNATE CH LINES

R branch of AsH	R_2 branch of CH	P branch of AsH	R_1 branch of CH
32,364·6	32,366·4	32,386·9	32,388·5
340·5	340·6	384·4	384·2
308·5	307·6	373·0	377·1
269·6	268·4	352·9	355·7
224·9	224·6	324·6	325·7
175·8	177·2	289·1	289·1
124·0	126·6	247·3	247·5
071·3	073·7	200·6	201·4
019·9	019·3	150·5	152·1

The other AsH band mentioned by Kimball and Bates was probably confused with the P branches of the 0,0 band of CH and the Q branch of the 1,1 band. The 1,1 band of CH forms a Q head at the approximate frequency of the AsH head mentioned by Kimball and Bates.

Pearse and Gaydon[3] have directed attention to the fact that the band attributed to As_2 by Kimball and Bates is probably identical with the Q branches of the 0,0 CH band.

This letter is published with the permission of the Council for Scientific and Industrial Research.

S. M. Naudé
T. J. Hugo

National Physical Laboratory,
Council for Scientific and Industrial Research,
Pretoria. Feb. 29.

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[1] Kimball, G. E., and Bates, J. R., *Nature*, 128, 969 (1931).

[2] Heimer, Tage, *Z. Phys.*, 78, 771 (1932).

[3] Pearse, R. W. B., and Gaydon, A. G., "The Identification of Molecular Spectra" (Chapman and Hall, London, 1950).

Relation between Activation Energy and Frequency Factor

It has been frequently observed that in some series of kindred reactions the activation energy of the process appears to be functionally related to the respective frequency factor *A*. For example, when one investigates a reaction taking place in various solvents, one often finds that *E* (the activation energy) and *A* change in the same direction. Such behaviour might indicate that the variation in the nature of the solvent affects the degree of solvation of the transition state, and consequently the activation energy and the entropy of activation (that is, *A*) in the same direction.

It appears that such relations do not hold for series of kindred unimolecular reactions taking place in the gaseous phase. For example, it has been pointed out[1] that the unimolecular dissociation processes of the type:

$$R.CH_3 \rightarrow R.CH_2\cdot + H, \quad RCH_3 = \text{toluene, } m\text{-xylene, } p\text{-xylene and } o\text{-xylene},$$

have a constant frequency factor (apart from the statistical factor of 2 for the xylenes). However, since the activation energies for these processes vary by about 3 kcal./mole only, and the experimental errors involved in their determinations might be as large as ± 2 kcal./mole, this evidence is not very convincing. We have, therefore, been searching for a series of kindred reactions in which activation energies vary over a wide range in order to be able to draw some definite conclusions about the behaviour of the frequency factors.

The series of unimolecular dissociation processes of the type

$$R.Br \rightarrow R\cdot + Br$$

seems to be suitable for such studies. Activation energies were determined for the following decompositions: allyl-bromide, trichlorobromo-methane, benzyl-bromide, benzoyl-bromide, methyl-bromide and phenyl-bromide. All these reactions were studied over a sufficiently wide range of temperatures to yield a reasonably accurate determination of *E*, and the results, computed by the least square method, are summarized in the accompanying table. (The frequency factor for CH_3Br decomposition has been computed by a different method; see, for details, ref. 5.)

R–Br	Ref	E kcal./mole	$A \times 10^{-13}$ sec.$^{-1}$	$t_{[illegible]}$ sec.
$CH_2:CH.CH_2$–Br	4	47·5	0·5	16·0
Cl_3C–Br	5	49	2	80·0
$C_6H_5.CH_2$–Br	4	50·5	1	6·0
$C_6H_5.CO.$–Br	6	57·0	5	0·60
CH_3–Br	5	~67	~2	0·001
C_6H_5–Br	7	70·9	2	0·0001
$\alpha.C_{10}H_7$–Br		70·9	3·5	0·000

Inspection of the table reveals that the frequency factors seem to be approximately constant for a variation in the activation energies of 24 kcal./mole. The approximate constancy of the frequency factors should be contrasted with variations in the rate constants, computed for one temperature, which vary by more than 10^5. This evidence supports strongly the claim that for a series of kindred unimolecular dissociation processes, in which one bond only is ruptured and the molecule is split into a radical anc
free atom, the frequency factor is a constant, c
pending on the nature of the ruptured bond a
independent of the structure of the molecule. Tl
conclusion has been drawn previously[2], but the expe
mental evidence was less satisfactory[3].

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D. Williams

Department of Chemistry,
University of Manchester.
April 9.

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The Born Approximation in Electron Diffraction

The Born approximation for the electron wa
scattered by an atom has been universally employe
for the interpretation of electron diffraction expe
ments directed toward the determination of molecul
or crystal structure. There is some justification f
this. Quantitative measurements of diffraction i
tensities performed to test the applicability of tl
approximation for electrons of the energies usual
used in structure work have, on the whole, bee
regarded as satisfactory verifications. In structu
work itself—in the work on gas molecules, f
example—the considerable success resulting from i
use has led to the feeling that even in the presen
of heavy atoms there might not be serious errc
There has perhaps been the implicit faith that wha
ever theoretical refinements were lacking would
least not alter substantially the structures to
derived. We have found, however, that there is
phase shift on scattering, not given by the first Bo
approximation (this is the familiar Born approxim
tion, the first term of a power-series expansion
the parameter $\alpha = -Ze^2/\hbar v$), which is appro
imately proportional to atomic number, depends
angle of scattering, and may become large ar
important. The suggestion of the existence of th
phase shift arose from the cases of uranium hex
fluoride (UF_6) and some other gas molecules.

Interpretations of electron diffraction data fro
uranium fluoride have uniformly led[1] to the conclusi
that the U—F bond-lengths are not all equal; but oth
physical data (spectra, entropy, dipole moment) ha
all been interpreted[2] as demanding the regular octah
dral structure. Altogether, although various argumen
have been made to support the possibility of unequ
bond-lengths, it would seem that the greater weig
of the evidence is against it. The electron diffracti
conclusions for a number of other molecules *M*
are strikingly similar, and show no obvious relati
to known structural chemistry. On the contrar
they all split the bonds into essentially two equ

oups differing in bond-length by amounts approx- ately proportional to the differences of atomic mbers. (The pattern observed for the heavy mole- le I_2 is normal.) This simple behaviour suggests inadequacy of the scattering theory rather than e existence of real structural asymmetries. The ost likely sources of difficulty are the neglect of ultiple scattering (by different atoms) and the in- curacies of the Born approximation for atomic attering. Multiple scattering clearly cannot pro- ice an effect depending strongly on difference of omic numbers, but interference between corrections the atomic scattering can.

We therefore neglect all such effects as double attering and valence distortion, and assume that e scattering by a molecule in practice still may be presented by a superposition of waves $f_j(\vartheta)e^{ikr}/r$ attered by the separate atoms. It is important that e amplitudes $f_j(\vartheta)$ may be complex, although the st Born approximation alleges them to be real. ith $f_j(\vartheta)$ written then as $|f_j(\vartheta)|\exp(i\eta_j(\vartheta))$, the attered intensity is proportional to

$$\sum_{i,j} |f_i(\vartheta)||f_j(\vartheta)|\cos\{\eta_i(\vartheta)-\eta_j(\vartheta)\}\frac{\sin sr_{ij}}{sr_{ij}},$$

here s is the magnitude $|\mathbf{k}-\mathbf{k}'|$ of the difference initial and final propagation vectors and r_{ij} is the paration of the atoms i and j. If the amplitudes e real, the terms of this expression contributed by split pair of distances $r_{ij} = r_e - \delta$ and $r_{ij'} = r_e + \delta$, ith like atoms j and j', become

$$2|f_i(\vartheta)|\;|f_j(\vartheta)|\cos s\delta\,\frac{\sin sr_e}{sr_e}.$$

ince this is just the result for complex amplitudes d $r_{ij} = r_{ij'} = r_e$, if $|\eta_i(\vartheta)-\eta_j(\vartheta)|$ is propor- onal to s, the features of diffraction patterns which ith the Born approximation lead to such splits may ill be interpreted in terms of symmetrical structures. he intensity is evidently highly sensitive to the hase difference only where the phase difference is ose to an odd multiple of $\pi/2$, and in the absence accurate intensity measurements it is only the rresponding behaviour that can be regarded as ell determined. Any moderately smooth and not o great deviations of $|\eta_i(\vartheta)-\eta_j(\vartheta)|$ from propor- onality to s, at other angles, and of the $|f_i(\vartheta)|$ om the Born approximation values, at any angle, uld well remain unnoticed in gas diffraction work.)

Preliminary estimates of the phase shifts $\eta(\vartheta)$ have een made by evaluating the second Born approxima- on, a procedure which may be justified by noting at for screening distances large compared with the ave-length the third Born approximation makes a ther small contribution to the phase. The absolute alue $|f(\vartheta)|$ of the scattered amplitude cannot be ery seriously in error since in the limit (pure coulomb attering) its value is exactly correct. The asymptotic hase shift is essentially divergent, however, and ows how screening, as one might expect, has a most nportant role. In particular, for exponential screen- g ($V(r) = -(Ze^2/r)\exp(-r/a)$), the phase shift for rward scattering has the value $\eta(0) = -\alpha/2$; for rge angles it increases as $-2\alpha\log(sa)$, where a is e screening distance.

The accompanying table illustrates the resulting greement. The 'observed' distance splits are the alues obtained from the observed diffraction pat- rns with the assumption of no phase shift; the lculated values are approximately the ones which ould follow from this interpretation even in the absence of actual distance splits if the phase shift were that given by the second Born approximation for exponential screening. The agreement is remark- able, especially because neither the conventional values $a_0/Z^{1/3}$ used for the screening distances (a_0 is the Bohr radius for hydrogen) nor the approximation of exponential screening itself could be expected to be quantitatively satisfactory. We may add that, to the best of our knowledge, there are no adequately reported gas studies which disagree with the phase shift; those involving heavy atoms and apparently providing support for the Born approximation, for example, are all based on data at s values less than would give the critical relative phase shift $\pi/2$. For crystal diffraction, on the other hand, the phase shift is presumably often important even when not large. We have examined only the intensity anomalies of fluorite[3], cuprous chloride[2] and zinc oxide[4]. Fluorite and cuprous chloride appear to be well explained by the phase shifts; zinc oxide is not.

Molecule	Distance	Apparent split (A.) Observed	Calculated (a)
UF_6	U—F	0 30(b)	0·28
OsO_4	Os—O	0 23(c)	0·24
$W(CO)_6$	W—O	0 24(c)	0·24
	W···O	0·23	0 23
WF_6	W—F	0·23(b)	0·22
WCl_6	W—Cl	~0 18(e)	0 18
IF_5	I—F	0·18(f)	0·15
$Mo(CO)_6$	Mo—C	0·13(c),(d)	0 13
	Mo···O	0 13	0·12
MoF_6	Mo—F	0·14(b)	0 12

(a) For $\lambda \sim 0\,06$ A., with the relativistic value of α.

(b) UF_6: Bauer, S. H., and Bastiansen, O., ref. 1. WF_6 and MoF_6: Bastiansen, O., unpublished work in these laboratories.

(c) Sheehan, jun., W. F., thesis, California Institute of Technology (1952).

(d) Mo—C and Mo···O splits assumed equal.

(e) From re-examination of the photographs described by Spurr, R. A., thesis, California Institute of Technology (1942).

(f) Results of Rogers, M. T., thesis, California Institute of Technology (1941), adjusted to a symmetrical (2– /2 2–'/2) split. Spectroscopic evidence (Lord, R. C., Lynch, jun., M. A., Schumb, W. C., and Slowinski, jun., E. J., *J. Amer. Chem. Soc.*, 72, 522 (1950)) indicates C_{4v} symmetry, and the actual I—F lengths may well not all be equal

Details of these matters are being studied and will be reported later. We are also trying to obtain direct experimental verification of failure of the Born approximation by studying the diffraction patterns of suitable molecules over a wide range of electron wave-lengths and by obtaining patterns at sufficiently great s values from molecules of undoubted symmetry.

Note added July 17. The difference in intensity of (331) and ($33\bar{1}$) reflexions from zincblende as reported by Miyake and Uyeda[5] corresponds in sign and possibly in magnitude to the present phase shifts, but the relative importance of these phase shifts and of the dynamic effect discussed by Kohra, Uyeda and Miyake[6] is not clear.

VERNER SCHOMAKER

Gates and Crellin Laboratories of Chemistry,

ROY GLAUBER

Norman Bridge Laboratory of Physics,
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Pasadena, California.
May 1.

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[1] Braune, H., and Pinnow, P., *Z. phys. Chem.*, B, 35, 239 (1937). Bauer, S. H., *J. Chem. Phys.*, 18, 27 (1950). The observations have been checked in these laboratories by Dr. O. Bastiansen.

[2] See especially Bigeleisen, J., Mayer, M. G., Stevenson, P. C., and Turkevich, J., *J. Chem. Phys.*, 16, 442 (1948) and Burke, T. G., Smith, D. F., and Nielsen, A. H., *J. Chem. Phys.*, 20, 447 (1952).

[3] Germer, L. H., *Phys. Rev.*, 56, 58 (1939).

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[5] *Acta Cryst.*, 3, 314 (1950).

[6] *Acta Cryst.*, 3, 479 (1950).

FORTHCOMING EVENT

Friday, August 22

Royal Anthropological Institute (at the University Arts School, Bene't Street, Cambridge), at 5 p.m.—Prof. Kaj Birket-Smith "The History of Ethnology in Denmark" (Huxley Memorial Lecture).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Chemist (Senior Scientific Assistant grade) in the Central Laboratory Service, Chiswick, with responsibility for section dealing with paints and surface protection—The Staff Officer (F/EV.211), London Transport, 55 Broadway, London, S.W.1 (August 23).

Chief Officer (with executive ability and appropriate qualifications in chemistry) for River Pollution—The Clerk to the Great Ouse River Board, Elmhurst, Brooklands Avenue, Cambridge (August 23).

Lecturer in the Department of Civil and Municipal Engineering—The Secretary, University College, Gower Street, London, W.C.1 (August 23).

Posts in connexion with the construction and development of a linear accelerator in Cambridge—The Secretary, Department of Physics, Cavendish Laboratory, Free School Lane, Cambridge (August 23).

Senior Assistant (Scientific) (temporary, with experience in histology, surgical technique and handling of farm animals) for experimental work—Dr. J. S. Perry, c/o Agricultural Research Council Field Station, Compton, Newbury, Berks (August 23).

Instrument Engineer (with a University degree, H.N. certificate in electrical engineering, or equivalent qualification) in the Research Laboratories at Leatherhead—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting Ref. AE/269 (August 25).

Senior Lecturers and Lecturers in Home Science (food and experimental cookery, foods and nutrition, and home management), New South Wales Department of Technical Education—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (August 25).

Leaders of Research Sections at the Central Research Establishment No. 2, at Isleworth, Middx.: General Metallurgist with sound practical experience and theoretical background (Ref. TT/513), and a Qualified Engineer with research experience to lead section engaged in work on mechanical engineering problems of the industry (Ref. TT/514)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (August 30).

Lecturer, and an Assistant, in Botany—The Assistant Secretary of University Court, The University, Glasgow (August 30).

Assistant Biochemist (with a University degree, or equivalent; a knowledge of physiology would be an advantage)—The Pathologist, Group Pathological Laboratory, Lakin Road, Warwick (August 31).

Veterinary Surgeons (preferably with the dual qualification of M.R.C.V.S. and B.Sc. (Vet.Sc.)) in the Field and Research branches of the Department of Veterinary Services—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (August 31).

Assistant Lecturer in the Department of Mathematics (preferably with interest in applied mathematics)—The Secretary, University College, Gower Street, London, W.C.1 (September 1).

Junior Lecturer or Lecturer (with an honours degree in botany, zoology or biology) in the Department of Biology—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (September 1).

Research Post in the Department of Metallurgy (applicant must possess an honours degree in metallurgy, preferably with at least one year's research experience, and will be expected to undertake work on age-hardening phenomena, and possibly later, to lead a team of workers)—The Registrar, The University, Liverpool (September 6).

Senior Research Officer for investigations into plant nutrition and biological problems, with particular reference to the cultivation of fruit trees, including citrus, in the Murrumbidgee Irrigation Area (Ref. No. 3940), and a Senior Research Officer (Chemist) to conduct research into various chemical aspects of plant growth and soil problems on the Murrumbidgee Irrigation Area (Ref. No. 3941)—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 6).

Lecturer in Dairying (graduate, preferably with experience in the dairying industry)—The Registrar, The University, Reading (September 13).

Lecturer (with special interests in some branch of electrochemistry) in Chemistry—The Assistant Secretary of University Court, The University, Glasgow (September 15).

Lecturer in Forestry (with a University degree, preferably in forestry, and practical experience of British forestry)—The Secretary, The University, Edinburgh (September 15).

Lecturer (honours graduate with appropriate qualifications and experience) in Sociology at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 15).

Senior Lecturer in Chemical Engineering—The Registrar, King's College, Newcastle-upon-Tyne (September 15).

Assistant Lecturer (graduate in chemical engineering, physics or mathematics) in Chemical Engineering, to undertake work in hydrodynamic problems of chemical engineering—The Registrar, College of Technology, Manchester 1 (September 17).

Senior Lecturer in Medical Bacteriology at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 20).

Veterinary Physiologist at Makerere College (University Colle of East Africa)—The Secretary, Inter-University Council for High Education in the Colonies, 1 Gordon Square, London, W.C.1 (Septe ber 20).

Assistant Lecturer in Botany at Makerere College (Univers College of East Africa)—The Secretary, Inter-University Council f Higher Education in the Colonies, 1 Gordon Square, London, W.C (September 30).

Mackinnon Research Studentship for research in the physic sciences, including chemistry, geophysics, astronomy and engineeri sciences—The Assistant Secretary, Royal Society, Burlington Hou Piccadilly, London, W.1 (October 10).

Director (graduate of a British university and Fellow of t Museums' Association, or equivalent qualifications)—The Directo City Art Gallery, Bristol 8 (October 22).

Assistant (Grade A) in Physics—The Principal, Technical Co lege, Queen Street South, Huddersfield

Assistant Psychologist in the Hospital and associated psychiatr clinics for adults and children—The Medical Superintendent, Sou Warwickshire Hospital Group, Central Hospital, Warwick.

Assistant Research Chemist (organic) in the Hop Researc Department—The Registrar, Wye College, Wye, Ashford, Kent.

Chemist to assist in laboratory dealing with members' day-t day production problems—The Printing, Packaging and Allied Trad Research Association, Randalls Road, Leatherhead, Surrey.

Chemist for research on nutritional aspects of trace elements, particular iodine—The Director, Laboratory of Human Nutritio Churchill Hospital, Oxford.

Electrical Engineer (Senior Experimental Officer grade) to wo in a team engaged on the development of servo-components (Re D.310/52A), and an Electrical or Mechanical Engineer Physicist (Experimental Officer grade) for work on problems co nected with either the generation and distribution of electrical pow in aircraft or electro-technology research in the design and develo ment of aeronautical equipment (Ref. D.311/52A); at the Roy Aircraft Establishment, Farnborough—The Ministry of Labour an National Service, Technical and Scientific Register (K), Almac House, 26 King Street, London, S.W.1, quoting the appropriate Re No.

Engineer at a Ministry of Supply establishment in Hampshir to design and test military engineering equipment, including bridg and other structures, motor-boats and mechanical devices—Th Ministry of Labour and National Service, Technical and Scientif Register (K), Almack House, 26 King Street, London, S.W.1, quotin E.331/51A.

Graduate (male) in Chemistry, Physics or Engineering, wit industrial experience, for the speedy assessment and solution c current problems in industrial packaging (ability to write reports fo the layman is essential)—The Printing, Packaging and Allied Trade Research Association, Randalls Road, Leatherhead, Surrey, quotin Ref. DPTO.

Intelligence Assistant (science graduate), competent in abstract ing, indexing and technical translation work (German and, if possibl Russian or Dutch) (Ref. A.20); and an Editorial Assistant (woma graduate, preferably in science) for preparing publications (Ref. A.21 —The Assistant Secretary, British Coal Utilization Research Associa tion, Randalls Road, Leatherhead, Surrey, quoting the appropriat Ref. No.

Lecturer (with a University degree in physics) in the Department of Applied Physics—The Secretary, Northampton Polytechni St. John Street, London, E.C.1.

Mining Geologist (with B.Sc. degree with honours in minin geology) in Sierra Leone—The Director of Recruitment (Coloni Service), Colonial Office, Sanctuary Buildings, Great Smith Stree London, S.W.1, quoting Ref. 27079/40.

Petroleum Chemists (with a degree in chemistry, chemic engineering or metallurgy) for short Service commissions in the Roy Army Service Corps—The War Office (AG8/CHI), Stanmore, Midd

Senior Lecturer in Biology in the Department of Applie Science, Wolverhampton and Staffordshire Technical College—Th Clerk to the Joint Education Committee, Education Offices, Nort Street, Wolverhampton.

Staff Tutor in Philosophy—The Director of Extra-Mural Studies The University, Edmund Street, Birmingham 3.

Statistician (Scientific Officer or Senior Scientific Officer grad to work on problems and methods in genetics and biological exper mentation—The Secretary, John Innes Horticultural Institutio Bayfordbury, Hertford.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

International Committee for Bird Preservation: British Sectio Annual Report for 1951. Pp. 48+4 plates. (London: Internation Committee for Bird Preservation, c/o British Museum (Natur History), 1952.) 2s. [19

National Smoke Abatement Society. Year Book 1952. Pp. 4 (London: National Smoke Abatement Society, 1952.) 1s. [19

Other Countries

Southern Rhodesia. Rainfall Handbook Supplement No. 2: Total of Monthly and Annual Rainfall for Stations in the Northern Are Pp. N. 59. 2s. 6d. Rainfall Handbook Supplement Nos. 3, 4 and 5 Totals of Monthly and Annual Rainfall for Stations in the Souther Western and Central Areas. Pp. S. 26+W. 23+C. 27. 2s. 6d. (Sali bury: Government Printing and Stationery Department, 1952.) [19

Geological Survey of British Guiana. Bulletin No. 22: I. Th Roraima Formation in British Guiana, by P. H. A. Martin-Kaye II. The Roraima Formation in the Neighbourhood of the Kamaran and Upper Ekereku Rivers, by P. H. A. Martin-Kaye. Pp. v+5 (Georgetown: Government Printers, 1952.) 1 dollar, 4s. 2d. [19

NATURE

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THE PRICE OF COLONIAL DEVELOPMENT

THE recently issued annual report and statement of accounts of the Colonial Development Corporation for the year ended December 31, 1951*, raises even more forcefully than last year's report the question of the future of the Corporation and its place in Colonial development. That place was taken for granted in a debate on aid for under-developed areas in the House of Lords on May 21, when the emphasis, particularly in speeches by Lord Henderson, Lord Milverton, Lord Rennell and others, was laid on the importance of scientific and technical assistance in the development of such areas and on the demands which such development made on scientific and technical man-power. Lord Milverton quoted an estimate that about 150,000 trained men were now being turned out annually from universities, technical training colleges and trade schools in the Commonwealth countries of South and South-East Asia, and Lord Reading, replying on the debate for the Government, dealt with this aspect of technical assistance at some length, asserting that technical assistance meant increasing the degree of knowledge right down the scale to the actual foreman working on the job, and that we in Great Britain ought to be the main source of the experts required.

This need, Lord Reading continued, came at a time when our man-power was stretched almost to its limit; but there was special machinery in the Ministry of Labour for finding such experts as are required. A sub-committee of Lord Hankey's Technical Personnel Committee also was concentrating its attention on overseas requirements. Lord Reading remarked that a chief difficulty was to assure such specialists about their future on their return from posts abroad. The Government had agreed to release Civil servants, if necessary, on secondment, and industry and the academic world could also help by agreeing to the release of certain members of their staffs on generous terms. Men were required of a wide range of skills, and, most particularly, men of eminence and high calibre with a sense of vocation.

Lord Reading thought that Britain would be failing in its duty and at the same time losing something of its status in the world if such men could not be found; and, while the report on the Colonial Territories for 1951–52, issued afterwards, testifies to technical assistance which has been forthcoming for those areas from American experts, a welcome feature of that survey is the extent to which it indicates the man-power situation in the Colonial territories has been improved from British sources. The Colonial Development Corporation's report notes that specialists of various kinds, particularly in accountancy and tropical agriculture, are still hard to find for overseas work, but otherwise has little to say about the trained man-power situation, beyond emphasizing that the Corporation's policy is to employ local men and women where they are available. The high turnover of staff appears to be connected rather with the reorganization and reorientation still proceeding in the second year of Lord Reith's chairmanship.

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* Colonial Development Corporation. Annual Report and Statement of Accounts for the Year ended 31st December 1951. (Cmd. 167.) Pp. viii+74. (London: H.M. Stationery Office, 1952.) 3s. net.

For the rest, the House of Lords debate followed the lines of discussion on the strategy of world development given in a P E P broadsheet last year. Lord Reading emphasized the success of the Karachi Conference in convincing the countries of the region that greater emphasis should be placed upon agricultural production as distinct from industrial output, and referred to some of the large-scale irrigation schemes such as the Gal Oya project in Ceylon, for 130,000 acres with a hydro-electric scheme providing 75,000 kilowatts, the Bakhra–Nangal scheme in India, with one dam across the Sutlej River little smaller than the Boulder Dam in the United States, the £37 millions project in the Damadar valley, the Lower Sind Barrage scheme of Pakistan to give a further 1 5 million cultivable acres, and the Thal scheme in the Punjab affecting 2 million acres and including irrigation, land colonization and road development. While the debate emphasized the demands which Colonial development must make on the capital, as well as the man-power, resources of Britain, it scarcely emphasized as incisively as a recent series of articles in *The Economist* the price that has to be paid. Important as are certain technical difficulties in Colonial development, such as the improvement of transport facilities, the problem of land tenure and the supply of trained man-power, the crucial issue is that of finance. Where the Colonial territories are concerned, this must, in the main, come from Britain, and the restoration of the United Kingdom to economic health is a prerequisite to Colonial or to Commonwealth development, even side by side with aid from the United States.

In these articles *The Economist* insists that the first step for Colonial development is to create a larger margin of savings at home and a credit surplus on the balance of payments, and that this means reducing our level of consumption relatively to our output. This is the prerequisite to Commonwealth development, and the only alternative to such development is starvation and unemployment. Besides this realistic and harsh gloss on Colonial development, in the light of which the Colonial Development Corporation's report should be considered, there are now available the annual report on Colonial Affairs, 1951–52, already noted, and the Return of Schemes made under the Colonial Development and Welfare Acts in the same period. The report itself was fully debated in the House of Lords on May 28, and the future of the Corporation was a main subject of the debate in the House of Commons on July 17, while a Broadsheet (No. 343) on Colonial Development issued by Political and Economic Planning on July 7 discussed the future of the Corporation in the light of its annual report and the statement made by the Earl of Munster in the Lords debate on May 28.

Looking first at the report itself, the Corporation's operating loss for the year was £1,070,043, as compared with £524,917 in 1950, bringing the accumulated loss sustained by the Corporation in four years to £4,594,599, although for the first seven years the Corporation was relieved from paying interest on t money advanced by the Government. The los were due, however, to the earlier more optimistic a grandiose activities of the Corporation before L Reith became chairman in November 1950. It now claimed that the lessons have been learnt a that any suggestions for immediate large-sc development, such as the Gambia Poultry Far must be treated with particular caution. Stress laid, too, on the way in which estimates have be overtaken in the past by rising costs, particularly marginal schemes, and, other things being equal, t declared policy in future will be to look for expe enced private enterprise partners to share in inve ment and in management. Schemes suggested governments who meet the essential but financial unremunerative elements with their own or wi Colonial Development and Welfare Funds, leavi the Corporation and its partners to take care of t rest, are to be consistently sought in future as o of the soundest lines of development.

On December 31, 1951, there were fifty-thr undertakings in operation, with a sanctioned capit of £35,729,294. Besides the Gambia Poultry Far four undertakings were liquidated during the ye and the report expresses confidence that the end a stage has been reached. Provided the Governme brings its financial requirements into line with i basic intention, confidence can be felt in the C poration, its purpose and its work.

For the second year in succession the anomalo position of the Corporation is emphasized, and t most significant section of the report is that whi discusses the financial background to the Corpor tion's operations.

The Corporation is constituted to operate co mercially; but its financial circumstances and co ditions are at variance with commercial practice a purpose. The Corporation has no funds of its ow the Government providing capital for approv schemes in the form of long-term redeemable loans rates of interest fixed by the Government. The advances have to be repaid, and the rate of intere has this year been raised again to 4¼ per cent, place of the original 3 per cent. The report prote both against the raising of the rate, with the co sequent difficulties in raising other loans or devisi workable schemes, and against the impossibility writing off losses. The result, it is suggested, mu be to deflect the Corporation from its primary purpo of opening up new fields of development unless t Government affords some measure of relief.

The Corporation was not set up to compete wi private capital but to supplement it, because th was obviously not enough private capital for t Colonial developments urgently required. Su development, however, implies adventure and ri at least a long wait and a problematic return, a the report puts the issue bluntly when it says th the motive which established the Corporation was do economic good but to do it without losing mone That motive, it is urged, is being frustrated administrative action through the application standard terms for long-term loans, because t orporation has neither the buffer of ordinary capital bear the risks nor the ability to pass on its costs the consumer, as does a public utility.

Lord Reith's plea was firmly rejected by the overnment in the House of Lords debate on May 28, hough the difference between the Government and pposition in this matter appears essentially to be ne of emphasis, rather than anything more fundaental, as Lord Ogmore suggested. Lord Ogmore laces the emphasis on the Corporation's responsiility to do economic good and appears to think that e Government should be concerned chiefly to see at the Corporation does not force on the Colonial eoples schemes of development which they do not esire. On the Conservative side the emphasis is laced rather on the protection of the taxpayer's oney. Both parties in principle agree to the existnce of the Colonial Development Corporation. erther seems disposed to face the fundamental issue nd to ask those further questions about the purpose nd methods of British Colonial development policy hich, as P E P points out, quite rightly, are escapable once we question the usefulness of the olonial Development Corporation in its present form.

Lord Ogmore in the House of Lords debate advoated first a new financial policy in which the orporation would be allowed to wipe out the cumulated losses and make a fresh start, and cond, that the Colonial Office, Colonial Governents and authorities under the American Point Four rogramme should use the Colonial Development orporation as the agent for their pilot schemes. ther speakers in the debate, like Lord Rennell, ord Balfour or Lord Perth, while agreeing as to the esirability of giving the Corporation a freer hand nancially, welcomed the association of the Corration with private enterprise, and Lord Rennell, particular, urged the need for decentralization. he report itself declares the Corporation's intention transferring in time full managerial, technical d financial responsibility for some undertakings to cal people, and a possible solution to the problem organization would be, as P E P suggests, to volve responsibility on a number of regional rporations, each of which would be expected to eak even after payment of interest, or to make no ore than a specified loss if the financial regulations ere thus relaxed.

There are plainly limits to the extent of such centralization if a central corporation is to remain swerable for the regional corporations, nor can the ssibility of functional devolution be dismissed ithout consideration. That method, which was scussed more particularly by Mr. R. Robinson in e House of Commons debate, might assist coeration with other agencies concerned in the velopment of the backward areas but has its own fficulties, even if it should offer greater economy in e use of the available technical and scientific perts while the present shortage continues. Apart om Viscount Hudson, however, speakers in the ouse of Lords did not concern themselves with this estion of functionalism and the most effective use the scientific expert; but there was some fairly general concern expressed that under the present financial regulations the Corporation may be diverted from its original purpose of filling the gap between what private enterprise is doing in the Colonies and what is being done by the local resources of the Colonial governments and become little more than an investment trust to help private enterprise.

With the drop of nearly 20 per cent in the estimates for 1952–53 for Colonial development and welfare schemes to a total of £13 millions, compared with the original annual ceiling of £17·5 millions and the revised ceiling of £20 millions of the 1940 Act, the gap is likely to be the wider and the consequences of any diversion of the Corporation from its original purpose the more serious. The Earl of Munster's reply on May 28 summarized the Government's policy to the Corporation under five headings. First, the Corporation must be given more time to prove itself. Secondly, in present circumstances, and in the interests both of the Colonies and of the Corporation, speculative projects should be kept to a minimum. Thirdly, the Corporation should continue its efforts to put its own house in order. Fourthly, the Corporation is only one of the agents of Colonial development: it was set up to deal with commercial projects; other projects were the function of Government, through Colonial Development and Welfare and through local public funds. Fifthly, making capital available to the Corporation on artificially favourable terms could not be justified in present conditions.

On the policy of reorganization and caution, the Earl of Munster said further that, before large sums of money were advanced, the Government should attempt to satisfy itself that the Corporation had thoroughly examined all the pros and cons of any scheme, that it had made due allowance for any risks or contingencies, and that it was capable of implementing what it set out to do. Before any new scheme was sanctioned the Secretary of State would require sufficient information to enable him to judge whether a *prima facie* case had been made out. Further, except in special circumstances, someone else besides the Corporation should share in the risk, whether private enterprise or a local government.

The Government's intention to supervise the Corporation more closely, in spite of the Earl of Munster's reminder that the Overseas Resources Development Act laid firmly on the Corporation the sole duty of investigating, formulating and carrying out any projects, is confirmed by what the Colonial Secretary, Mr. Oliver Lyttelton, said in the House of Commons on July 17. Of Colonial development in general, Mr. Lyttelton admitted that over the next decade we would not have collected sufficient capital, although over the next three years this would not be the dominant factor: shortages of steel and of skilled labour, delays in importing machinery and the indifferent organization of local resources were likely to be the limiting factors.

Turning to the Colonial Development Corporation he reiterated the view that the Corporation was intended to act as a commercial concern and to pay its way, taking one year with another. Entirely uncommercial projects, such as much research and experimental work, were outside the ambit of the Corporation, and the Corporation should not undertake projects which were unlikely to yield a gilt-edged rate. The Colonial Secretary then delineated more precisely the four criteria which would determine his approval of capital grants for the Corporation, at least one of which must be satisfied. He would inquire, first, whether the Colonial Government in the territory concerned was willing to participate if it had the money to do so; second, whether any local knowledge and experts had been mobilized, for example, on the board of the operating company in that territory; whether any local capital had been offered and accepted participation; and whether the Corporation had tried to associate itself with any company in the United Kingdom or elsewhere carrying on the same kind of business.

Exception can scarcely be taken to these criteria by those who have the interests of the Corporation and of the Colonial territories at heart; but it remains to be seen whether in practice they may not amount virtually to abolishing the Corporation. They do not dispose of the basic argument in the Corporation's report that its activities are already too severely confined by the financial rules which govern its operations, and the merits of a more vigorous policy and the ways in which such a policy could be pursued deserve closer attention than Government or Opposition spokesmen were disposed to give them in either debate. The P E P broadsheet already mentioned is of particular interest here. Apart from its close analysis of the activities of the Corporation and of the factors which inhibit both private investment in the Colonies and investment by a Government corporation, the broadsheet discusses the possibilities of new policies in this field.

The broadsheet frankly recognizes the difficulties on either side, and its discussion of such matters as the financing of experiments and pilot schemes is realistic. It finds no sound reason for the proposal to form a new organization for research and pilot projects, and while it does not insist as firmly as *The Economist* articles on the price to be paid for Colonial development and welfare, it points out clearly enough that the answer to be given to the financial questions regarding the Corporation's future depend both on the judgment as to how vigorous a policy the Corporation should pursue and the view taken of the broader issues of Colonial development. The right questions are asked, and the broadsheet is a contribution to the clearer understanding of the aims and methods of development without which no satisfactory policy can be framed. As the broadsheet comments, it is not much use to create institutions without any very clear idea of what they are intended to achieve. The dominant impression left by the recent debates is that, while both Government and Opposition wish to continue the Colonial Development Corporation, neither have any very precise ideas as to what it is intended to do, the real basis of selection of projects, of the relation of its activities to Colonial welfare and whether and how there should be closer collaboration with the Colonial Development and Welfare Fund.

FLUORESCENCE OF ORGANIC COMPOUNDS

Fluoreszenz organischer Verbindungen
Von Prof. Theodor Förster. Pp. 312. (Göttingen
Vandenhoeck und Ruprecht, 1951.) 32.50 D. mark

FLUORESCENCE methods of estimation exten
to much lower ranges of concentration than thos
based on light absorption, since the latter work b
differences or ratios between light beams with an
without absorption, whereas fluorescence, beside
being very specific, is measured from a zero whic
can be made very low by paying sufficient attentio
to apparatus design. Within recent years the need
which have arisen in various fields to estimate ver
small quantities of certain vitamins, uranyl salt
aromatic hydrocarbons, etc., together with develop
ments of photoelectric cells, electron multipliers an
electronic circuits, have caused a number of fluor
meters to be put on the market. The result has bee
a great widening of interest in the subject of fluo
escence, the mysteries of which have until lately bee
the cult of very few. On the basis of the reversib
nature of light absorption, it might be expected the
fluorescence would be a common and relatively simp
phenomenon; it is, however, rare and easily affecte
by disturbing factors which provide many pitfalls fo
the unwary experimenter.

Prof. T. Förster's book is not immediately intende
for the instruction of beginners in the avoidance
errors in measuring fluorescence; although practic
methods are dealt with, commercial fluorimeters a
not described in detail. It is a critical, accurate an
up-to-date academic account for the serious studen
of each of the various aspects which have bee
explored by individual workers, with very complet
references. The chapters include discussions of th
relations of the structure of molecules and their powe
to fluoresce, the theoretical principles of light absor
tion and emission, fluorescence spectra, quantu
yields, measurements of mean life before emissio
polarization phenomena, and 'quenching'. For th
practical worker, 'quenching' is a matter of th
greatest concern; it refers to the reduction in th
fluorescence of a solution due to rise of temperatur
increase of concentration, or the addition of foreig
'quenchers'. Most molecules, which are not fluo
escent, are 'quenched' by 'internal conversion', th
is, the excitation energy is converted into molecul
vibrational energy by a radiationless process formal
explicable as a crossing of potential energy curve
The work of G. N. Lewis and Kasha has shown th
in many cases this involves the intermediate form
tion of 'triplet' excited levels of long life a
potentially important photochemical possibiliti
Collisions with foreign 'quencher' molecules may al
produce triplet levels, or may form radicals t
photochemical reactions of which have been studi
by Weiss and M. G. Evans. The relationship betwe
triplet production and radical formation is a proble
of great present interest. At very low temperatur
and under appropriate conditions, triplet levels gi
a luminescence of their own, with a very long me
life, and affording new means of characterizi
molecules which may never exhibit norm
fluorescence.

Another interesting field in which Prof. Först
has himself made notable advances is that
resonance energy transfer between molecules.
crystals such as anthracene, and in solutions

ighly fluorescent substances, electronic energy may ass from molecule to molecule before radiation of uorescence occurs. The distance over which such ansfers take place may be as large as 50 A. or more, o that the effect may be observed in solutions of oncentration 10^{-4}–10^{-3} *M*. Resonance transfer is of nportance in the study of photosynthesis by chlorohyll in plants and in the use of fluorescent substances s scintillation counters for radioactive rays. After ong hiding its light under a bushel, fluorescence is ow being brought out into the daylight, and rapid dvances in practice and theory may be confidently redicted.

E. J. Bowen

TEXT-BOOKS OF ORGANIC CHEMISTRY

Organic Chemistry

By Louis F. Fieser and Mary Fieser. Second edition. Pp. xv+1125. (Boston, Mass.: D. C. Heath and Co.; London: George G. Harrap and Co., Ltd., 950.) 7.50 dollars; 42*s*.

Organic Chemistry

By Dr. A. F. Holleman. Revised by Prof. J. B. Vibaut. Translated from the sixteenth Dutch dition by Dr. Samuel Coffey. Pp. xiv+660. (New York and Amsterdam: Elsevier Publishing Co., nc.; London: Cleaver Hume Press, Ltd., 1951.) 5*s*.

Organic Chemistry

By Dr. I. L. Finar. Pp. xv+696. (London, New York nd Toronto: Longmans, Green and Co., Ltd., 1951.) 0*s*. net.

MOST organic chemists have their own ideas concerning the perfect text-book for their ubject, and a surprisingly large number possess the nergy to bring their conceptions to fruition. As a esult, students at all levels have a wide choice of uide to explore what Wöhler termed the "monstrous nd boundless thicket" of organic chemistry.

The popularity of the first edition (1944) of the ext-book by Prof. and Mrs. L. F. Fieser was due ot only to its wide scope and up-to-date treatment ut also to the clarity, readability and occasional umour of its exposition. These characteristics are etained in the new edition, which incorporates the ignificant advances of the past six years. Two major missions in the first edition have been remedied with he introduction of chapters on reaction mechanisms a triumph of well-written condensation) and on eterocyclic compounds. Space for these inclusions as been found by substantial pruning of previously ver-written chapters (for example, steroids and uinones) and by adaptations of the format. Only ne misprint could be detected, and the printing and inding are admirable. The pre-eminent usefulness f this book for all classes of student arises as much rom its enthusiasm and feeling for the subject as rom the attributes described above.

Roughly comparable in scope is the text-book of Prof. A. F. Holleman, revised and adapted by Prof. . B. Wibaut; but the treatment tends to be oldashioned and rather disjointed. Discussion of the sual homologous series is carried through with ainstaking thoroughness; the more advanced topics re, however, treated much more cursorily. There are ome startling omissions. The enormous advances in the separation of the constituents of protein hydrolysates are dismissed in four lines with no reference to paper chromatography. Again, in the section dealing with benzenoid substitution the concepts of inductive effect, mesomeric effect and hyperconjugation are not even mentioned; there is a similar lack of reference throughout to modern ideas concerning reaction mechanisms. It would not be inaccurate to classify the work as a present-day representative of an older type of text-book. The translation on the whole reads smoothly, although it is hoped that, in any future edition, the monstrosity "higherhydric" will be eliminated. The printing and binding are good.

The content of Dr. I. L. Finar's book is deliberately restricted to the basic groundwork of the subject and does not deal with topics such as the more complex natural products. Although thus limited in scope, the treatment is both complete and modern with full mention of the unifying physico-organic concepts. In particular, this seems to be the first organic chemistry text-book to include an elementary exposition on molecular orbitals, and recently introduced reagents and techniques (for example, lithium aluminium hydride) are discussed. The style is clear and readable, and the book can be recommended as providing a sound foundation for more advanced study.

R. A. Raphael

TEMPORAL INTEGRATION AS A CLUE TO MIND

The Organization of Behavior

A Neuropsychological Theory. By D. O. Hebb. (Wiley Books in Clinical Psychology.) Pp. xix+335. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1949.) 32*s*. net.

SINCE its publication, Prof. D. O. Hebb's book has been widely and sympathetically discussed, and has won a place among the more notable contributions to current theory in physiological psychology. Its author was unusually well equipped for the ambitious task he undertook, namely, to formulate a theory of behaviour embodying recent developments in the neurophysiology of the brain as well as in experimental psychology itself.

Dr. Hebb allies himself at the outset with those theorists in psychology, sometimes called 'reductionists', who have no hesitation in introducing neurophysiological concepts to explain human behaviour. The 'non-reductionists' take the view that this cannot be done without injury to the psychological facts. Dr. Hebb attempts to safeguard himself against criticism from this direction by not denying or ignoring the complex facts of behaviour. He does not deal with mind by reducing it to the level of what is now known about the body; he rather suggests highly complicated forms of neural interaction which may help to explain what is now known about mind. Here his main contribution lies in his conception of *temporal* integration in cerebral activity. This conception has received strong support from the independent work of H. F. Harlow on 'learning sets' and of H. O. Mowrer on the persistence of self-defeating behaviour.

The theoretical gap which Dr. Hebb proposes to fill he attributes to the failure of neurophysiology to explain the events that occur in cortical transmission, that is, during the interval between the arrival of an excitation at a sensory area and its departure from the motor area of the cortex. It is this failure which, in his view, has made it impossible for psychology to develop an adequate treatment of thought. He begins by directing attention to the apparent incompatibility between perceptual generalization, on one hand, and the stability of memory, on the other, and suggests a way out of this dilemma by effecting a compromise between configurationism and learning theory. At this point he brings in his distinction between perceptual unity and perceptual identity. The former—that is, the figure-ground relationship—he concedes to the configurationists, is sensorily determined and, so to speak, is 'given' in experience. The latter, he insists, is the result of learning. He is consistent in supposing that the mnemonic trace involves structural change and that perception depends, not on a pattern of excitation, but on the excitation of specific cells.

The theory of the book briefly amounts to the following. The more constant the stimulation from an object, the more readily it will be identified and so evoke a response. Repeated stimulation results in the formation of 'assemblies' of association-area cells, which facilitate other such assemblies. After stimulation has ceased, a cell assembly can act for a short time as a closed system and so prolong the interval during which structural change can occur. A series of cell assemblies produces a 'phase sequence', of which human thought is the most extended example. A phase sequence is a process that co-operates fully with external stimulation without being fully controlled by it, thus allowing for 'autonomous cortical processes' and for the psychological phenomena of expectancy and set.

The theory is developed in considerable detail, and, though it is speculative, the speculation is specific and thus renders it subject to the tests of observation and experiment as further evidence becomes available. Its usefulness in clarifying problems of perception, learning, motivation, and intellectual deterioration is a first step towards its verification. John Cohen

A REVIEW OF SCIENTIFIC INSTRUMENTS

Journal of Scientific Instruments

Editor: Dr. H. R. Lang. Vol. 28 and Supplement No. 1, 1951. Pp. xvi+388+iii+80. (London: Institute of Physics, 1951.) Bound, £3 12*s*.; unbound, £3.

The *Journal of Scientific Instruments*, the monthly publication of the Institute of Physics, deals with the principles, construction and use of scientific instruments and is produced by the Institute with the co-operation of the National Physical Laboratory. When the *Journal* was started in 1923 it was the only periodical devoted to the subject of scientific instruments, and it soon obtained a high reputation among physicists and manufacturers of scientific instruments. This high reputation has been maintained through successive editorships. The present editor, Dr. H. R. Lang, the secretary of the Institute, has been responsible for Vols. 9–28, covering the period 1932–51. His task has not been made easier in recent years, first by war-time restrictions, then by post-war difficulties due to increased and continually rising costs of production, and, more recently, by the added responsibility of the publication of a sister monthly, the *British Journal of Applied Physics*. Nevertheless, a comparison of Vol. 28 with previous volumes shows that not only all the regular features and the high standard of the articles and book production have been maintained, but also that, in Vol. 28, the innovation of an attractive and informative supplement of papers on vacuum physics has been introduced. The editor and the advisory committee, under the chairmanship of Dr. R. S. Clay, are thus to be congratulated for their fortitude and their progressive attitude.

Vol. 28 contains four special articles, ninety-six original contributions, laboratory and workshop notes, reviews and notices of new books and descriptions of new instruments, materials and tools, in addition to the previously mentioned supplement. The range of subject covered is wide and most branches of physics are represented. Rarely does an author have more than one contribution; but Dr. Kantorowicz, formerly at the National Institute of Medical Research, London, and now at the Pametrada Research Station, Wallsend-on-Tyne, has no less than five laboratory and workshop notes in the volume. All the contributions are remarkably free from errors and misprints. Since quite a high percentage of the papers show by the dates of receipt that they required modification before final acceptance, it is suspected that the concise and effective form in which they appear is in no small part due to the conscientious and devoted manner in which the referees have carried out their arduous and voluntary task. It is a pleasure to record that the *Journal*, as it richly deserves, continues to prosper and that its circulation, both to members and non-members of the Institute, is on the increase. It is excellent value for the price. S. Weintroub

MAMMALS OF THE OLD WORLD

Checklist of Palæarctic and Indian Mammals, 1758 to 1946

By J. R. Ellerman and T. C. S. Morrison-Scott. Pp. vi+810. (London: British Museum (Natural History), 1951.) 65*s*.

All students of mammals welcome the appearance of this volume and are greatly indebted to the authors for their painstaking labour in providing a much-needed corner-stone in the structure of systematic mammalogy. The list, based on the unrivalled collections of the British Museum (Natural History), is not merely one of the working tools that every systematist must make for his own use but is also a critical revision of the mammals inhabiting an immense area of the earth's surface. It deals with mammals of the palæarctic and Indian regions, thus linking up with the already existing lists of the mammals of the Malayan and Ethiopian regions.

The authors give critical introductory paragraphs for each order and family, and indicate the diagnostic characters of each genus and species by reference to the appropriate works or by specially devised keys. The distribution of each species is approximately shown, though "it should be remembered that the distributions of many mammals are imperfectly known and that the ranges of many of the larger mammals are shrinking every year".

In the time covered by this revision, from the tenth edition of Linnæus to the end of 1946, an immense number of forms has been described. With the accumulation of adequate collections for critical nparison it has become evident that many of the ms were separated and named on insufficient owledge of their variation, and the authors are le to relegate a large number of specific and sub-ecific names to the synonymy. They have, however, ly indulged in 'lumping' to the extent justified by e evidence, and they believe that there is probably uch more to be done ; they have therefore arranged e sub-species in order of priority for the convenience subsequent revisers. Nevertheless, the authors cognize no fewer than 809 species of mammals in e palæarctic and Indian regions as here defined.

Nomenclatorial difficulties are dealt with in a way at will commend itself to all right-thinking zoo-gists ; the authors mention some of the works that ve proved most troublesome, and list a number of mes that they have submitted to the International mmission on Zoological Nomenclature to be placed the "Official List". "There are workers who seem take a delight in bedevilling zoology with esoteric anges of nomenclature. . . . Zoologists who dis-ver a name which would cause confusion or incon-nience, though antedating a later but currently lopted name, should refrain from publishing their nfortunate find, and instead should hurry it off to e Commission for burial in the appropriate 'Index', the same time requesting the Commission to place the appropriate 'List' the later but currently used me. These are the principles which we have deavoured to follow. . . ."

It is fitting that this book is dedicated to the emory of the late James Lawrence Chaworth-usters, who had spent much time on the synonymies the species of palæarctic mammals. The results of s patient and lengthy researches into the type calities and the dates of publication of species scribed in the eighteenth and early nineteenth nturies are incorporated in this volume, especially r the Insectivora, Chiroptera and Rodentia. Had haworth-Musters lived, he would undoubtedly have ken a large part in the work of preparing this list ; s death was a great loss to systematic mammalogy.

The paper, printing and binding of this work leave thing to be desired, and are fully in keeping with e high standard set by the publications of the ritish Museum since the end of the War. This lendid volume brings great credit to all concerned its making.

L. HARRISON MATTHEWS

FLORA OF ARIZONA

rizona Flora

y Thomas H. Kearney, Robert H. Peebles, and llaborators. Pp. viii+1032+32 plates. (Berkeley d Los Angeles: University of California Press; ondon: Cambridge University Press, 1951.) 56s. 6d. et.

ARIZONA, one of the largest of the American States, being almost the size of Italy with early 114,000 square miles, presents a wide range of pography. The land rises from almost sea-level to plateau at an altitude of well over 12,000 ft. and cludes the mile-deep Grand Canyon. The rainfall as a yearly average which varies from as little as ree inches to nearly ten times that amount, while e frost-free period may be as short as three months r extending nearly throughout the year. In accord-nce with these variable conditions, the vegetation, hile in general of a dry type, ranges from desert to evergreen pine forests. The environments provide a remarkable range of ecological conditions and support the flora of some 3,370 species with which this work deals, comparable in extent and diversity to that of the whole of France. Moreover, the flora embraces a considerable proportion of endemics, more than 160 in number. The vegetation is notable for the unusually high representation of three families, in particular the Cactaceæ, seventy-one species, the Euphorbiaceæ, eighty-four species, and the Polygonaceæ, ninety-four species. It is undoubtedly the desert vegetation for which Arizona is most famous, and especially the Cactaceæ, in which the area is so rich, including twelve species that are endemic. Of these cacti, *Carnegiea gigantea*, the State flower of Arizona, is the best known and the largest, attaining a height of fifty feet and possibly living for 150–200 years. Its fruits and seeds furnished food for the native Indians. At the other extreme, in respect to size, is the endemic and very local *Navajoa peeblesiana*, with rounded stems only 3 cm. high bearing spongy spikes. It is the members of the Cactaceæ that are mostly portrayed in the forty-five reproductions from photographs with which this work is illustrated.

The Euphorbiaceæ are represented by no less than forty-seven species of *Euphorbia*, while in the Polygonaceæ the genus *Eriogonum* is particularly rich with fifty-seven species. The largest genus in the flora is *Astragalus*, represented by more than seventy species, of which eight are endemic. Some of these are highly toxic because of their remarkable capacity for accumulating selenium from the soil. Others, too, though reported not to contain selenium, are nevertheless very poisonous and cause the famous loco disease of sheep and cattle.

Another well-represented genus in the Scrophulariaceæ is *Pentstemon*, with fifty-eight species, of which two are endemic. Needless to say, the flora includes a number of very peculiar types, not least curious being the parasite *Ammobroma sonoræ*, of which the only visible portion above the ground is the saucer-shaped receptacle bearing numerous small flowers that open in concentric rings.

The introductory matter of this flora provides a useful summary of the topography and climatic conditions and other aspects of the physiological environment, with a very brief account of the geographical elements that comprise the flora. The great bulk of the text consists of keys to the families, to the genera within each family, and for each genus a key to the species. No full descriptions are provided for the species themselves; but the information in the dicotyledonous key is somewhat fuller than such usually provides. In addition to this, the distribution of each species in Arizona is stated, together with its altitudinal range, the type of habitat, time of flowering, and the general geographical distribution. The proof of the full value of such a work must be its use in the field, and it is for the convenience of this purpose that more extended descriptions have been sacrificed. If one regrets that decision, it is largely because these condensed diagnoses whet the appetite for a full account of this fascinating flora.

The chief criticism that one has to level against this book is that the page headings have been entirely wasted. If, instead of merely "Arizona Flora" or "Flora of Arizona" which appear throughout on alternate pages of the text, the relevant order or genus had been cited, it would have greatly assisted the reader in converting a redundancy to useful information.

E. J. SALISBURY

ARID ZONE RESEARCH

THE Advisory Committee on Arid Zone Research, set up by Unesco, recommended at its first meeting, held in April 1951, that special attention should be given to the collection of information and the discussion of problems concerning arid zone hydrology and particularly water supply. Thus on the Committee's advice, Unesco obtained and is printing a series of reports on hydrology and its problems in the arid areas of the world written by a number of authors, together with climatological maps of such areas.

Unesco in 1952 also organized, jointly with the Government of Turkey, a symposium on "Hydrology of the Arid Zone" which was held in Ankara during April 25–29. This conference was opened by the President of the Turkish Republic. Papers were given by representatives of about a dozen nations and dealt with: (1) the statics and dynamics of underground water; (2) its physical and chemical properties; (3) the hydrological balance and the effects of water utilization; (4) methods of prospecting for water; (5) the relation of hydrology to other sciences. Each of these subjects was introduced by a general review paper, after which papers were given on particular aspects of it. Many of the papers aroused considerable interest and provoked active discussion, and it was generally thought that the conference had proved very useful. Its proceedings will be published. Visitors taking part in the symposium received very kind hospitality from the Turkish authorities during and after the meeting. This included an excursion to part of the arid area of Central Turkey.

The Advisory Committee on Arid Zone Research also held its third meeting in Ankara in April. In its recommendations it followed its policy of giving priority to the collection, dissemination and discussion of information. Thus it recommended the preparation and printing of reviews of research on: (1) arid zone plant ecology; (2) sources of energy available in arid regions. Symposia on these two subjects were proposed for 1953 and 1954 respectively. On the Committee's recommendation, Unesco gave financial help to the Government of Israel in publishing the proceedings of its Symposium on Desert Research that was held in Jerusalem during May 7–14 (see below) and to the Institute of Biology (U.K.) to help towards the travel expenses of participants in its symposium on the "Productivity and Biology of Hot and Cold Deserts" that is to be held on September 25–27 next in London.

Unesco has asked its member States to appoint persons from whom advice may be obtained in a number of fields related to arid zone research. Such panels of experts have now been appointed by fifteen States and have already proved useful. The Committee recommended that this scheme be extended.

It also considered the preparation of a handbook that should give advice on the collection of basic data needed in planning the development of arid areas.

A scheme is now in operation in which certain research institutions, carrying out research in arid areas or concerned with their development, may be designated as suitable for the exchange of personnel and information and for the reception of visiting scientists. After considering their qualifications, the Committee recommended that the following institutions be added to those already designated. Particulars about them can be obtained from Unesc (a) Fen Fakultesi Botanik Enstitusu (Institute Botany, Faculty of Science), University, Ankar Turkey; (b) Department of Botany and its Ge botanical Research Laboratory of the Negev, Hebre University, Jerusalem, Israel; (c) Institut França d'Afrique Noire, Dakar, French West Afric (d) Jaswant College, Jodhpur, India; (e) Tohu Islah ve Deneme Istasyonu (Seed Improveme Station), Eskischir, Turkey.

The Committee considered the question of givi travel grants to men of science desiring to carry o research or make field studies abroad. It reco mended that the Director-General might give suc assistance in a limited number of cases provided "(a) that the proposed research or field study com within the scope of the Arid Zone Programme (b) that the work is of importance to several Unes Member States having arid and semi-arid areas (c) that the results of the work will be freely availab to the public; (d) that the request for transportatio assistance by the individual is supported by th Unesco National Commission in his country; (that the individual has obtained approval for th research or field study from the appropriate authorit at the institution or in the area in which the wor is to be done".

On the research side the Committee recommende a small grant to assist in the study of the vegetatio on certain nitrate- and sulphate-rich soils in Sout Algeria.

H. G. THORNTON

AN international symposium on "Desert Research' organized by the Research Council of Israel in co operation with Unesco, was held in Israel durin May 7–14. The growing interest in research devote to various aspects of arid zones and their reclamatio has been further stimulated by Unesco's activitie especially by the establishment of the Arid Zone Re search Committee, and by the Unesco symposiu on "Hydrology of the Arid Zone" (see above). Th symposium in Israel was the first of its kind to b organized by a member-state of Unesco, and th first the programme of which did not restrict itself t one special subject of arid zone research but include several topics, and gave the opportunity for scientist in those fields of research to get an integrated pictur of various aspects of desert research.

About fifty-five men of science from eightee countries attended the symposium. At the openin ceremony in Jerusalem guests were welcomed b the Prime Minister, Mr. D. Ben-Gurion. Dr. Shen-Y chief of the Bureau of Flood Control of the U.N Economic Commission for Asia and the Far East brought the greetings of the Secretary-General of th United Nations, and Dr. F. J. Malina, of the Natura Science Department of Unesco, spoke on behalf o the Director-General of his organization. A shor outline of the significance of the symposium was give by Dr. W. C. Lowdermilk, F.A.O. Adviser to th Government of Israel, who presided over th symposium.

Three days were devoted to scientific sessions i Jerusalem, the next three days to scientific excursion in the Negev, the Coastal Plain, and Galilee, and final day to further scientific sessions in the Institut of Technology, Haifa.

Among the general papers were those by Leighly nited States) on “Dry Climates : their Nature and stribution” ; Kellogg (United States) on “Poten- lities and Problems of Arid Soils” ; Monod (France) “Biology and Arid Regions” ; and Bagnold (Great itain) on “The Surface Movement of Blown Sand Relation to Meteorology”. According to Prof. B. Leighly, the extent of areas with a deficient ater balance can be correlated with the wave- ttern of the mean isobars at a height of 3 km. ove sea-level. Dr. D. Amiran (Israel) pointed out at the boundaries of semi-arid areas in Israel are ntinually shifting except where they are nearly ed by the topography of the area, as in the Jordan t.

There was complete agreement with Dr. E. C. ellogg in his emphasis on economic and social ctors in the utilization of arid and semi-arid soils, d interest in his view that in this area under- azing as well as over-grazing constituted a danger ith regard to soil erosion.

After a survey of the present position of biological search for arid zones by Prof. Th. Monod, Dr. R. A. gnold spoke on the mechanism of soil and sand ansport by wind and explained his theory on the lation of the formation of sand ridges to the thermal ructure of the atmosphere. Prof. C. W. Thorn- waite (United States) referred to some further data support of Dr. Bagnold’s figures.

Papers on climatology and meteorology in arid and mi-arid regions were read by Prof. P. Meigs (United ates), Prof. C. W. Thornthwaite (United States) d Mr. S. Duvdevani (Israel). Prof. Meigs dealt ith the preparation of homo-climatic maps, and owed in particular a map of Israel and Jordan. e discussed the parameters to be used in the eparation of these maps. Prof. Thornthwaite dealt ith problems of water planning, stressing the portance of assessing potential evapo-transpiration, e amount of which can under certain circumstances found by using phenological indications as curately as by special measurements. The dis- ssion on this paper was concerned with the iformity of the water-storage capacity of soils, apo-transpiration from various growths, and the e of atmospheric measurements to ascertain rigation needs ; for a first planning the nature of e crop is not considered of critical importance in sessing these needs. Mr. Duvdevani had measured e dew deposit on a prepared surface at various ights above the ground. The deposit at stations m. or less above the ground depends on the topo- aphy, the soil and the season, and particularly on e water content of the uppermost layer of the soil ; ove a wet soil the deposit decreases upwards, above dry soil it first increases and then decreases. The ysical meaning of these measurements was raised the discussion without conclusion.

Six papers were read in the Section on Soils. Prof. S. Hills’s (Melbourne) lecture dealt with the lationship of physiography and climate, and with e influence of former physical conditions (as found om ‘fossil’ lateritic soils and sand ridges now earing vegetation) and geomorphic features and atterns of natural drainage. The dramatically dden and devastating effects of locally produced ods in desert areas was the main subject of Dr. . C. Lowdermilk’s lecture. Prof. A. Reifenberg srael), in a historic survey, showed the relationship the encroachment of the desert to stable social nditions of government. Prof. G. Aubert (France) stressed how soils science had applications in the planning of irrigation, and Prof. S. Ravkovitz (Israel) dealt with the wind transport of soil material ; according to him the salts in the loess soils in the Southern Desert of Israel were probably wind-borne from the Dead Sea. Dr. G. Leone’s (Italy) lecture on the stabilization and re-vegetation of coastal dunes of Tripolitania introduced a discussion which stressed a similar state of affairs in this respect in the whole Mediterranean area.

The lectures in the Section on Biology were many-sided, embracing human physiology, general ecology, zoology and phytology, all with emphasis on desert environment. Dr. W. S. Ladell (Nigeria) gave a review on the physiology of life in high ambient temperatures which included the result of his research during the past ten years. He stated that Europeans temporarily resident in a tropical climate learn to tolerate severe heat with less discomfort than the local inhabitants. He refuted the theory that warm climates are detrimental to health and to productive work. He held the view that white settlers in hot regions had succumbed, when they had succumbed, to disease rather than to climatic factors. Ladell also discussed the physiological changes in the course of acclimatization to heat, the role of sweat and chlorine loss and of the central regulation mechanism involved. He stressed the point that in order to become acclimatized one has to expose oneself and not carefully to avoid exposure. Prof. F. S. Bodenheimer (Israel) spoke on the physiology of animals in arid zones with special reference to the frequent occurrence of dark and black colours.

Prof. F. W. Went (United States) spoke about the different germination mechanisms of desert plants which inhibit their germination at the wrong temperatures or after insufficient rains. He stressed the role of water in the germination of desert annuals. When the soil was kept wet all the time no germination occurred for many species. The reason for this lies in the presence of germination inhibitors inside the seeds, which are not leached out by small amounts of precipitations. With too much rain not only the inhibitors but also a growth-promoting substance is leached out. The inhibitors are formed continuously as soon as the seeds are wet. Dr. H. G. Thornton (Great Britain) dealt with his new approach to microbiological research work on desert soils, and Prof. Ch. Killian (France) gave a description of the vegetation of the Chott Hodna (Algiers) and analysed its edaphic conditions. The results are indicator values of the various plant communities, particularly with regard to chemical properties. Dr. B. T. Dickson (Australia) and Dr. P. C. Duisberg (United States) dealt in particular with plants in arid and semi-arid zones, Dickson with the Australian experience of transplanting plants into Australia, and Duisberg with the commercial utilization of desert plants from North America. Afforestation in arid areas was the subject of Sir Harold Glover’s (Great Britain) lecture, which contained advice for planting, seeding and felling in such a way as to minimize the encroachment of the desert. Prof. M. Even-Ari (Israel) gave a short account of the water balance of desert plants, especially their adaptation to the dry season by decreasing their transpiring surface. Dew formation and active condensation of water vapour out of the atmosphere possibly constitute additional water sources for these plants. In the discussion, Prof. Went pointed out that the real suction forces of plants are apparently much stronger than those obtained by cryoscopic measurements of osmotic values.

Prof. A. Bonne (Israel) and Dr. M. Ezekiel (F.A.O.) presented the point of view of the economist and explained the importance both of economic planning and of general economic and statistical surveys of food requirements. Prof. M. R. Huberty (F.A.O.) explained the structure and purpose of the Food and Agriculture Organization with special reference to its activities in the field of ground-water studies.

Introductory to the excursions, Mr. P. L. O. Guy (Israel) gave an account of the remnants of the soil and water conservation service which existed in the Kurnub upper-catchment area during the Byzantine period and suggested that the site should be rebuilt as an experimental reserve; Mr. A. de Leeuw (Israel) outlined the overall irrigation scheme for Israel with special emphasis on the problem of water storage.

In the session held in Haifa, Mr. E. W. Golding (Great Britain) told of recent British experience on the utilization of wind-power for the generation of electricity by windmills of modern type, and gave a general discussion on the economic exploitation of wind energy with particular reference to this region. The remaining papers of the last day dealt with problems of ground water and water in soils. Dr. P. Danel (France) dealt with the physics and the measurements of the flow of ground water and with the application of the methods of measurement which he and his co-workers in Grenoble had developed. Dr. L. A. Richards's (United States) papers also dealt largely with the technique of measurements, in this case with the physical properties of soils, especially as regards their power to retain water. The relevance of such measurements to irrigation methods was discussed, as well as the foundations of the new subject of soil physics. The paper of Dr. A. N. Khosla (India) was read by his colleague, Dr. R. D. Dhir, and dealt with the relation of surface water and ground water in arid zones. He gave a simple formula which he has applied successfully to several catchment areas in India to determine the yearly run-off from catchment areas. The formula is based on monthly average temperatures only. In the discussion it was pointed out that Dr. Khosla's method may be correlated to Thornthwaite's method of evapo-transpiration. Prof. L. Picard (Israel) reviewed the history of ground-water investigations, and Dr. M. G. Drouhin (Algiers) spoke on hydrological studies in desert regions.

In the closing session Sir Ben Lockspeiser (Great Britain) summed up his impressions of the conference, followed by a discussion to which, among others, Kellogg and Monod made valuable contributions. It appears that the main lessons to be learned from this symposium are as follows: (1) Desert research requires many disciplines, and although men of science usually prefer to talk to specialists in their own discipline, a conference of this type bringing together the various experts dealing with arid zones is valuable and should be repeated every four or five years. (2) In all the branches men of science are still struggling to clarify their ideas; in some of them even commonly accepted definitions and terminology are still lacking. Nevertheless, (3) the biggest hindrance to progress at the present time is the lack of available data in branches where there is common agreement on which data should be assembled, and there are generally accepted techniques for assembling them. This is true particularly for soil and
water studies and also for certain specialized meteo
ological data. The members of the conferen
unanimously accepted the following resolutions:

"This symposium wishes to draw the attention
the Director-General of Unesco to the followi
resolutions:

"1. That interested Governments be invited
strengthen existing research devoted to vario
problems of arid zones at existing national centr
with a view to (*a*) encouraging fundamental researc
and (*b*) the eventual creation of national bodies whe
the practical problems of each area can be broug
to a focus and considered as a whole.

"2. That the effort devoted to field surveys, unde
taken to obtain the basic data on the arid zone
should be extended and means provided for increas
training facilities for technical personnel required f
field studies and operations.

"3. The symposium attaches great importance
the exchange of scientists and the sharing of traini
facilities on an international basis.

"4. The symposium appreciates the practical i
terest and support of arid zone research and develo
ment of the United Nations, its Specialised Agenci
and of international non-governmental scienti
organizations, and warmly supports the recon
mendation of the Advisory Committee on Arid Zo
Research that Unesco should initiate steps for t
preparation of a handbook to guide collection
basic data".

The proceedings of the symposium will be pu
lished by the Research Council of Israel with financi
support by Unesco.

S. GOLDSTEIN

THE SCIENCE OF DOMESTIC HEATING*

THE subject of domestic heating is of particul
interest at the present time in Great Brita
when the quantity of coal for use in homes may w
have to be reduced as a result of both the eve
increasing demand for coal to satisfy the expandi
power requirements of industry and the urge
economic need to export more coal.

Coal must continue to be the principal domest
fuel in Britain for many years to come, the supp
of alternative fuels being totally inadequate for th
purpose, so that there is every incentive to impro
heating methods and appliances with the view
obtaining more heat and comfort from less co
Furthermore, the greater scarcity of coal and its risi
cost, together with an advance of scientific techniqu
and equipment, have given an added impetus to
more scientific approach to the problem duri
recent years.

The chimney fireplace was first introduced in
England during Norman times and was the beginni
of the familiar open fire of to-day. The early chimne
were large and troublesome; but their size was reduc
only slowly, and it was not until Rumford suggest
a narrowing of the throat of the fire, to reduce roo
draughts and to combat down-draught, that an
marked improvement occurred. A further restrictio
of the throat, with consequent additional advanta
followed upon the introduction of cast iron as

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* Summary of a Friday Evening Discourse delivered to the Roy
Institution on May 16 by Mr. J. S. Hales, of the British Coal Utilisat
Research Association.

naterial of fireplace construction; but this advance vas lost later when the tile surround became popular nd precluded the use of proper throat control. Cold lraughts increased again, furnishings and clothing ecame lighter, and comfort decreased once more.

It is not always appreciated that, of the heat vailable in coal burned in an ordinary stool-bottom rate in a tile surround, only some 20–25 per cent is mitted as useful heat in the form of radiation. Of he remaining heat, up to 20 per cent passes into the rickwork of the fireplace, and the rest is lost in the lue gases, which include smoke, and in any unburned uel in the ashes. If the chimney is on an inside wall, proportion of the heat lost into the brickwork and n the flue gases may be regained, but the amount is mall because of the low temperature of the flue ases, caused by their admixture with excessive air lrawn into the unrestricted throat of the fire. Attempts have been made, from the seventeenth entury onwards, to make better use of the heat vhich passes into the brickwork of an ordinary open ire, usually by the design of so-called 'convector' ires, in which the fire is partially enclosed within a netal casing. Air circulates through the annulus so ormed, and is heated before re-entering the room. Modern types of convector fire are continuously urning and incorporate underfloor air-control for he rapid revival of 'dead' fires.

Although comparatively inefficient, the open coal ire has the redeeming feature of attractiveness, which s doubtless the principal reason for its retention in omes. To be fully acceptable, however, the open ire must provide an optimum degree of comfort ombined with an economical use of coal.

Comfort may best be defined as the simulation ndoors of the outdoor conditions on a calm, sunny lay in spring—namely, a source of radiation, a noderate air temperature, no excessive air movement nd a reasonable humidity of the air. The economical ttainment of this degree of comfort demands that reater attention be paid to existing methods of ouse-building. A source of radiant heat alone cannot ive the desired room air temperature, while purely onvection heating, which tends to require the mainenance of high air temperatures, leads to a high heat oss and consequent heavy fuel consumption in the ast majority of present-day British houses. This eat loss can only be reduced by careful insulation f walls, ceilings and windows, and by the exclusion f unnecessary draughts. Unfortunately, satisfactory nsulation is impossible in most existing houses, so hat a compromise between solely radiant and purely onvective heating methods needs to be effected.

Such compromises have been proposed for as long s two hundred years, for the *cheminée de Nancy* was n effect an open fire which provided convection eating also. Modern appliances still seek to provide adiant and convective heating, and also to reduce he air flow up the chimney to the acceptable figure f about 2,500 cu. ft./h. for average rooms and ccupancy.

The many earlier proposals for better house-heating nay have been neglected because of a lack of proper esting equipment and facilities. These difficulties re now being removed, however, and in modern esearch into methods of domestic heating use is made f such instruments as the integrating radiometer, the ontinuous-recording balance, and the recording nemometer for the simultaneous measurement of the adiation, rate of fuel consumption and air flow, espectively.

The outstanding problem of domestic fires, and one which will remain as long as coal is the chief fuel, is that of reducing or eliminating smoke emission. From the time when coal was first used as a fuel, suggestions have been made for reducing smoke, many of which require the smoke to pass through red hot cinders before its escape. Devices of this kind undoubtedly reduce smoke, but are difficult to develop as a controllable home appliance. Nevertheless, the attack on smoke has received added impetus from the recent development of precise measuring equipment, such as the thermal precipitator which measures the rate of deposition of tar or soot from flue gases.

The use of instruments of this type and those mentioned earlier, together with the application of modern techniques, should lead to a more rapid improvement in our methods of domestic heating which will remove many of the current criticisms to which we are subjected.

BRITISH COLONIAL TERRITORIES, 1951–52

THE survey "The Colonial Territories 1951–52"*, which includes the usual chapter on research and surveys, again precedes the annual report on Colonial research and provides the essential background against which the recently published "Return of Schemes" made under the Colonial Development and Welfare Acts 1951–52 (see p. 311), and the annual report, "Colonial Research, 1951–52", still to appear, should be appraised. Considerable emphasis is again laid, in the general survey forming Part 1, on political developments, notably the new policy in Malaya, and the problems connected with closer association in Central Africa and with the coming into force of the new Nigerian constitution; but, on balance, the main emphasis in the survey for this year is on economic matters. Financial stringency, for example, and the need to husband funds available for research schemes under the Colonial Development and Welfare Acts, have led to a marked decline in the number and size of research schemes made during the year; but some £1,231,000 was disbursed on such schemes during the year.

Recommendations by Colonial Governments for inclusion in the Colonial Research Service of more than sixty specialist and research posts in departments of agriculture and in veterinary services have been approved; some twenty new appointments were made on Colonial Research Service terms, and fifteen research studentships awarded. Nevertheless, there were still 988 vacancies in the Colonial Service in spite of 1,396 appointments during the year, and, of these vacancies, 281 were in the educational service, mainly for teachers of scientific and technical subjects and for primary teachers. Only 141 civil engineers and 68 mechanical engineers were recruited as against 169 and 70, respectively, during 1950, but 169 medical practitioners were recruited as against 131 for the previous year. The planned expansion of the Colonial Geological Surveys is now almost complete, with an overseas staff of 180, compared with 58 in 1947. In this field valuable help has also been given by United States and Canadian geologists, chemists and mining engineers under a scheme of the Economic Co-operation Administration, and, besides an increase in the total area geologically mapped during the year, continued progress is reported in the investigation of mineral deposits as well as in the discovery of water supplies. The growing interest of the universities in Colonial geology is also proving of practical value. A party of field surveyors, including three Americans recruited by Economic Co-operation Administration, has reconnoitred by geodetic triangulation from eastern Uganda (near Mount Elgon) down the east side of Lake Victoria to Tanganyika and also measured a base near Kisumu. Geodetic triangulation continued in Basutoland, and the Royal Air Force maintained its air-photography programme in Central and East Africa.

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* Colonial Office. The Colonial Territories, 1951–52. (Cmd 8553.) Pp. x+140. (London: H.M.S.O., 1952.) 4s. 6d. net.

In Zanzibar the work of the team investigating the disease of cloves which threatened the industry with extinction is showing fruitful results. It is now confirmed that the death of young clove trees and the 'die-back' of older clove trees is caused by a parasitic fungus, and there is evidence that 'sudden-death' disease is caused by another fungus. It is expected that methods of control will eventually remove the threat to the economy of the territory, and during these investigations the team also determined the cause of a disease of coconuts. Work with systemic insecticides at the West African Cocoa Research Institute promises to provide a useful adjunct to the method of controlling the 'swollen-shoot' virus disease by cutting out diseased trees.

The survey gives some figures which should be kept in mind in considering the expenditure of £14 million during the year from Colonial Development and Welfare Funds. During the year the dollar surplus of the Colonial territories was 455 millions, 330 millions of which accrued during the first half-year. Development plans adopted during the year include the £75 million plan for the Gold Coast, which does not include the Volta River project, the publicly owned parts of which are estimated to cost a further £65 million with an expenditure by private enterprise of £40 million on the aluminium industry. In the Gold Coast plan, which is to receive £3 million from Colonial Development and Welfare Funds, some £48 million coming from local resources, 17 per cent is to be applied directly to increasing productive capacity in agriculture and industry, 35 per cent to communications and 33 per cent to social services. The revised plan of the Kenya Government for the ten years ending in 1955 contemplates expenditure of £35 million compared with the previously approved £20 million, and here also emphasis is placed on measures designed to improve the agricultural industry. Development plans approved up to March 31, 1952, totalled £456 million, against which £78 million was to come from Colonial Development and Welfare Funds.

Special attention has been given to the problems of mechanization of agriculture in Colonial territories, and the plague of the desert locust (*Schistocerca gregaria*) is being energetically combated by modern mechanized methods in Somaliland Protectorate, Aden Protectorate and Kenya, which is the main danger area; and to co-ordinate such campaigns with those of other countries, a Technical Advisory Committee on Desert Locust Control has been set up to advise the United Nations Food and Agriculture Organization. The urgency of developing the livestock industry has focused attention on the best methods of cattle breeding; a survey of cattle-breeding policy and research was undertaken in the African territories during 1951, and the report is now under consideration. There are now fifty fisheries officers serving or in training, and a feature of the year has been the promising results obtained in fish-farming in the West Indies and in East and West Africa. Supplies to the Colonial territories were adversely affected during the year by world shortages, particularly of iron and steel semi-manufactures, non-ferrous metals and chemicals which contain sulphur. United Kingdom exports of semi-manufactured steel to Colonial territories could not be maintained at the 1950 level.

With regard to education, the survey reports that almost all the buildings in the first programme of the University College of the West Indies will be in use during this year; at University College, Ibadan, in Nigeria, three halls of residence, the science laboratories, arts block and administration building wil be occupied in October this year, and the Nigerian Government has granted £1·5 million for building a new teaching hospital. Courses began last January at the two new colleges of arts, science and technology to be known respectively as the Kumasi College o Technology and the Nigerian College of Technology while work has started on the new buildings of the Royal Technical College, Nairobi, which will serve all the British East African territories. Studies o educational policy and practice in West and in East and Central Africa were initiated, and the findings o the two missions are to be discussed at a conference later this year. An accelerated Development Plan for Education in the Gold Coast was published during the year, and extra-mural departments have been firmly established at the University College of the West Indies and at Ibadan. To meet the need for trained teachers while training institutions are being built up in Malaya, the Malayan Teachers' Training College, at Kirkby, near Liverpool, was opened as a short-term project. Besides the 3,417 students at the Colonial universities and university colleges, there were more than five thousand Colonial students in Britain.

In the health field, the Medical Departments of the African territories are now up to establishment fo medical practitioners, except for a few officers with special experience or qualifications such as pathologists, but in Malaya many vacancies remain. The training of medical auxiliaries is receiving high priority, and the many schools for training locally pharmacists, laboratory assistants, radiographers and physiotherapists are working to capacity. It is hoped that the rural health centres which are being developed will soon be playing as important a part in the life o rural communities as does a hospital service in urban areas. Tuberculosis is now perhaps the greatest socio-medical problem in the Colonial territories, and effort to tackle this problem have been intensified during the year, including the active exploitation of B.C.G vaccination; but in the absence of specific drugs o rapidly effective preventive measures, success i likely to be slow and costly. In leprosy, however successful treatment by the most modern drugs ha completely changed the outlook, and in this world missionary bodies and voluntary organizations have played a conspicuous part. Malaria remains the most universal menace to health, and its complete eradication has so far proved possible only where favourable conditions exist. Total elimination has been maintained in Cyprus, and in Mauritius the incidence ha become negligible, although *Anopheles gambiae* has no succumbed so readily to the residual spraying technique which was rapidly lethal to the principal carrier, *Anopheles funestus*. Some eight hundred olonial student-nurses are taking general nursing, ental nursing or midwifery courses in the United ingdom.

A chapter on international relations, besides giving picture of the extent of technical co-operation both hrough the Specialized Agencies of the United ations and in other ways, gives a clear account of reat Britain's relations with the Trusteeship Council nd of the reasons which led the United Kingdom to ppose two, and abstain from five, resolutions in the discussion by the Fourth Committee of the General Assembly of the report of the Committee on Information from Non-Self-Governing Territories. This is but a single illustration of the way in which this survey of Colonial territories is an invaluable contribution to the discussion of Colonial affairs in general or to the consideration of Colonial development and welfare schemes, and it forms a very useful guide to the scientific and technical work which is reported more fully elsewhere.

NEWS and VIEWS

araday Society: Prof. J. W. McBain, F.R.S.

THE Faraday Society has elected Prof. John William cBain an honorary life member. Prof. McBain has eld the chairs of physical chemistry in the Univerities of Bristol in Great Britain and Stanford in he United States, and after his retirement from tanford was for a time director of the National hemical Laboratory of India. Prof. McBain's ontributions to colloid science and surface chemistry re well known; he was the first to undertake a omprehensive study of the constitution of soap olutions, and is universally recognized as the disoverer of the ionic micelle and a pioneer of the cience of colloidal electrolytes. In this work he has een ably assisted by his wife, Mrs. M. E. Laing cBain. His experimental verification of Gibbs's dsorption equation, by slicing off a very thin layer rom the surface of a solution, and comparing the oncentration of solute in this layer with that in he bulk solution, stands out as one of the boldest xperimental researches in physical chemistry of the ast quarter of a century. He was awarded the avy Medal of the Royal Society in 1939.

Meteor Train

DR. A. R. HOGG, chief assistant at the Commonealth Observatory, Mount Stromlo, Canberra, rites that a spectacular meteor train was seen uring the course of photometric observations at the ommonwealth Observatory. The train first appeared n May 4 at 19h. 15m. G.M.T. (05h. 15m. E.S.T.) gainst a dark sky. For a few seconds it had the ikeness of a comet's tail, about 5° long. This simlarity soon vanished and within thirty seconds of ormation the train was a straight line. In a further alf-minute the top third of the line apparently bent orthwards a distance of about 2°. Subsequent hanges were more gradual. Fifteen minutes after ormation the train was visible as a faint diffuse orse-shoe-shaped glow centred 2 or 3° higher than he original train. Thirty minutes after the formation he area was searched with a wide-field telescope f 5-in. aperture, but no trace of the train could be een. The angular dimensions were estimated from ketches made at the time, and reference to the ackground of identified stars. This gave the position f the centre of the train as near R.A. 14h. 40m. and ec. 37° S. (1950). If it be assumed the meteor first ppeared at the average height of such objects 100 km.), the train was about 20 km. long and istant 140 km. from the observer on a true bearing f 245°. At this point it would not have been illumnated by direct sunlight. The distortion of the train the first half-minute represented a component of otion at the 80–100 km. level of at least 480 km./hr. moving to the north. From the date of appearance and direction of the train the meteor could have been a member of the Gamma Aquarii shower.

Scintillation of Stars and the Atmosphere

A RECENT issue of the *Irish Astronomical Journal* (1, No. 8; December 1951) contains, among others, a paper on "Scintillation and Atmospheric Seeing", by H. E. Butler, of Dunsink Observatory, which gives an excellent account of the reasons for this phenomenon. The study by means of a photoelectric cell of the most rapid fluctuations present in the light from a star has been carried out at Dunsink. The equipment will record fluctuations in the light intensity at frequencies between 0 and more than 1,000 c./s., and very interesting results are shown graphically on a plate. Besides its astronomical applications, there is also the meteorological significance, because the amount of scintillation at any moment could be a measure of the amount of turbulence that is present at the time in the telescope beam. It has already been shown that considerable changes in the scintillation can occur with changing weather.

Research on the Constitution of Alloys

THE Constitution of Alloys Group of the British Iron and Steel Research Association has recently issued a statement dealing with the principal gaps in current research on alloys constitution and indicating its willingness to encourage and assist such research. The alloys that have been insufficiently studied are as follows: high-temperature materials, and, in particular, higher-melting-point alloys of Groups V and VI, systems containing borides, and ferrous alloys containing silicides; ferrous alloys in general, and, in particular, the binary alloys of iron as a basis for further studies of the complex equilibria involved in ternary and quaternary alloys, and also the relationship between the various carbides in alloy steels; magnesium alloys, their heat treatment, and especially the ternary and more complex alloys; high-tensile brass-type materials and the complex bronzes; and finally, general work on the physics of alloys, especially the crystal structures of intermetallic phases and accurate measurement of lattice spacings. It should be noted that by enumerating this list of topics no implication is intended that other subjects and systems in metallurgical research are of lesser interest or do not merit so much study. The Group would also be glad to know of existing equilibrium diagram work which has not been reported to it, and of projected research programmes involving the constitution of alloys. Those interested should communicate with the Secretary, Constitution of Alloys Group, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Fluorescent Lighting in Museums

An important article in the April issue of the *Museums Journal* (reprinted from *Museum*, 5, No. 1, March 1952, by permission of Unesco) by M. J. Genard, of the University of Liège, on "Extreme Ultra-Violet Radiation from Tubular Fluorescent Lamps and its Effect on Museum Lighting", deals with a subject of great interest to all those concerned with the preservation of objects exposed to artificial light. The paper opens with an admirable survey of the principles involved in fluorescent lighting. Details are then given of the research work of the author and other investigators, from which it appears that radiation from tubular fluorescent lamps in the ultra-violet zone of the spectrum between 310 and 400 mμ is not more injurious than the corresponding radiation from incandescent lamps or sunlight, as long as the conditions of illumination and atmosphere are identical. On the other hand, it is known that the 254-mμ ultra-violet radiation of mercury causes intense photo-chemical reaction in many materials. It would therefore seem probable that there is a region of the spectrum in this vicinity which is to be regarded as particularly dangerous. Tubular fluorescent lamps emit an ultra-violet radiation extending as far as 280–290 mμ in the short wave-lengths. It is feared that these radiations may accelerate photo-chemical deterioration in view of the very marked deleterious action of the neighbouring zone of the spectrum. Neither sunlight nor the light of incandescent lamps contains ultra-violet elements of such short wave-lengths as those found in the light of fluorescent lamps. It is also established that the continuous radiation, due to the fluorescent powders used in certain types of tube, sometimes extends into these extreme wave-lengths. It is to be feared that these types may be more harmful than the others. The transmission curves of the glass in existing varieties of fluorescent tube differ little one from another. It should, however, be possible to use glass which absorbs all rays below 320 mμ. After a tube has been in use for a thousand or so hours, the extreme ultra-violet radiation is approximately 25 per cent less.

National Central Library: Annual Report for 1950

The thirty-fifth annual report of the executive committee of the National Central Library covers the year ended February 28, 1951 (pp. 35; from the Library, Malet Place, London, W.C.1; 1951). Building operations for the reconstruction of the building in Malet Place commenced in October 1950, and it was expected that the west wing and much of the east wing would be ready for occupation in June 1951. The Treasury grant for the year was increased from £22,500 to £25,000, of which £1,000 was to compensate for the third stage in the discontinuance of the contributions from the Carnegie United Kingdom Trust. These, since 1916, have totalled £293,786, including £84,500 to outlier libraries and £41,499 to regional library systems for the compilation of union catalogues, and the report includes a warm acknowledgment of the value of this generous support. There has been a good response from all types of libraries to the trustees' appeal for increased financial contributions, and such contributions were 39·5 per cent higher than those from similar sources during 1948–49. Issues of books from or through the Library during the year decreased by 2,332 to 94,220; but applications increased to 92,740 from 87,931 during 1949–50, the percentage of applications successfully handled being 65·3 as against 71·49 during 1949–50. Issues to university libraries again increased, by 5 42 per cent, to 13,479, while the calls on university libraries for the more specialized books and periodicals also continue to increase. Issues to outlier libraries increased by 20,271, and other specia libraries lent a total of 1,810 books to meet specia needs: fourteen further libraries were added to the list of outlier libraries during the year. Issues from the Scottish and Irish Central Libraries, however decreased to 12,616 and 11,959 respectively, as compared with 15,397 and 12,493 in 1949–50. A total of 609 libraries co-operating in the regional system and the London Borough libraries inter-lending system lent 170,979 volumes to other libraries within their own system and 24,865 books to libraries in other regional systems or to non-regional libraries through the National Central Library, as compared with 164,152 and 21,423 in the previous year. Books lent through the international lending service rose from 994 (twenty-three countries) during 1949–50 to 1,58 (thirty-eight countries), and books borrowed from 420 (nineteen countries) to 584 (nineteen countries) Less time was spent on cataloguing Russian books and periodicals; but 4,899,620 entries have now been supplied for the national Union Catalogue.

Science in Latin America

Four publications have appeared of late which chronicle contemporary scientific activities in Latin America. Three of them, which form part of the very comprehensive series of lists published by the Unesco Science Co-operation Office for Latin America, are entitled as follows: "Venezuela, Vol. 1" (pp. 131) and "Brazil, Vol. 3" (pp. 230) of the list of "Scientific Institutions and Scientists in Latin America", and "Latin American Contribution to Scientific Progress Chemistry, 1948–49" (pp. 50). The fourth volume published by the Ministry of Education of the Argentine, is a "Compilation of the Bibliographies in the Library of the Faculty of Agronomy and Veterinary Science of the University of Buenos Aires" (pp. 30). The two publications dealing with Brazi and Venezuela follow the familiar pattern adopted for other Latin American countries (see *Nature*, 165, 589 (1950); 166, 1059 (1950); 167, 972 (1951)), and their scope is indicated by their titles. The volume on chemistry is one of a number of reports which it is intended to publish every two years, for the purpose of making known the Latin American contributions to the progress of science; the text, in English, gives abstracts of the work, grouped under topics, and a bibliography of papers. The fourth work, though theoretically restricted to papers and books in the field of agriculture and veterinary science, liberally interprets this restriction to mean any publication in science and engineering with a bearing on the field in question; it is sub-divided by subjects, and within each subject the contents are listed alphabetically by author.

National Institute of Economic and Social Research: Report for 1951

The National Institute of Economic and Social Research, which was founded in 1938 as an independent non-profit-making body, has as its object the propagation of knowledge of the social and economic conditions of contemporary society. In its report for 1951 (pp. 32; from the Institute, 2 Dean Trench Street, Westminster, London, S.W.1; 1951), it is explained that the activities of the Institute are

ow to be directed largely to research into industrial
nd commercial capital, and inquiries have already
een started into the finance of public companies
nd the stock of capital assets. Among previous
search projects now nearing completion are
vestigations into trends in retail trading, con-
umers' expenditure and behaviour during 1920–38,
nd the location of industry. The inquiry into trends
retail trading traces the changing pattern of retail
ading during the past fifty years or so. with par-
cular attention to the development of multiple-shop
nd co-operative retailing. The project dealing with
ocation of industry was undertaken by the Institute
n the invitation of the Board of Trade for the
urpose of investigating the private costs of firms
hich have opened branch manufacturing plants.
n interim report was presented to the Board of
rade in 1950 in which the costs of the branches
ere compared year by year with those of the parent
ctories. On the basis of the work already done, it
hoped to establish the cost of mobility in certain
dustries and to assess the relative importance of
arious location factors in these industries.

fth Plant Breeders' Conference

The fifth Plant Breeders' Conference under the
uspices of the Agricultural Research Council was
eld during July 24–26 at the John Innes Horti-
ltural Institution, Bayfordbury. Prof. K. Mather
nd Dr. E. E. Cheesman represented the Agricultural
esearch Council. Dr. C. D. Darlington was in the
hair. The scope of this year's conference was
idened to include not only members of the British
lant breeding institutions but also representatives
om the National Vegetable Research Station,
otato Genetics Station, East Malling and Long
shton Research Stations, the Scottish Horticultural
esearch Institute, certain university departments
nd commercial seed firms. This enlargement
sulted in a valuable exchange of ideas between
search workers in different fields. The morning
rogrammes were devoted to demonstrations of work
rried out by the four departments of the John
nes Horticultural Institution. In all, there were
irty different demonstrations. The afternoon
ogrammes consisted of papers followed by dis-
ssions. The papers were: "Breeding for Yield",
G. D. H. Bell and R. N. H. Whitehouse; "Variety
esting", by J. C. Haigh; "Reproduction of Stocks",
F. R. Horne; "Aids to Plant Breeding", by
. J. C. Lawrence; "Aims and Methods in Plant
reeding", by D. Lewis. A summary of each paper
nd a full account of the conference will appear in
eredity. The next conference is expected to be
ld at the Plant Breeding Division, Stormont,
orthern Ireland, during July 6–7, 1954.

russels Conference on Ultrasonics

The proceedings of the International Conference on
ltrasonics, held in Brussels during June 1951 (see
ature, 168, 106; 1951), have now been published
book form by the Koninklijke Vlaamse Academie
oor Wetenschappen, Letteren en Schone Kunsten van
elgie (Brussels; 225 francs), under the auspices of
hich it took place. Thirty papers, divided into four
ctions, are covered in about three hundred pages:
ropagation in fluids; absorption in electrolytes and
bration potentials; propagation in liquid mixtures
nd suspensions; propagation in liquid helium. The
nference thus dealt with the fundamental aspects
ultrasonics in fluids, in contrast to the international conference in Rome for the previous year, which was concerned mainly with applications in industry and medicine. Many of the papers in the first three sections at the Brussels conference were devoted to the theoretical or practical aspects of ultrasonic absorption considered as viscous or relaxation effects, and some discussion took place on the validity of the supposition that dilatational—as well as shear—viscosity plays a part in these phenomena. In the fourth section, there are a number of papers discussing the various theories which have been put forward to explain the existence of 'second sound' in liquid helium II.

Birmingham Symposium on Analytical Chemistry

Following the International Congress on Analytical Chemistry in Oxford during September 4–9, the Midlands Society for Analytical Chemistry is arranging a symposium on analytical chemistry, to be held in the Chemistry Department of the University of Birmingham, during September 11–12. The main purpose of the symposium is to give those chemists in the Midlands who are unable to attend the Oxford Congress, the opportunity of hearing papers by, and meeting, analytical chemists of international repute. Prof. Fritz Feigl, of Rio de Janeiro, will be the honorary chairman. The programme on the first day will consist mainly of papers concerned with fundamental concepts of analytical chemistry, and the second day will be devoted to original methods. In addition, visitors will have the opportunity of seeing some of the research projects being carried out in the Research School of Analytical Chemistry at Birmingham, which is one of the largest and best equipped in Europe. The registration fee for non-members of the Society is 10*s*. and for members 5*s*. Further details can be obtained from the honorary secretary of the Society, W. T. Edwards, 100 Rymond Road, Birmingham 8.

International Institute of Welding: Meeting in Gothenburg

The annual meeting of the International Institute of Welding will be held this year in Gothenburg during September 7–13. On the first day there will be a meeting of the governing Council of the Institute, and the following four days, September 8–11, will be devoted to meetings of the fifteen technical Commissions composed of representatives appointed by the societies belonging to the Institute. On the morning of September 12 visits will be made to shipyards and other works in Gothenburg, and in the afternoon four papers on "Welding in Shipbuilding" will be given by representatives of France, Great Britain, Sweden and the United States. The official programme will close with a further meeting of the governing council on September 13, after which those taking part will be free to join in a series of works visits in Stockholm, Malmö and other industrial centres, organized by the Swedish member societies of the Institute. Further information and enrolment forms can be obtained from Mr. G. Parsloe, Secretary-General, International Institute of Welding, 2 Buckingham Palace Gardens, London, S.W.1.

Museums and Education: Seminar in New York

A seminar on "Museums and Education", organized by the United Nations Educational, Scientific and Cultural Organization, will be held in Brooklyn during September 14–October 12, under the directorship of Dr. Douglas A. Allan, director of the Royal

Scottish Museum, Edinburgh, with Dr. Hanna T. Rose, of the Brooklyn Museum, New York, as associate director. Senior officers will deal with individual subjects as follows: Dr. Torsten Althin (Tekniska Museet, Stockholm), science museums; Dr. J. Wijenbeek (Municipal Museum, The Hague), art museums; and Dr. F. T. de Souza (Ministry of Education, Rio de Janeiro), educational organization. Forty-five participants representing their respective countries in the United Nations will attend the seminar, together with fifteen expert observers, representing interested parallel or kindred organizations. There will be opportunities for inspecting museum and educational projects as far afield as Washington, D.C. The topics for discussion will include the following: subjects of education in various countries suitable for museum treatment, and the extension of school and college curricula to utilize museum resources for the training of museum and educational staffs for the work under consideration; the varied techniques required for different mental ages; contributions to the development of the handicapped; the initiation of fundamental education in under-developed countries; and the employment of the latest scientific inventions in the more advanced centres.

Lectures on Nuclear Reactors

A course of thirty lectures will be given in the City and Guilds College, University of London, during the 1952–53 session by members of the Atomic Energy Research Establishment (Ministry of Supply), Harwell. The first group of twelve lectures will be concerned with slow-neutron natural uranium reactors, concluding with a detailed description of the large pile at Harwell (BEPO). Another group of six lectures will deal with particular aspects of reactors of various types. Information will be given on the various possible systems, and the problems involved in metallurgy, chemistry, engineering, heat transfer and physics, will be discussed. One lecture on health physics will be included. A group of three specialized courses will include five lectures for mathematicians on more advanced slow- and fast-neutron theory; five lectures for engineers on heat transfer and reactor design; and a lecture for physicists on the experimental use of a reactor, followed by the opportunity to take part in experiments involving neutron diffusion and the measurement of a neutron flux. At the end of the course it is hoped to arrange a visit to inspect the Harwell piles and give an opportunity for informal discussion with the various lecturers. All the lectures are free to students of the City and Guilds College and London intercollegiate students; for others a fee of ten guineas, to be paid to the City and Guilds College, London, S.W.7, will be charged for the whole course, with reductions for those who wish to attend only a selected part.

British Institution of Radio Engineers: Awards for 1951

The British Institution of Radio Engineers has announced the following awards for 1951: *Clerk Maxwell Premium* (for the most outstanding paper published in the Institution's *Journal* during the year), to Dr. H. Paul Williams (formerly of A. C. Cossor, Ltd., and now with Fairey Aviation Co.) for his paper on "Subterranean Communication by Electric Waves"; *Heinrich Hertz Premium*, to R. E. Spencer (E.M.I. Engineering Development, Ltd.) for his paper on "The Detection of Pulse Signals near the Noise Threshold"; *Louis Sterling Premium*, t Emlyn Jones (Mullard Research Laboratory) for hi paper on "Scanning and E.H.T. Circuits for Wide Angle Picture Tubes"; *Leslie McMichael Premium* to R. G. Kitchenn (formerly of the Local Lines an Wire Broadcasting Branch of the Engineer-in-Chief' Office, General Post Office) for his paper on "A 8-Channel Transmitter for an Experimental Carrie Wire-Broadcasting System"; *Brabazon Premium* (fo the most outstanding contribution to the Institution' *Proceedings* on radio or electronic aids to aircraf safety), to G. E. Roberts (Decca Navigator Co Ltd.) for his paper on "The Design and Developmen of the Decca Flight Log"; *Marconi Premium*, t E. G. Rowe (Brimar Valve Division, Standar Telephones and Cables, Ltd.) for his paper on "Th Technique of Trustworthy Valves"; *President' Prize* (awarded to the most successful candidate i the Graduateship examination) and the *Electroni Measurements Prize* (awarded to the most outstanding candidate in Part IV, electronic measurements, of the Graduateship examination), to G. R Beswick (Birmetals, Ltd., Quinton, Birmingham) *Mountbatten Medal* (awarded to the most successfu candidate who passed the Graduateship examinatio while serving in the Armed Forces), to C. J. Whit (B.B.C., Daventry, and formerly of the R.A.F.).

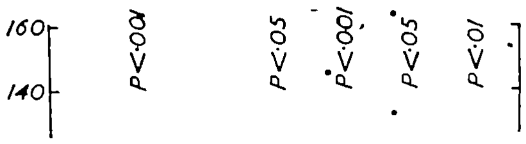
Announcements

Mr. William E. Miller has been nominate president-elect of the British Institution of Radi Engineers for 1952–53. Mr. Miller has been a membe of the Institution for twenty years and was electe a vice-president in 1948, having previously bee chairman of the General Council. He was one of th original signatories to the incorporation of th Institution in 1932.

The first of the Radio Industry Council's premium of 25 guineas for technical writing, to be awarded t authors of technical articles deserving to be commended by the industry, has been won by Mr. J. R Acton, of the Ericsson Research Laboratorie Nottingham, for his article on "The Single-Puls Dekatron", published in the February issue c *Electronic Engineering*. The dekatron is a new typ of gas-filled cold-cathode ray tube now bein developed for use in scalers and computors.

Mr. T. E. Goldup, a director of Mullard, Ltd., ha been appointed chairman of the Board of Governo of the Ministry of Supply School of Electronic Malvern, in succession to Prof. Willis Jackson, professor of electrical engineering, Imperial College c Science and Technology, London. Mr. Goldup, wh has had a wide experience of technical education i the electronics field, has been with the Mullar organization for more than twenty-nine years, an was formerly a member of the research staff c the Signal School, Portsmouth.

Erratum. In the communication entitled "Som Electrical Differences between Healthy and Viru infected Potato Tubers", by C. G. Greenham *et al* which was published in *Nature* of June 7, p. 973, it regretted that the top portion of the illustration incorrect and should be as follows:



SCIENTIFIC CIVIL SERVICE

PROMOTION OF INDIVIDUAL RESEARCH WORKERS

IT is announced that, as in previous years, special posts have again been created to provide for the romotion in the Scientific Civil Service of individual esearch workers of exceptional merit. These promotions, which include for the first time one to the rade of chief scientific officer, are effective from July 1.

Chief Scientific Officer

Mr. S. B. Gates has been at the Royal Aircraft Establishment, Ministry of Supply, since 1915, where e has acquired a reputation as one of the leading uthorities in Great Britain on fundamental problems in aerodynamics. He has been particularly concerned with control problems, and the comparative ease with which the modern high-speed aircraft can be andled by the pilot owes much to his work.

Deputy Chief Scientific Officers

Sir Donald Bailey joined the Experimental Bridging Establishment, now the Military Engineering Experimental Establishment, Ministry of Supply, in 1929 and has been continuously working on design nd development of bridging equipment for the Army. His most spectacular achievement is the ridge which bears his name, which has been found o have outstanding advantages in other fields of ivil engineering.

Dr. F. E. Jones joined the Telecommunications Research Establishment, Ministry of Supply, in 1940 nd played a large part in the development of elecronic circuits used in radar equipment for the R.A.F. He has also played a prominent part in the appliation of radar techniques to the study of weather nd of weather forecasting.

Dr. K. M. Smith, director of the Plant Virus Research Unit, Cambridge, of the Agricultural Research Council, s a noted authority in the field of plant virus research. He has described many new virus diseases of hortiultural and other plants and has investigated their ransmission by insects and other means; he has tudied the causal viruses by filtration and electron microscopy and, more recently, has greatly extended nowledge of the polyhedral diseases of insects. He s the author of a number of books on plant virus iseases.

Dr. R. L. M. Synge, of the Rowett Research nstitute, was jointly responsible with Dr. A. J. P. Martin for the early study and development of partition chromatography as an analytical procedure. He is also known for his structural studies on the ature of gramicidin, and, more recently, for his hemical studies of the nitrogenous compounds in reen leaves and micro-organisms and the influence of degradation of protein in the rumen on its utilizaion by the ruminant animal. He is continuing to develop physicochemical techniques, such as electrophoretic ultra-filtration, for the analysis of substances of biochemical interest.

Senior Principal Scientific Officers

Mr. G. Bradfield joined the National Physical Laboratory in 1949 to initiate work on ultrasonics after experience since 1923 in industry, the Air Ministry and the Telecommunications Research Establishment, Malvern. His earlier work was concerned mainly with the design and development of radio valves and centimetre radar, including responsibility for the design of complex war-time navigational devices. Since 1945 he has been engaged primarily in ultrasonic studies and is now a recognized authority on the subject. He is perhaps best known for the techniques developed for various purposes, such as flaw detection and the determination of elastic constants of crystals of isotropic and anisotropic solids over wide temperature ranges. In these fields the use of barium titanate as a novel piezoelectric material of high coupling has been explored and has yielded much improved devices.

Dr. W. P. K. Findlay, who is officer in charge of the Mycology Section of the Forest Products Research Laboratory, is a graduate of the Imperial College of Science and Technology, London, where he was awarded the Edward Forbes Medal and a Remanet Fellowship. In 1925, on a Fellowship of the Empire Cotton Growing Corporation, he studied first at Cambridge and later in Trinidad. In 1927 he joined the Forest Products Research Laboratory and was associated with K. St. G. Cartwright at the beginning of the Laboratory's systematic investigation into fungal decay in timber. As a result the technique of recognition, in the absence of fructification, of the fungi responsible for various kinds of wood rot by growing them in cultures was developed and has led to the establishment of the Wood Destroying Fungi Section in the National Collection of Fungi. He has also undertaken the mycological aspects of comprehensive investigations into the influence of fungal infection on the mechanical properties of wood. Dr. Findlay has been joint honorary secretary of the Biological Council from its inception in 1945 and has also been president of the British Mycological Society.

Mr. A. H. Ford-Moore has served in the Chemical Defence Experimental Establishment of the Ministry of Supply since 1921. He has played a leading part in chemical research into methods of defence against chemical warfare. He is an outstanding experimentalist and well known for his work on the organic chemistry of sulphur and phosphorus.

Dr. M. H. Hey, of the Department of Mineralogy, British Museum (Natural History), is a mineralogist and chemist of outstanding quality. His work on zeolites and his correlation of their properties with their crystal structure, and especially his study of the role of water in their constitution, was done between 1930 and 1937. He has specialized in inorganic microanalysis, and it is due to him that the chemical composition, and therefore the crystal structure and content of the unit cells of many new minerals, have been established. In addition to his chemico-mineralogical work, Dr. Hey has charge of the great collection of meteorites in the Natural History Museum; in this work he has contributed many analyses of new meteorites and has just completed a new catalogue of the collection. He is the author of "An Index of Mineral Species and Varieties arranged Chemically".

Mr. W. R. Lane joined the Chemical Defence Experimental Establishment of the Ministry of Supply in 1929. His work has been mainly concerned with the physics of chemical defence problems, in which field his fundamental studies on the mechanism of the break-up of liquid drops and the formation of aerosols has contributed materially to present-day knowledge. His ingenious microburette for accurately delivering small drops of known size has now become a well-known instrument which is used in laboratories all over the world.

Dr. J. G. Nagelschmidt, of the Safety in Mines Research Establishment, is a mineralogist of international reputation and is now engaged on research into the mineralogical aspects of pneumoconiosis. He has been a pioneer in the application of X-ray diffraction techniques to the study of clay materials, in the application of new mineralogical techniques to the study of dusts responsible for lung disease, and in the application of the electron microscope to the study of clay minerals and dusts. He has developed and is still developing new techniques for the quantitative mineralogical analysis of small dust samples and for the identification of particular mineral particles too small for identification with the optical microscope. He is a member of the Industrial Pulmonary Diseases' Committee of the Medical Research Council and is secretary of the Sub-Committee on Dust.

Dr. H. H. M. Pike joined the staff of the Research Department, Woolwich, now under the Ministry of Supply, in 1932, his early work being concerned with the internal ballistics of guns. More recently he has turned his attention to the study of the phenomena occurring during the detonation of high explosives, and his findings are the basis of civil defence teaching in connexion with the effects of blast on buildings.

Mr. J. S. Preston has been at the National Physical Laboratory for the past twenty-five years and was at first concerned with the development of photometric and radiometric methods of measurement. Through his work a standard design for commercially produced photo-emissive cells for precision photometry has been adopted. Later his attention was attracted to selenium cells, and he undertook investigations into their use in physical photometry; but the wide divergence between the theory and their practical behaviour led to a detailed investigation into the fundamentals of the constitution of rectifying contacts. This in turn was followed by work on the deposition and properties of a wide variety of thin films, and in this connexion the most recent development is the discovery of the technique necessary for the deposition on glass of a transparent electrically conducting metallic film of low resistance; this will have considerable practical value, as an electric current passing through the film will generate sufficient heat to prevent the deposition of moisture. Mr. Preston was the general secretary of the International Commission on Illumination during 1932–49.

Dr. J. Thomlinson joined the Royal Aircraft Establishment, Ministry of Supply, in 1939, where his work has been directed to the problems connected with the landing and take-off of aircraft from ships at sea and from confined spaces on land. He carried out the first known fundamental investigation into the performance of arrester gears used in deck landings of aircraft, and he originated and has since been responsible for the development of the flexible deck system for landing high-speed aircraft.

Mr. C. K. Thornhill entered the Ministry of Supply in 1940 and has been attached to the Armament Research Establishment since 1943. Througho this period he has worked with conspicuous succe on mathematical problems connected with guns an explosions. His contributions to the field of gu erosion were recognized by the United States Gover ment in 1947 by the award of the American Med of Freedom.

Mr. J. H. Whitaker, who joined the Royal Ai craft Establishment, Ministry of Supply, in 1936, a mechanical engineer and has made valuable con tributions in many fields. He became a recogniz authority on aircraft fuel and oil systems during th Second World War and has since been responsib for the development of essential components f guided missiles.

PHYSICAL SOCIETY

ANNUAL GENERAL MEETING

AT the annual general meeting of the Physica Society, held at the Royal Institution on Ma 20, the reports of the Council and of the honorar treasurer and the accounts and balance sheet for 195 were presented and adopted. The officers and Counci for 1952–53 were elected (see *Nature*, June 14, p. 995) At the extraordinary general meeting held immediately prior to the annual general meeting, Profs. Ott Hahn and M. T. von Laue were elected to honorary fellowship of the Society, and certain changes in th articles of association of the Society, which woul make the procedure of election of officers and Counci more democratic, were agreed to be submitted to th Board of Trade for approval.

During 1951, the Council reports, the membershi rose to 2,025 and the activities of the Society agai increased. It is gratifying to note that the decline i recent years in the number of newly elected Fellow has been arrested and that there have been substantial increases in both the studentship and fellowship grades. The work of the Society has been considerably hampered by rising costs of publication an shortage of paper, and the Council has given earnes consideration to the possibility of effecting economie and increasing efficiency. A scheme for introducin a reduced basic subscription for membership of th Society, with separate payment for all publications has received considerable support and it is likely tha some such scheme will be adopted for operation i 1953. Closer collaboration has been effected betwee the Society and the Institute of Physics, and member now receive notice of meetings of the Institute, whic they are invited to attend. They may also obtai one of the Institute's two journals at a reduce subscription-rate.

In addition to nine science meetings held in Londo during the year, a two-day meeting was held a University College, Southampton, and three-day meetings at University College, Swansea, and at th Queen's University, Belfast. In April a conversazion for members and their friends was held in the room of the Royal Society and the Royal Geographica Society. The seventeenth Thomas Young Oratio was delivered by Prof. W. D. Wright, who spoke o modern problems in colorimetry; the thirty-fift Guthrie Lecture by Prof. N. F. Mott, on the mechanical properties of solids; and the 1951 Parson Memorial Lecture by Mr. F. Twyman, on Sir Charle Parsons and optical engineering. Sir Thomas Merto was the recipient of the sixth Holweck Medal of the Société Française de Physique and the Holweck Prize of the Physical Society; the presentation took place on May 15 at the Salons de l'Université à la Sorbonne, Paris, when Sir Thomas delivered the Holweck Discourse on the subject of new methods of making diffraction gratings. Sir George Simpson received the sixth Charles Chree Medal and for his address gave reminiscences of fifty years work in geomagnetism and geophysics. The twenty-eighth Duddell Medal was presented to Dr. A. B. Wood, who gave an account of his work on underwater acoustics, and the seventh Charles Vernon Boys Prize to Dr. J. H. E. Griffiths, who discussed ferro-magnetic resonance.

Details of the activities of the four Groups of the Society, the Colour, Optical, Low Temperature and Acoustics Groups, together with a list of the numerous bodies on which the Society is represented, are given n the annual report. In addition to science meetings, the Low Temperature Group held two major conferences—the Oxford Conference on Low Temperatures, and the Eighth International Congress of Refrigeration, in London. The Acoustics Group took an active part in the establishment of *Acustica*, and also in the general arrangements of the Acoustics Division of the Building Research Congress held in London during September.

The honorary treasurer again directs attention to the dependence of the financial structure of the Society on the success of the annual exhibition, which, although it had a record attendance and was of high standard, nevertheless resulted in a much smaller financial benefit to the Society than in the previous year. Thus the Society only just paid its way during 1951, and the future outlook depends very largely on the extent to which costs continue to rise. However, with the continued support of its members and with the suggested modifications in the form of subscriptions, it is hoped that the financial position of the Society may be made secure without curtailment of publications or activities.

MARINE BIOLOGY IN SCOTLAND

REPORT FOR 1950–51

THE annual report and collected reprints (Nos. 57–87) of the Scottish Marine Biological Association for the year 1950–51* have recently been pubished. A study of this volume leaves no doubt that the Association's Millport Laboratory is working most successfully and at very high pressure. The scientific staff now numbers nine (excluding the Director), and their researches cover many fields, including plankton nvestigations, a re-survey of the fauna of the Clyde Sea Area, the life-history of barnacles, the factors governing barnacle settlement and their relationship with those governing other settling organisms, the operation of fishing trawls, oyster culture and marine algology. Of special interest and importance is the initiation of experiments in underwater television, for which a special grant has been obtained from the development fund of the Association. A new device for measuring the depth at which gear is working in the sea is also being developed. Already this apparatus can be used to a depth of 200 m. with an accuracy of ± 2 per cent in continuous readings on deck.

To improve facilities at the Station, a new two-story building with a reinforced concrete seawater storage tank on its roof is being built. The masonry of some extra research rooms, and a new workshop and store are mainly completed. Reconstruction of the aquarium is about to be put in hand. Certain administrative changes have also been made by which the Director of the Station acts also as Secretary to the Council—an arrangement that should bring about increased efficiency and smoother running of the whole establishment.

The Oceanographical Laboratory at Leith now comes under the administration of the Association, a special sub-committee of which has been nominated to advise on matters of scientific policy. The programme of research follows two main lines—plankton recorder surveys and investigations into the relationship between the herring and its environment during the Scottish summer fishery at Fraserburgh. During the year some thirty thousand miles of recorder sampling was carried out, the analysis of which must alone be a huge undertaking.

Until lately the Leith laboratory was administered by Hull University College and its reports published as *Hull Bulletins of Marine Ecology*. It is intended to continue their publication in the same format but under a suitably modified title such as *Bulletins of Marine Ecology*.

The Laboratory's present accommodation at Leith and Edinburgh is unsatisfactory and inadequate; but negotiations are now proceeding for the purchase of a property in Edinburgh which, when converted and equipped, will be more suitable.

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* Scottish Marine Biological Association. Collected Reprints, 1951: Nos. 57–87. (Millport: Marine Station, 1952.)

COLONIAL DEVELOPMENT AND WELFARE

DETAILS OF SCHEMES FOR THE YEAR 1951–52

THE schemes detailed in the latest return made under the Colonial Development and Welfare Acts, covering the period April 1, 1951–March 31, 1952*, bring the total commitments for development and welfare schemes under the Acts to £83,983,947, of which £16,038,184 is for the year in question, and for research schemes to £10,745,100, of which £868,851 is for the year ended March 31, 1952. Of this, £373,826 is for agriculture, £136,803 for medicine, £109,804 for social science, £70,575 for tsetse and trypanosomiasis research, £42,778 for insecticides research, £42,045 for fisheries research, £38,050 for locust control and £9,100 for products research. There are no grants for research fellowships, and only £1,420 for economic research.

Of the actual research schemes, the largest are £97,220 for the establishment of the West African Institute of Social and Economic Research, covering capital and recurrent expenditure during July 1, 1951–March 31, 1956, £70,600 as supplementary provision for four and a half years for the establishment of a West African Rice Research Station at Rokupr, Sierra Leone, and £95,000 for the establishment of a Veterinary Research Laboratory and ancillary facilities in the Federation of Malaya. Pilot schemes for the reclamation of tsetse-infested land in Kenya, Uganda and Tanganyika are allotted £70,000 over four years, and £38,000 over four and a half years is granted for the establishment of a Fisheries Research Unit at the University of Hong Kong. Other grants include £34,500, also over four and a half years, for research into the incidence of maize rust in West Africa, £31,500 (over the period January 1, 1952–March 31, 1956) for physiological and biochemical research at Makerere College, Uganda, £34,000 for the establishment of a training centre for ecologists selected for work in Colonial territories, £28,750 for the Anti-Locust Research Centre, and a supplementary £26,620 for the East African Agriculture and Forestry Research Organization for the year ending December 31, 1952.

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* Colonial Development and Welfare Acts. Return of Schemes made under the Colonial Development and Welfare Acts by the Secretary of State for the Colonies with the Concurrence of the Treasury in the period from 1st April, 1951, to 31st March, 1952. (Cmd. 211.) Pp. 44. (London: H.M.S.O., 1952.) 1s. 6d. net.

The only other grants exceeding £20,000 are: £25,000 for hiring and equipping aircraft for disseminating insecticides in East Africa, £23,000 for further research over four and a half years by Dr. C. A. Walton into relapsing fever in East Africa, £24,403 (supplementary) for the Nutrition Field Station, Fajara, Gambia, £22,083 over four years for re-establishment of the Herbarium at Sandakan, North Borneo, and appointment of a botanist, and £21,000 over three years for the Ecological Land Use Survey, British Honduras. Reference should also be made to the grants of £19,300 for investigation, over five years, of seismic activity in the Windward and Leeward Islands, £17,500 to extend clove research at Zanzibar until August 31, 1953, £15,400 for experiments in East Africa on the dissemination of insecticides from fixed-wing aircraft, and £14,000 for the establishment of a Colonial pool of plant pathologists at the Commonwealth Mycological Institute.

Grants of particular scientific interest for development and welfare schemes, apart from those for scholarship training schemes and the like, include £31,000 for the establishment of an Applied Nutrition Unit at the London School of Hygiene and Tropical Medicine, £150,000 for a Technical College at Nairobi, a further £202,500 for Makerere College, £130,000 for tsetse and trypanosomiasis reclamation in East Africa, £55,300 for the Geological Survey of Somaliland Protectorate, £21,911 for a survey of timber resources in Northern Rhodesia, £9,283 for the extension of the Government Veterinary Research Station, Mazabuka, £52,500 for the Geological Surveys Department of Nyasaland, and £150,000 for the comprehensive survey of the Shire Valley project. A further grant of £52,234 is to University College, Ibadan, Nigeria, and £87,700 for the development of medical and health services in Gambia, while of £6,784,700 for the revised Ten-Year Development Plan for Nigeria, £1,049,832 is for agriculture, £853,053 for technical education, £154,674 for forestry, £395,899 for leprosy control, £1,587,861 for medical and health, and £223,261 for veterinary services. £43,163 is granted for animal husbandry in Sierra Leone, £30,000 for agricultural development in Basutoland, £51,474 for anti-malarial works in Mauritius, £200,000 to the University of Hong Kong, £42,706 for meteorological services in South-East Asia, £55,000 for the Eastern Caribbean Farm Institute, £58,337 for meteorological services in the West Indies, £25,867 for cocoa development in British Guiana, and various sums totalling £311,050 to the University College of the West Indies and its teaching hospital. Grants for road development schemes, rural water supplies, the establishment of local broadcasting services and the like figure prominently among the remainder.

REACTIONS OF PHENYL RADICALS IN SOLUTION AND IN THE GASEOUS PHASE

By M. T. JAQUISS and DR. M. SZWARC
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THE reactions of phenyl radicals in solution have been extensively investigated by many workers. A comprehensive summary of these studies has been presented in a monograph by Waters[1]. It appears that phenyl radicals react differently with aliphatic and with aromatic solvents. With the former they seem to undergo an atom transfer reaction; for example:

$$n-C_6H_{14} + Ph\cdot \rightarrow C_6H_{13}\cdot + Ph.H.$$
$$CCl_4 + Ph\cdot \rightarrow CCl_3. + Ph.Cl,$$

while the reactions with aromatic solvents lead to the formation of substitution products. Waters[2] interpreted the course of this substitution reaction by the equation

$$Ph\cdot + C_6H_5X \rightarrow Ph.C_6H_4.X + H. \qquad (1)$$

It is particularly interesting to note that the reaction of phenyl radicals with toluene leads to the formation of the isomeric methyl-diphenyls $CH_3.C_6H_4.C_6H_5$, and that dibenzyl was never detected among the products of the reaction[3]. This observation seems to exclude the alternative interpretation of the reaction, namely,

$$Ph\cdot + C_6H_5.CH_3 \rightarrow Ph.H + \cdot C_6H_4.CH_3 \qquad (2)$$
$$Ph\cdot + \cdot C_6H_4.CH_3 \rightarrow Ph.C_6H_4.CH_3, \qquad (3)$$

since the inequality:

$$C_6H_5.CH_2{-}H \text{ dissociation energy} < CH_3.C_6H_4{-}H \text{ dissociation energy}$$

requires that phenyl radicals should abstract preferentially the hydrogen atom from the methyl group rather than from the benzene ring. Such a reaction, however, would lead to the formation of benzyl radicals:

$$C_6H_5.CH_3 + Ph\cdot \rightarrow C_6H_5.CH_2\cdot + Ph.H, \qquad (4)$$

and thus dibenzyl or diphenyl-methane would be expected as products of the reactions, contrary to the observations.

This peculiar behaviour of phenyl radicals induced us to investigate their reactions in the gaseous phase. Several sources of phenyl radicals were explored by using pyrolytic methods. We found that iodo-benzene, bromo-benzene, mercury-diphenyl, benzyl-benzoate, benzoyl-bromide and benzil generate phenyl radicals in our experimental arrangement, whereas benzo-phenone and azo-benzene required for their decomposition temperatures higher than our experimental conditions permitted. All experiments were carried out in a flow system, described in previous communications[4], the total pressure being of the order 10–20 mm. mercury, and the time of contact of the order of half a second.

Iodo-benzene decomposes rapidly at temperatures of about 600° C. The decomposition is complicated by the presence of iodine atoms and molecules, and therefore is not suitable for studying the reactions of phenyl radicals. Neither is it convenient to use romo-benzene as a source of phenyl radicals, since e decomposition requires rather high temperatures 00–900° C.) and consequently is complicated by the onsiderable amount of products formed by the ecomposition of toluene used as a carrier gas.

The decomposition of benzyl-benzoate (studied in ur laboratories by Mr. J. W. Taylor) seems to take lace according to the expression :

$$Ph.CO.O.CH_2.Ph \rightarrow Ph.CO_2 + Ph.CH_2\cdot, \qquad (5)$$

ollowed by the rapid reaction

$$Ph.CO_2 \rightarrow Ph\cdot + CO_2.$$

the presence of toluene, phenyl radicals react ccording to (4), producing benzyl radicals :

$$C_6H_5.CH_3 + Ph\cdot \rightarrow C_6H_5.CH_2\cdot + Ph.H, \qquad (4)$$

nd the dimerization of the latter yields dibenzyl. he experimental results are given in Table 1, which hows that two benzyl radicals, that is, one molecule f dibenzyl, are produced for each molecule of enzyl-benzoate decomposed (or for each molecule of arbon dioxide formed in the pyrolysis). The initial ecomposition (5) accounts for half the amount of ibenzyl collected, whereas the second portion is ndoubtedly produced by reaction (4).

TABLE 1. DIBENZYL SEPARATED FROM BENZYLBENZOATE BY CHROMATOGRAPHIC TECHNIQUE

T °C.	Carbon dioxide (m.mol.)	Dibenzyl (m.mol.)	Ratio of dibenzyl to carbon dioxide
674	0·448	0·407	0·91
666	0·322	0·312	0·97
704	0·481	0·482	1·00
698	0·404	0·389	0·96
691	0·323	0·321	0·99
687	0·298	0·339	1·16 (?)
699	0·430	0·428	1·00
700	0·399	0·425	1·06
697	0·423	0·404	0·95

m.p. 51° C. after a gentle pressing on a porous tile

The decomposition of benzoyl bromide, investi- ated by Ladacki, Leigh and Szwarc[5], appears to be clean-cut reaction proceeding according to the ollowing mechanism :

$$Ph.CO.Br \rightarrow Ph.CO + Br,$$

ollowed by the rapid reaction

$$Ph.CO \rightarrow Ph\cdot + CO.$$

nder conditions prevailing in our experiments, romine atoms react with toluene yielding hydrogen romide and benzyl radicals[6] :

$$C_6H_5.CH_3 + Br \rightarrow C_6H_5.CH_2\cdot + HBr. \qquad (6)$$

owever, the amount of dibenzyl collected in the yrolysis of benzoyl bromide exceeds that anticipated n the basis of reaction (6) only (see Table 2), and his observation indicates that phenyl radicals eacting with toluene produce benzyl radicals. oreover, benzene was detected among the products f the decomposition, and this proves definitely that eaction (4) takes place (we are indebted to Anglo- ranian Oil Co. for their help in analysing toluene for ts benzene content).

Pyrolysis of benzil appears to be the most con- enient source of phenyl radicals. The reaction takes lace according to the expression :

$$Ph.CO.CO.Ph \rightarrow 2Ph.CO,$$

TABLE 2

T °C.	Carbon monoxide (m.mol.)	Dibenzyl (m.mol.)	Melting point	Ratio of dibenzyl to carbon monoxide
662	1·44	1·15	50–51° C.	0·80
662	1·05	0·84	50–51° C.	0·80
617	0·65	0·49	51–52° C.	0·75
638	1·68	1·20	48–50° C.	0·70
657	1·20	0·97	49–50° C.	0·81

followed by the rapid reaction

$$Ph.CO \rightarrow Ph\cdot + CO.$$

Thus, the rate of formation of phenyl radicals can be measured conveniently by the rate of formation of carbon monoxide. The investigation is simplified by the fact that phenyl radicals are the only reactive species produced initially in the system. Dibenzyl was the only non-volatile product produced in the pyrolysis taking place in the presence of toluene, which proves beyond any doubt that phenyl radicals react with toluene according to (4).

$$C_6H_5.CH_3 + Ph\cdot \rightarrow C_6H_5.CH_2\cdot + Ph.H. \qquad (4)$$

The experimental results are given in Table 3. The melting points of the non-volatile products collected indicate that they contain more than 95 per cent of dibenzyl (in this connexion see also Tables 1 and 2). It has been shown that a mixture containing 95 per cent of dibenzyl and 5 per cent of diphenyl melts at 46–47° C.

TABLE 3

T °C.	Carbon monoxide (m.mol.)	Dibenzyl (m.mol.)	Melting point	Ratio of dibenzyl to ½ carbon monoxide
003	2×0·336	0·324	48–50° C.	0·965
593	,, 0·434	0·417	49–51° C.	0·96
000	,, 0·654	0·626	49–51° C.	0·96
723	,, 0·593	0·560	48–50° C.*	0·94

* After gentle pressing on porous tile

We conclude, therefore, that phenyl radicals reacting with toluene in gaseous phase and at high temperatures abstract hydrogen atoms from methyl groups. On the other hand, the reaction in solution and at room temperature leads to their addition to benzene ring. We suggest tentatively the following explanation for the divergence of the behaviour of phenyl radicals. Phenyl radicals, having one hydrogen atom removed from the ring, might approach sufficiently close to the nucleus of an aromatic compound for a relatively strong π—π bond to be formed. To appreciate the strength of such a bond, let us compare $D(CH_3—CH_3)$ with $D(C_6H_5—C_6H_5)$. The C—C dissociation energy of the former is 83 kcal./mole, while we estimate the magnitude of the latter at about 97 kcal./mole. (Investigation of the pyrolysis of bromo-benzene carried out in our laboratories by Mr. D. Williams leads to $D(C_6H_5—Br) \sim 71$ kcal./mole. This value, in conjunction with the relevant thermo-chemical data, leads to $D(C_6H_5—H) \sim 102$ kcal./mole and $D(C_6H_5—C_6H_5) \sim 99$ kcal./mole.) This remarkable increase in the C—C dissociation energy probably measures the strength of the π—π bond in diphenyl[7]. The formation of a π—π bond between a phenyl radical and an aromatic compound leads to a 'hot' complex which contains all the energy of the interaction. Such a 'hot' complex is certainly unstable at the high temperatures and low pressures prevailing in our experiments, and thus it decomposes rapidly. On the other hand, in solution and at room temperatures the excess of energy might be removed by collisions with molecules of solvent, and thus the stabilized complex might survive until a collision with another phenyl radical would lead to the abstraction of hydrogen atom and completion of the reaction.

The fact that the addition reaction prevails at room temperature indicates that its activation energy is probably lower than that of the hydrogen abstraction reaction. Indeed, the analogy with the corresponding reaction of methyl radicals[7] might suggest an activation energy of the order of 8 kcal./mole for reaction (4). [March 20.

[1] Waters, W. A., "The Chemistry of Free Radicals" (Oxf. Univ. Press, 1948).

[2] Waters, W. A., see ref. 1, p. 147 and p. 149

[3] Hey, D. H., *et al.*, *Research*, 4, 386 (1951).

[4] Szwarc, M., *J. Chem. Phys.*, 17, 431 (1949); *Proc. Roy. Soc.*, A, 198, 267 (1949).

[5] Ladacki, M., Leigh, C. H., and Szwarc, M., *Proc. Roy. Soc.* (in the press).

[6] Szwarc, M., *Nature*, 161, 890 (1948).

[7] Trotman-Dickenson, A. D., and Steacie, E. W. R., *J. Chem. Phys.*, 19, 1097 (1951); see also *J. Amer. Chem. Soc.*, 72, 2310 (1950).

[8] Szwarc, M., Ghosh, N. B., and Sehon, A. H., *J. Chem. Phys.*, 18, 1142 (1950).

ARCTIC AEROBIOLOGY

FUNGI AND BACTERIA, ETC., CAUGHT IN THE AIR DURING FLIGHTS OVER THE GEOGRAPHICAL NORTH POLE

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WHEREAS previous contributions[1] have been concerned with material gathered by Polunin while flying over northern Canada in 1947, the present communication reports upon the result of subsequent flights from central Alaska to the North Pole and back which he made in the following years—in the last instance accompanied by Kelly and S. M. Pady. In the meantime, the work had been adopted as an extra-mural research project by the Defence Research Board of Canada, and it is a pleasure to express gratitude for the all-important governmental assistance in Canada and the United States which has thus been obtained and co-ordinated. These flights were special ones in United States Air Force B-29 (Superfortress) aircraft of the 72nd (Very Long Range) Reconnaissance Squadron operating out of Ladd A.F. Base, Fairbanks, Alaska, and in this connexion our warm thanks are due to the late General Dale V. Gaffney, Colonel Neil D. van Sickle, and Lieut.-Col. Charles F. Overstreet, for the unique facilities afforded and the splendid co-operation of all their officers and men concerned. Thanks and appreciation are also due to the Royal Canadian Air Force for much incidental transportation and hospitality, and to the Defence Research Board in general and Lieut.-Col. G. W. Rowley and Mr. C. P. McNamara of the Arctic Research Section in particular, for their efficient handling of many problems involved. Without such support and the co-operation of many other bodies and individuals, in Washington and Ottawa, Montrea and Alaska, the chance to do this work could scarcely have materialized. There were also the pilots of those long (and in the first case arduous) flights, and the five or six busy navigators and radar observers who made up such a large proportion of the picked and trained crews of fifteen or sixteen—not to mention the almost equally essential ground-staffs o many and various categories, among whom were Major Joseph J. Slack (O.C. Base Weather Detachment), Captain Vaughan (operations officer), the Engineering and Intelligence personnel, and Colone R. R. Stewart (base supply officer).

The first of his polar flights was made by Polunin on September 13–14, 1948. Planning had extended over much of the previous year, with the design and construction of special apparatus for the purpose, and been backed by active work at laboratory techniques by Pady and Kelly[2]. The apparatus, which it is hoped to describe and figure in more detail elsewhere[3] was required for exposure of Petri plates vertically against the unobstructed airstream in front of an aircraft travelling at high speed, with low temperatures outside and possible pressurization inside Essentially it consisted of a steel plate replacing the front large 'Plexiglas' window in the nose, into which a short piece of steel tube was welded in a horizontal position so as to act as a sleeve and lead to an opening in the plate that could be closed by a metal sliding door. A second steel tube, 68 cm. long and blocked off with a handle at the back, was made to slide within the sleeve; its inside diameter was such that it would just take a standard (10 cm diameter) Petri dish which rested against a blocking-off metal plate just behind the front end of this inner tube or cylinder and was held in place by lateral steel clips. In the sleeve was cut a loading-breech with an airtight cover to allow changing of the Petri dishes when the inner tube was withdrawn and the sliding door closed. Loading was accomplished by pressing a sterile, unwrapped, but still covered, Petri 'plate' into position and then removing the cover, after which the breech was quickly closed, the sliding door opened, and the inner tube slid forward and locked in the exposing position in which the Petri plate was held flat against the airstream well ahead of anything else on the plane. In connexion with the construction of this apparatus special thanks are due to Prof. J. S. Foster, of McGill University.

The sticky surface for 'catching' was a thin smear of silicone grease (DC-4-ANC-128-A) on the inside of the base of the Petri dish; this particular grease retains its stickiness through the remarkable temperature-range of − 75° C. to more than 200° C. and appears to be neutral to most biological activity Expert mathematical advice had indicated that we might expect at least 40 per cent of the particles in the atmosphere to penetrate any air-cushion—for example, that might be built up in front of the Petri plate which was already far enough ahead of the nose to avoid its air-cushion—and consequently become stuck on the silicone surface during flight.

Practically throughout the first polar flight and a training and testing preliminary, plates were loaded and exposed for periods of up to ten minutes. Then on return to the laboratory, the silicone surface was 'poured' with melted agar for observation of the fungi and bacteria the growth and development of which were able to proceed when the nutrient covered the surface to which they had become attached. It ad been established that in such circumstances embers of both groups can produce satisfactory olonies[3], the results of such growing and subsequent b-culturing for determination being indicated in e present instance in a table[4]. It should be noted at throughout this article the 'bacterial' colonies are pt to include very occasional (usually single) ones f non-filamentous yeasts which have a very similar ppearance. No Actinomycete was found.

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* At present on leave of absence as J. S. Guggenheim Memorial Fellow and Research Fellow of Harvard University, Cambridge, Mass.

Whereas the counts are low and indeed often ithin the bounds of possible contamination, their rouping and the working of the controls give condence in their general validity. Thus plates that ere exposed on a wooden post 50 ft. up on a hangar t Ladd A.F. Base throughout the 17 hr. 25 min. of e polar flight gave 100 bacterial and 78 fungal olonies in the case of an agar plate and 350 bacterial nd 72 fungal (of which 60 were filamentous yeasts) the case of a silicone plate which had flies sticking it. Plates exposed for an hour each in the nose f the aeroplane very early in the polar flight gave 13 acterial and 9 fungal colonies in the case of an agar late and 20 bacterial and no fungal colonies in the se of a silicone one; similar exposures for three ours much later in the flight gave 13 bacterial and fungal colonies in the case of an agar plate and 3 bacterial and no fungal colonies in the case of a licone one—which suggests that the air in the lane was not at all heavily loaded and that the licone smear afforded, at least for bacteria, a not es effective method of catching and observing by ubsequent growth than did the very 'general' utrient agar employed. More important were the ading, etc., controls performed very early in, and peated towards the end of, the polar flight. Each nsisted of three 'exposures' of silicone plates, amely: (a) a normal loading, uncovering, re-cover-g, and removing of the plate in the breech without oving the sliding inner tube, (b) the same operation ith, before re-covering and removal of the plate, a ormal sliding of the tube momentarily up to and ack from the unopened front door, and (c) the same (b) except for an opening of the door and further iding forward of the inner tube so that the Petri late was exposed for 2–3 sec. just in front of the rwardmost part of the steel plate before retraction, osing of the door, and re-covering and unloading. ust after take-off for the Pole, (a) and (b) were blank ut (c) gave 22 bacterial and 3 fungal colonies; much ter, on the homeward flight, (a) was blank, (b) gave nly a single bacterial colony, and (c) was blank. he only seriously disconcerting feature about these ntrols is the reading given by (c) after take-off, hich suggests dire need for that scouring of the rward fixed part of the apparatus which was soon be accomplished. It may be expected to have en effected by the time the real exposures were arted many minutes later, although an outlet of ntaminated air due to pressurization may have mplicated this issue.

The main conclusion to be drawn from the results f this very fortuitous sampling as indicated in the able[4] is that, although the air above and around the orth Pole may tend to be practically sterile, it is by o means entirely so. Thus a few bacteria and very ccasional yeasts appear to have been present in a iable condition on this occasion, especially at or ightly above 8,500 ft. in the vicinity of the Pole self. There also appeared to be a slight bacterial eak' not far north of Point Barrow; but unformately, owing to pressurization difficulties, no readings could be taken in this region on the return journey. The relatively high bacterial counts obtained from the earliest exposures made over central Alaska were not borne out by those made farthest south on the return flight, although there is still a significant increase of colonies here (7 on 5 plates exposed for a total of 22 minutes) over the counts made most recently though at the higher altitude of around 18,500 ft. farther north (3 on 9 plates exposed for a total of 31 minutes). The speedy turnover of plates was effected largely to give fresh surfaces, because many rapidly became iced and it was not then realized that 'catching' could nevertheless in all probability still proceed, as supercooled water droplets occur rather than ice crystals in clean air down to −41° C.[5].

Through the kind co-operation of meteorological and monitoring services, we are familiar with the probable sources of the air-masses in which the plates were exposed, on both the northward and homeward-bound flights. There is some suggestion of correlation between the air-mass sources and the biota observed, even if the readings are apt to be patchy. Thus, whereas northward to around 77° N. the exposures were made in air of relatively southern and favourable origin (in which 19 totalling 80 minutes showed 157 colonies in spite of an almost blank 'run' near the middle), north of here the air-mass was of less favourable (northern and largely frozen-up) source, and the next five exposures totalling 24 minutes showed only 2 colonies. The rise thereafter is not accounted for by the computed air-mass sources but may well be due to an extension southward to nearly the 80th parallel in the meridians of the 'pole of inaccessibility' of the very mixed air which tends to circulate around the geographical North Pole, and which on this occasion appears to have had, in part at least, a less unfavourable origin in the Canadian Arctic Archipelago. Thus we have a run of 12 exposures totalling 44 minutes bearing 76 colonies and extending to the actual Pole, followed by 21 totalling 49 minutes and bearing only 18 colonies—quite possibly because, with the exception of the first two which were lower (a 2-minute exposure at 3,000 ft. as the Pole was circled proved entirely blank), they were all exposed at much higher altitudes of mostly more than 18,000 feet. Around 25,000 feet above sea-level over the vicinity of the North Pole, the atmosphere appeared to be entirely sterile. It is quite conceivable that the very low temperatures (at least down to − 48° C.) encountered at these higher latitudes and altitudes may have accounted for a lack of viability in some instances, but it is not now thought that the abiotic radiation effect, if any, is here as great as in temperate regions. Meanwhile it must be emphasized that only the most tentative conclusions should be drawn from these results, which are of a mere preliminary and largely qualitative nature.

The second aerobiological flight over the North Pole took place in March 1949, the object being to carry further such observations as had been made on the previous occasion and to compare winter with more-or-less æstival conditions, while hoping to make a flight under full summer conditions at some later date. Meanwhile Kelly and Pady, particularly, had worked at the apparatus and techniques so that this time it was possible to have the following three systems in operation all together: (1) the qualitative 'artificial hand' for exposing Petri plates in front of the nose of the aircraft as used on the previous occasion, except that, instead of the general silicone smear, two similarly smeared microscope slides which could be removed for separate treatment and examination were stuck with drops of rubber cement side by side on the inside of the bottom of each plate; (2) a General Electric "Electrostatic Bacterial Air-sampler" taking sterile Petri plates and installed in a glass-faced aluminium box connected with the outside atmosphere by 1-in. bore rubber tubes leading from the nose and so arranged, with the inlet pointing forward and the outlet turned aft, as to create a 'Venturi' effect causing a gentle flow of air through the box; and (3) a filter of glass-wool and lens-paper packed in a brass hose coupling of 1-in. inside diameter, similarly connected (in the outlet through a flow-meter) with the outside air by 1-in. hosing. The sampler employs an electrostatic field of some 6,500–7,000 volts and takes two Petri plates at a time, one having its base positively charged and the other negatively, the biota and other particles being precipitated on to their inside surfaces; a constant volume of one cubic foot of air a minute is sampled by being blown over the sterile surface, either a silicone smear or agar medium being used in the dishes. Each filter is made of four disks of glass-wool, each disk being of four thicknesses of the 'wool' as it comes from a fresh roll, cut with a 1½-in. cork-borer and enclosed by lens-paper disks to prevent shearing and to hold the spicules in, this 'stack' being placed in the detachable hose coupling the ends of which are plugged with cotton-wool and then covered with parchment paper caps for sterilization and finally storing after wrapping in a clean paper towel for protection against dirt.[3]

The experience of the previous polar flight had suggested that the air might be virtually sterile, as had winter work by Kelly and Pady over the prairies; on the other hand, we now supposed that catching could proceed even under bad icing conditions; so instead of a large number of short exposures we decided to make most of them last a full hour. On return to the laboratory one of each pair of the nose-exposed slides was microscopically examined for fungi and the other for pollen grains, the area perused in each case being that of a 22 × 50 mm. cover-slip and the mount employed in the latter case being glycerine jelly containing basic fuchsin; the silicone-smeared plates from the electrostatic sampler were 'poured' with agar and the agar ones incubated directly; the glass-wool and lens-paper filter plug was removed with sterile forceps from each coupling and shaken vigorously for ten minutes with 50 c.c. of sterile water, 5-c.c. and 2-c.c. portions being then placed in Petri dishes and melted agar added before incubation at 25° C. and counting after five days.

The results of an abortive mission on March 28 and of a successful polar flight on March 29 and 30 are indicated in another table[4]. All apparatus was well scoured by air before use, the controls and briefer exposures including various loading and other controls of the nature of those practised on the previous occasion with the artificial hand. These were entirely blank as regards pollen grains or allied spores, as were unexposed slides and several exposed for periods of up to seven minutes at various stages of both the 1949 flights, with the exception of a 7-min. exposure made as we were turning in the immediate vicinity of the North Pole, which had on one slide a ragweed or closely allied pollen grain and a smut or allied fungal spore and, on the other, two spores apparently of *Cladosporium*. It is quite possible that these were contaminations, but it is thought that they probabl represent valid observations. Four silicone contro placed at intervals through the flights in the electrostatic sampler and taken out and wrapped aft closing and opening the lid gave an average o 2·25 colonies, whereas nineteen proper exposure gave an average of 5·42 colonies.

Concerning results there appears to be little to sa except that the air at the highest latitudes and eve well south may by ordinary standards be judged o this showing to be virtually sterile in winter—as wa perhaps to be expected in view of the great distanc almost any disseminules would have to travel whe frozen conditions obtained and snow covered mo areas for 2,000 miles or more southward from th Pole. Nevertheless, it was a point worth demonstrating in view of the very wide dissemination foun or postulated in other circumstances elsewhere, an it is hoped that it may still be possible later on t carry out a full summer repetition of this work i order to determine more of the situation at tha season.

It may be noted that the electrostatic sampler an filters gave usually very different results, which wer in most of the present instances much higher in th latter case, sometimes by more than ten times, an that there is again some correlation between biota an air-masses, as can be seen by comparing the number given in the second table[6] with the computed source and extents of the air-masses in which we were flying Thus whereas a 'lumping' of methods and group gives an average of 1·49 bacterial plus fungal colonie per cubic foot for the March 28 'abort', during whic we were flying mainly in Pacific-maritime air "wit trajectory over Kamchatka, east Siberia and interio Alaska", a similar lumping of the colonies obtaine from the entire North Pole flight which was starte on the following day in air of relatively unfavourable northern origin gives a figure of 0·496. It is interesting to note that the only at all high figures wer obtained on the former flight, and the only ones o the polar flight that really approached them wer either from exposures made near the beginning (whe we may quite likely have been flying in air o relatively favourable origin) or at the very highes latitudes (where the air was much mixed and whe the above-mentioned pollen grain and spores appea to have been trapped). The only slide observed i some weeks of searching to have two pollen grain upon it was exposed on the return flight from th Pole about the north coast of Alaska where ther may have been a mixing of air of a relatively souther source, although this is not borne out by the bacteria and fungal colonies observed via the electrostati sampler and filters; however, it should be noted tha its fellow was the only slide from either flight whic was observed on direct microscopic examination t have more than two fungal spores upon it (it ha four), which suggests an airborne patchiness such a we have met before.

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[1] *Nature*, 160, 876 (1947); 162, 379 (1948); 168, 718 (1951).

[2] *Science*, 110, 187 (1949).

[3] Since this paper was written and finally passed for publication, a account of the apparatus employed has appeared in *Canadian J Bot.* (29, pp. 206–214, 1951).

[4] Not reproduced here, as essentials of it were previously publishe as Table 2 (pp. 342–43) in *Svensk Botanisk Tidskrift* (Bd. 45, H.2 1951) owing to delays in official clearance of the present paper which was drafted early in 1950. Reprints of that more genera paper are available on request to Nicholas Polunin, Gray Herbarium of Harvard University, Cambridge 38, Mass., U.S.A.

[5] Fournier d'Albe, E. M., *Nature*, 162, 921 (1948). Brewer, A. W. and Palmer, H. P., *Nature*, 164, 312 (1949). Brewer, A. W. (see)

[6] Cf. Table 3 (pp. 347–48) in *Svensk Botanisk Tidskrift* (Bd. 45, H.2 1951) and see ref. 4 (added in proof).

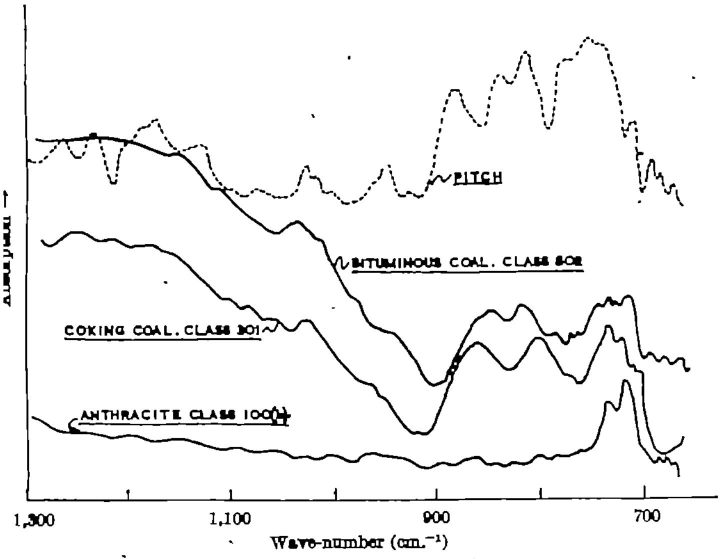
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Infra-Red Spectra of Coals

Cannon and Sutherland have reported attempts to tain infra-red absorption spectra of coals, first by amining thin slices of coal[1] and, secondly, by dis- rsing the finely ground coal in 'Nujol' (liquid raffin)[2]. Using the latter technique, they found it as essential to grind the coal to a particle-size of s than one micron before successful spectra could obtained. Their examination was limited to the equency-region 1,000–10,000 cm.$^{-1}$.

We have found that thin slices of coal and dry inding of coal are both unsatisfactory. Satisfactory ectra have been obtained by the technique of inding 1 gm. of coal together with 4 ml. of 'Nujol' r 18 hr. in a power-driven agate pestle and mortar. his suspension, in which 80 per cent of the coal articles were less than 1 micron in size, was used for reparing a cell with a layer thickness of 0·05 mm. nergy transmission was low, due to scattering of e incident radiation by reflexion from the particle rfaces, so that large slit-widths were necessary. o compensate for this scattering, backgrounds were repared using a suspension of spectroscopic carbon n 'Nujol', prepared as for coal.



Infra-red spectra of coals and pitch

The infra-red absorption spectra (see illustration) f three coals (all of ash content less than 1 per cent) nd of a low melting point pitch were obtained, over he frequency-range 750–1,300 cm.$^{-1}$, using a Grubb arsons single-beam spectrometer. The pitch was elted on a heated rock-salt window to give a niformly thick film.

The anthracite gives a spectrum differing consider- bly from those of the other two coals. It is interest- ng to note that organic groupings which occur in itch also occur in coal.

No attempt has been made to assign organic roups to the absorption peaks recorded. An extensive programme is in progress for the further elucidation of these spectra.

R. R. Gordon
W. N. Adams
G. I. Jenkins

National Coal Board,
Central Research Establishment,
Stoke Orchard, Glos. June 4.

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[1] Cannon and Sutherland, *Trans. Farad. Soc.*, 41, 280 (1945).

[2] Cannon and Sutherland, *Nature*, 156, 240 (1945).

Nature of the Solution obtained by Pyridine Extraction of Coal

In a recent communication on the internal surface of coal[1], Dryden has directed attention to the interesting agreement between (*a*) the minimum particle-size observed by Nagelschmidt and Cartwright[2] in electron micrographs of films deposited from dilute ethylenediamine extracts from coal, (*b*) particle-sizes observed in the ultramicroscopic examination of similar extracts[3], and (*c*) the order of particle-size concerned in the model of colloidal structure of coal suggested by Bangham *et al.*[4].

The solutions obtained by the pyridine extraction of coal are commonly believed to be, like the ethylenediamine extracts, essentially colloidal dispersions. Nevertheless, the average molecular weights of the substances present in such solutions are only of the order of 500–1,400, and are inconsistent with their supposed colloidal nature[5].

We have found that electron micrographs of the films formed by the evaporation of diluted pyridine extracts were almost identical in appearance with those described by Nagelschmidt and Cartwright. Examination of the particles by electron diffraction gave diffuse patterns only, resembling those for collodion; and we had therefore interpreted our electron micrographs as being merely an extension to smaller dimensions of similar but grosser aggregation phenomena observable by optical microscopy.

We have now further examined our pyridine extract solutions. Samples of the diluted pyridine solution of a coal extract ($\beta + \gamma$ fraction) and of its chloroform-soluble components (γ fraction) were spread on a glass slide and the solvent eliminated by rapid heating to 180–200° C. in a stream of nitrogen. The specimens were then kept under a vacuum of 10^{-2} cm. of mercury for about one hour. The deposits thus formed were collected on collodion, or 'Formvar', by stripping off a film cast over the deposit. The structure previously observed with the deposits disappeared as a result of this treatment. Typical electron micrographs are shown in Figs. 1, 2 and 3. The cracked portions of the films were chosen to illustrate the varnish-like appearance of the deposit. Fig. 4 shows an intermediate stage in the deposition of the material, illustrating the melting of the aggregates observed in earlier photographs. There was no evidence of the presence in the material of discrete particles.

It would have been interesting if Nagelschmidt and Cartwright had made some comment on the behaviour

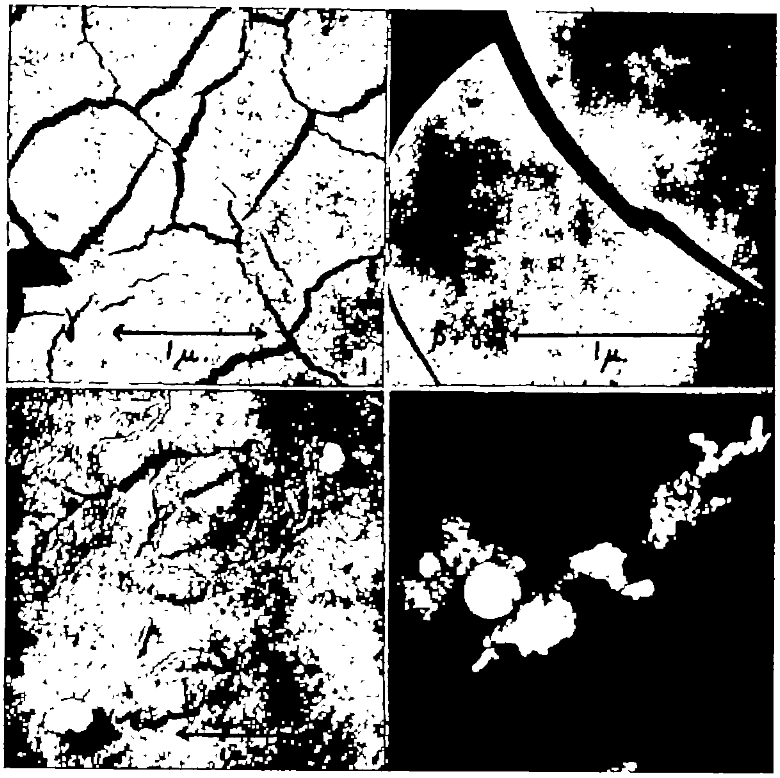

Fig. 1. γ extract: coal, 0.942. Heated to 200° C. in nitrogen
Fig. 2. β + γ extract: coal, 0.942. Heated to 200° C. in nitrogen
Fig. 3. As Fig. 1. Gold shadowed, 45°
Fig. 4. Specimen as Fig. 1. Partly fused

of their material under electron diffraction, since the particles are of suitable size for this technique with the *E.M.*3 instrument. Resolution of the particle structure by this means might be difficult (compare the X-ray studies of soap micelles by P. A. Thiessen *et al.*[6]); but the diffraction pattern could probably be distinguished from that of the 'Formvar' substrate.

A fuller account of the work will be published elsewhere.

E. Boult
H. R. Thirsk
H. E. Blayden

Department of Physical Chemistry
and Coke Research,
King's College,
Newcastle upon Tyne 1. May 15.

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[1] Dryden, I. G. C., *Nature*, 169, 269 (1952).

[2] Kagelschmidt, G., and Cartwright, W. J., *Nature*, 169, 270 (1952).

[3] Kann, L., *Fuel*, 30, 47 (1951).

[4] Bangham, D. H., *et al.*, *Fuel*, 28, 231 (1949).

[5] Shaw, F., and Blayden, H. E. (to be published).

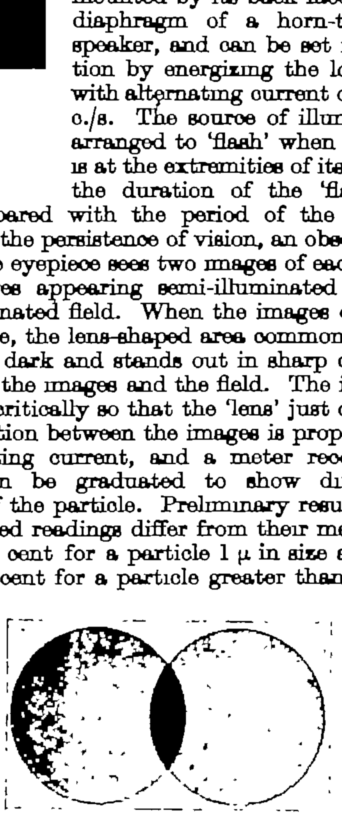
[6] Thiessen, P. A., *et al.*, *Z. phys. Chem.*, 156, 447 (1931); 165, 453 (1933); 176, 397 (1936).

A Method of Measuring and Grading Microscopic Spherical Particles

The study of particulate matter such as dust often entails either the measurement of the individual diameters of small spherical particles viewed through a microscope, or the determination of the size distribution of such particles by counting the numbers having diameters lying within specified ranges. The conventional methods of performing these operations have not proved sufficiently accurate for some investigations being undertaken at this Unit, and a new instrument has been devised for the purpose.

The principle of the instrument consists of producing two identical coplanar images of each particle the centres of which are separated by a variable distance. The separation between the centres when the two images are arranged to touch is equal to the diameter of the images. The two images can be formed in various ways. The method described here, besides providing critical adjustment for accurate measurement of the individual diameters, also allows adaptation for rapid grading by size of the particles.

The practical arrangement consists of a normal microscope optical system, modified by the introduction of a small mirror inclined at 45° to the vertical to reflect the light beam from the objective into a horizontal eyepiece. The mirror is mounted by its back face on to the diaphragm of a horn-type loud-speaker, and can be set into vibration by energizing the loudspeaker with alternating current of about 50 c./s. The source of illumination is arranged to 'flash' when the mirror is at the extremities of its vibration, the duration of the 'flash' being short compared with the period of the vibration. Because of the persistence of vision, an observer looking into the eyepiece sees two images of each particle, these images appearing semi-illuminated against a fully illuminated field. When the images overlap, as in the figure, the lens-shaped area common to both is completely dark and stands out in sharp contrast to the rest of the images and the field. The instrument can be set critically so that the 'lens' just disappears. The separation between the images is proportional to the energizing current, and a meter recording the current can be graduated to show directly the diameter of the particle. Preliminary results suggest that repeated readings differ from their mean by less than 3 per cent for a particle 1 μ in size and by less than 1 per cent for a particle greater than 10 μ.



The following methods for grading the particles into size-groups eliminate the recording of each individual value. In the first method it is arranged that, after adjustment of the continuously variable separation has been made, the energizing current is discriminated by amplitude and an appropriate counter triggered. In the second method the energizing current is modulated by a low-frequency uare wave. For odd half-cycles of the modulating .ve the value of the current corresponds to the ver limit of a size-range, and for even half-cycles the upper limit of the range. The images of particles thin the size-range can be distinguished from others the field of view by their characteristic feature of erlapping during odd half-cycles and not overpping during even half-cycles. The images of rticles smaller than the lower limit do not overlap ring either half-cycle, while the images of particles ger than the upper limit overlap all the time. switch enables each size-range with a corresponding unter to be selected in turn. Each time a particle th the characteristic feature mentioned above is en, a triggering pulse (initiated by a foot switch) routed to the counter appropriate to the size-range.

V. TIMBRELL

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ıeumokoniosis Research Unit (S. Wales),
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May 29.

Interaction of Macromolecules and Fibrinogen

RICKETTS[1] has described an interaction between ·xtran and fibrinogen. It was therefore decided to vestigate the interaction of several other polymers, sed in transfusion therapy, with fibrinogen of human id bovine origin.

Dextran fractions of intrinsic viscosities 0·41, 0·31, 24 and 0·06, and possessing branching factors (ratios α 1–6 glucosidic linkage to α 1–4 glucosidic linkage) arying from 4 : 1 to 11 : 1 were used. A commercial eparation of polyvinylpyrrolidone, gum acacia in line, and a hydrolysed laminarin fraction of trinsic viscosity 0·2, were also investigated.

Solutions containing 1·5, 3·0 and 6·0 per cent of ie polymers in 0·9 per cent saline were each added equal volumes of solutions containing 0·4, 0·8 and ·6 per cent of fibrinogen also in 0·9 per cent saline. he tests were made under the following conditions.

(1) *Solutions mixed at 25° C. and then placed in a frigerator at* 4° *C. for* 16 *hr.* All the dextran fractions, ith the exception of the one of intrinsic viscosity ·06, gave a precipitate. Polyvinylpyrrolidone, minarin and gum saline gave precipitates of similar agnitude to the dextran fractions of intrinsic iscosity 0·41 and 0·24. The amount of precipitate as greater with increasing concentrations of both brinogen and polymer.

(2) *Solutions mixed at* 37° *C. and then placed in an icubator at* 37° *C. for* 16 *hr.* Only laminarin formed n insoluble complex at this temperature; but when ie temperature of the remaining solutions was wered to 4° C., precipitation of the complex took lace with each of the other polymers.

Dilutions of the polymers at concentrations 0·75, ·5 and 3 per cent were made at 37° C. in plasma. n aliquot was incubated at 37° C. during 8 hr. and nother at 4° C. during a similar period. No precipitation occurred with any polymer at either mperature. However, complex formation did take lace in a 5 per cent albumin solution containing per cent sodium citrate, 0·9 per cent saline and ·4 per cent fibrinogen, the reaction being carried ut as in method (1). This indicates that it is not ıst simple solubility in citrate or albumin which is reventing the formation of the complex. The dextran–fibrinogen complex was prepared on a larger scale and injected intravenously into mice at a dose-level of 300 mgm. per kgm. of body-weight. None of the mice showed any untoward reaction.

It is well known that dextran fractions above a certain critical molecular size, namely, 59,000, increase the sedimentation-rate of erythrocytes[2]. Solutions containing 1 and 2 per cent of dextran (intrinsic viscosity 0·31) were made in a 5 per cent albumin solution. Red blood cells, washed free from plasma with saline, were added to this solution; the erythrocyte sedimentation-rate in the albumin–dextran solution was of the same order of magnitude as that of blood containing a similar dextran concentration. Hence the removal of fibrinogen had not affected the sedimentation-rate of erythrocytes. The electrophoretic pattern of plasma containing dextran is being examined to see if it is possible to detect any evidence of a soluble dextran–fibrinogen complex.

These preliminary investigations indicate that the property of forming a complex with fibrinogen is not peculiar to dextran but is also possessed by polyvinylpyrrolidone, gum acacia and laminarin, and since the complex formed contains only approximately 1 per cent of the polymer in solution and 10 per cent of fibrinogen, it probably would have no pathological significance.

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Benger Research Laboratories,
Holmes Chapel, Cheshire.

A. H. RATCLIFFE

Department of Surgery,
University, Manchester.
July 3.

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[1] Ricketts, C. R., *Nature*, 169, 970 (1952).

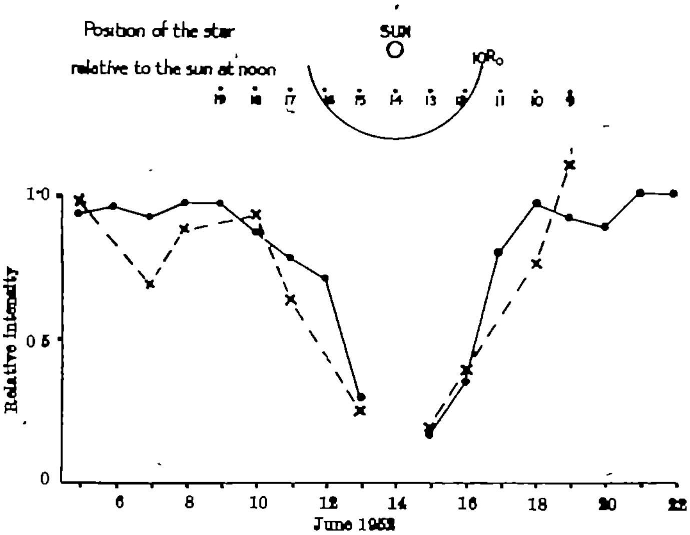
[2] Thorsén, G., *Acta Chir Scand*, supp. 154 (1950).

Occultation of a Radio Star by the Solar Corona

IT has been suggested[1] that the radiation from a radio star might be cut off by refraction in the solar corona, even when the angular separation of the sun and the star is several times the angular radius of the visible disk ($R_{\odot}$). The existing data on the coronal electron density have been used for predicting the effective radius of the sun for occultation on various frequencies[1]. Link[2] has calculated the circumstances of the occultation for 1952 and has also shown that the observed intensity of the radiation from the radio star should increase before the actual occultation. Attempts were made to observe these effects in June 1950 and 1951 when the radio star in Taurus (05·01) passed within an angular distance of about 4·5 $R_{\odot}$ from the sun's centre, but intense sunspot radiation prevented any useful results being obtained.

Measurements of the intensity of the radio star 05·01 were again made on frequencies of 210, 81·5 and 38 Mc./s. during the period June 5–20, 1952; as in the earlier observations, interferometers of large resolving power were used for reducing the amplitude of the record from the undisturbed sun. In addition, the position of the star was measured each day on 81·5 Mc./s.

No accurate observations were possible on 210 Mc./s., owing to the disturbing effect of a small sunspot; but reliable results were obtained on both 81·5 and 38 Mc./s. throughout most of the period. The results of the intensity measurements are shown in the accompanying graph. The measurements on 38 Mc./s. were less accurate than those on 81·5 Mc./s., due to the limited angular discrimination of the aerial system.



●—●—, 81·5 Mc./s. ; ×—×—, 38 Mc./s.

Apparent intensity of the radio star in Taurus as it passed near the sun's southern limb

It was predicted that on 38 Mc./s. a well-defined occultation should occur at a separation of about 5·2 $R_☉$, little effect being observable on 81·5 Mc./s. However, as shown by the graph, a decrease of amplitude of record occurred on both frequencies, even when the separation was as great as 10 $R_☉$. The position measurements (which were possible on all days except June 13, 14 and 15) showed no deviation greater than 2′ of arc.

The observed reduction in amplitude of the records could imply an actual reduction in flux density at the earth. On the other hand, since interferometers of considerable resolving power were used, it is possible that the reduction was due to an apparent increase in the angular diameter of the star. Such an increase in diameter might be caused by irregularities of electron density in the outer corona between 4 and 10 $R_☉$. The observations at 38 Mc./s. would be consistent with a source the apparent diameter of which increased from about 15′ of arc when the separation was 10 $R_☉$, to about 45′ of arc at 4·5 $R_☉$. On 81·5 Mc./s. the corresponding figures are 8′ and 25′.

The interpretation of these results in terms of the structure of the outer solar corona will be considered in a separate paper.

This work was carried out as part of a programme of radio research at the Cavendish Laboratory, supported by the Department of Scientific and Industrial Research. One of us (F. G. S.) is indebted to the Royal Commission for the Exhibition of 1851 for a senior studentship.

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June 27.

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Heats of Formation of Mercury Dimethyl, Diethyl and Diphenyl and some Associated Bond Dissociation Energies

THE values obtained by Berthelot[1] for the heats o formation of some of the organic compounds o mercury have been in doubt for some time. A re-examination of these compounds is especially important, since their heats of formation can be combined with other recent thermochemical data to give the mean bond energy of the C—Hg bond and the heats of formation of various alkyl and aryl halides. The values fo the halides throw considerable light on C—halogen bond dissociation energies and the C—H dissociation energy in benzene.

The problem was approached through the heat of combustion of mercury dimethyl, diethyl and diphenyl, and in every case a result was obtained which differed appreciably from that of Berthelot.

The materials were prepared by the method of Gilman[2] and, in the case o the liquids, carefully purified by repeated fractionation. The mercury diphenyl was purified by recrystallization from methanol.

The liquids were distilled under high vacuum into thin-walled glass capsules which were then sealed. The solid diphenyl was compressed into pellets. Combustion was carried out in a stainless steel bomb and, since incomplete combustion to the extent o 1–2 per cent was observed, the products of combustion were analysed and the calculation of results based on the weight of carbon dioxide found. Appreciable amounts of mercuric oxide were also present and these were estimated and a correction made. The following values have been obtained for the heat o formation of the mercury compounds :

$$Q_f(\mathrm{Hg(CH_3)_2},\ l) = -14{\cdot}3 \pm 0{\cdot}1 \text{ k.cal./mole.}$$

This is markedly different from Berthelot's result o − 36·8 k.cal/mole, but agrees excellently with the value − 14·31 ± 1·85 k.cal./mole derived by Skinner and his co-workers, from a thermochemical study o the reactions of mercury dimethyl with alcoholic solutions of halogens and mercuric halides :

$$Q_f(\mathrm{Hg(C_2H_5)_2},\ l) = -6{\cdot}5 \pm 0{\cdot}2 \text{ k.cal./mole.}$$

This again disagrees with Berthelot (− 15·7 k.cal./ mole) but is much closer to the Skinner[4] value o − 9·9 ± 1·7 k.cal./mole, especially if the estimated error is taken into account.

$$Q_f(\mathrm{Hg(C_6H_5)_2},\ c) = -71{\cdot}6 \pm 0{\cdot}3 \text{ k.cal./mole.}$$

Berthelot's value is − 92·1 k.cal./mole. Skinner quotes two values, − 67·1 ± 3 and − 56·5 ± k.cal./mole, the large difference being due to considerable uncertainty as to the correct value for the heat of formation of phenyl bromide. The thermochemical data obtained by Skinner *et al.*[3,4] can be combined with our values for the heat of formation of the mercury compounds to give the following results :

$Q_f(\mathrm{CH_3Br},\ g) = 8{\cdot}6$ k.cal./mole $\qquad Q_f(\mathrm{CH_3I},\ l) = 2{\cdot}3$ k.cal./mol
$Q_f(\mathrm{C_2H_5Br},\ l) = 22{\cdot}1$ „ $\qquad Q_f(\mathrm{C_2H_5I},\ l) = 10{\cdot}13$ „
$Q_f(\mathrm{C_6H_5Br},\ l) = -16{\cdot}3$ „ $\qquad Q_f(\mathrm{C_6H_5I},\ l) = -28{\cdot}8$ „

From these values, knowing the C—H dissociation energy in the hydrocarbon, the following C—halogen bond-dissociation energies may be found :

$(CH_3 - Br) = 67{\cdot}8$ k.cal./mole $D(CH_3 - I) = 53{\cdot}4$ k.cal./mole
$(C_6H_5 - Br) = 66{\cdot}5$ ″ $D(C_6H_5 - I) = 52{\cdot}6$ ″

ı view of the possible errors in the assumed data, e feel that the above dissociation energies are subject) an uncertainty of about ± 2 k.cal./mole.

Butler and Polanyi[5] have measured the C—I ıssociation energy in phenyl iodide by means of yrolytic decomposition. Szwarc[6] has repeated this ork and obtained a higher value. Also, Szwarc and Villiams[7] have found the C—Br dissociation energy ı phenyl bromide.

From these results and the heats of formation of aseous phenyl iodide, phenyl bromide and benzene, ıe heat of formation of the phenyl radical and the —H dissociation energy in benzene may be derived.

—hal. dissociation energy in k.cal./mole		$Q_f(C_6H_5)$ in k cal /mole	$D(C_6H_5 - H)$ in k cal /mole
(Ph − I) ∼ 55	(ref. 5)	∼ − 67·9	∼ 100
(Ph − I) > 57	(ref. 6)	∼ − 70	∼ 102
(Ph − Br) = 70·9	(ref. 7)	− 60·7	102

Finally, the measured heats of formation enable s to calculate the sum of the Hg—C dissociation ıergies in the compounds investigated:

$D(Hg - Me_2) = 57{\cdot}1 \pm 2$ k.cal./mole
$D(Hg - Et_2) = 48{\cdot}5$ k.cal./mole
$D(Hg - Ph_2) = 60$ ″ } limits of error uncertain

We should like to add that our experimental results ɔuld not have been extended so widely but for the aluable work carried out on the thermochemistry f these mercury compounds by Skinner and his o-workers in Manchester.

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Precursors of Protoporphyrin in *Chlorella*

ON the basis of studies of *Chlorella* mutants a ıiosynthetic chain has been formulated leading from ırotoporphyrin through Mg protoporphyrin, Mg ·inyl pheoporphyrin and protochlorophyll finally o chlorophyll[1]. We have recently isolated a *Chlorella* nutant which promises to reveal some of the precursor ›orphyrins leading up to protoporphyrin.

This mutant, W_5B-17, arose from an irradiation vith ultra-violet light of the protoporphyrin-pro‑lucing W_5B cells. The W_5B-17 cells appear almost olourless or pale brown. On solid medium they leak ·ut porphyrins which are more soluble than proto‑›orphyrin and discolour the agar pink. It has been ound possible to grow this mutant in liquid culture vithout diminishing the pigment yield. Starting vith a colourless medium, by the end of the week he medium turns a deep chocolate-brown colour due o the accumulation of porphyrins produced by the nutant. From fifteen litres of medium it is estimated hat a total of approximately 1·5 gm. of porphyrins s produced.

Preliminary studies of the porphyrins from this nutant indicate that it consists of a number of com‑›onents. From the R_F values of the paper chromato‑rams[2] it is concluded that there are present, in this nixture, porphyrins containing 2, 3, 4, 5 and possibly 8 carboxyls. The fraction containing two carboxyl groups per molecule represents most of the porphyrin produced: it consists of protoporphyrin and two additional main porphyrin components. One of these main components may be an immediate precursor of protoporphyrin since its absorption spectrum indicates that it contains one vinyl group in contrast to the two vinyl groups of protoporphyrin.

In the past, workers who have attempted a study of porphyrin precursors have been limited in material primarily to the porphyrins excreted by patients with some metabolic lesion in their porphyrin metabolism. Such studies have been difficult because the disease is rare, the isolation of the pigments tedious and the yields small. This new mutant now makes available unlimited quantities of several of the protoporphyrin precursors. It is hoped that studies on this alga will not only provide information on the important biosynthetic chain of heme and chlorophyll but also may eventually contribute to an understanding of porphyrinuric diseases in man.

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Structure of Lanostenol

RECENTLY, the molecular structure of lanostadienol (lanosterol), $C_{30}H_{50}O$, an important 'triterpenoid' constituent of wool-wax, has been studied intensively. Ruzicka *et al.*[1] and Barton, McGhie *et al.*[2] have suggested three possible formulæ and, considering the evidence available, were unable to decide between them. Earlier, we had begun an X-ray structure analysis to provide unequivocal proof of the molecular structure of lanostadienol. This investigation has provided, in addition, a complete description of the stereochemistry of the molecule, avoiding the complex orthodox methods of stereochemistry. From earlier work, lanostadienol is known to contain four rings, one inert double-bond and one active double bond in the terminal *iso*propylidene group of the long side-chain. Hydrogenation of the active double-bond yields lanostenol, and the iodoacetate of this compound[3] was selected as a suitable 'heavy-atom' derivative for the structure analysis.

The crystals of lanostenol iodoacetate, $C_{32}H_{53}O_2I$, are orthorhombic, the space group being $P2_12_12_1$. There are four molecules in the unit-cell of dimensions. $a = 7{\cdot}6$, $b = 10{\cdot}9$, $c = 38{\cdot}6$ A. The x, y and z parameters of the iodine atoms were determined from Patterson F^2 syntheses of the projections along the a and b axes. The first Fourier syntheses, $\rho\ (0yz)$ and $\rho\ (x0z)$ were computed with the majority of signs fixed by the contributions of the iodine atoms, and from these electron-density distributions the general disposition of the molecule in the unit cell was evident. Due to the existence of false peaks adjacent to the iodine atoms, the initial difficulty in solving the structure was the location of the acetate group. However, after testing various molecular models, the detailed configuration of the molecule was achieved, refinement proceeding by successive Fourier syntheses until the reliability factors, $\frac{\Sigma \mid F_o - F_c \mid}{\Sigma \mid F_o \mid}$, were reduced to 22 and 25 per cent

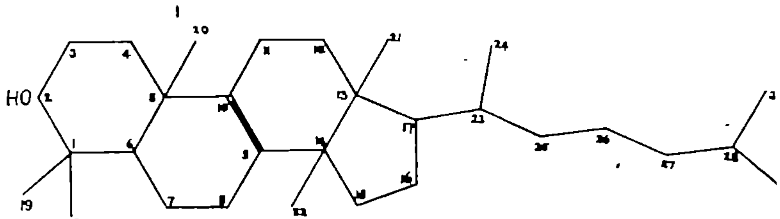

Fig. 2. Formal representation of the molecule

for the 0*kl* and *h*0*l* sets of reflexions respectively. A section of the electron-density distribution projected on the *bc* plane and selected to display one complete molecule is shown in Fig. 1,*a*. The corresponding diagram of the molecule is given in Fig. 1,*b*. The *b* axis projection (not shown here) provides a relatively clear picture of the molecule viewed approximately side-on to its main length. The combined information in the two projections provides a precise determination of the molecular structure and stereochemistry of lanostenol.

The formal representation of the chemical structure of lanostenol is given in Fig. 2, the ring skeleton consisting of three six-membered rings and one five-membered ring fused in a manner similar to that observed in cholesterol. The rings *A*/*B* and *C*/*D* are *trans*-fused, with the presence of the inert double-bond at C(9)–C(10) deduced from the distortion of the *B*/*C* ring system apparent in Fig. 1,*a*. Due to the presence of the double-bond at C(9)–C(10) the ring system *B*/*C* should be symmetrical; but the fusion of the five-membered ring *D* to the six-membered ring *C* distorts the latter (see Figs. 1,*a* and *b*). The *gem*-dimethyl group C(18), C(19) is attached to C(1), while single angular methyl groups C(20), C(21) and C(22) are attached to C(5), C(13) and C(14) respectively. The *iso*-octane chain is attached by C(23) to C(17) of ring *D*.

The molecular structure, determined by this method, is in agreement with the partial formula of McGhie *et al.*[4] and Barton *et al.*[5] for the ring system

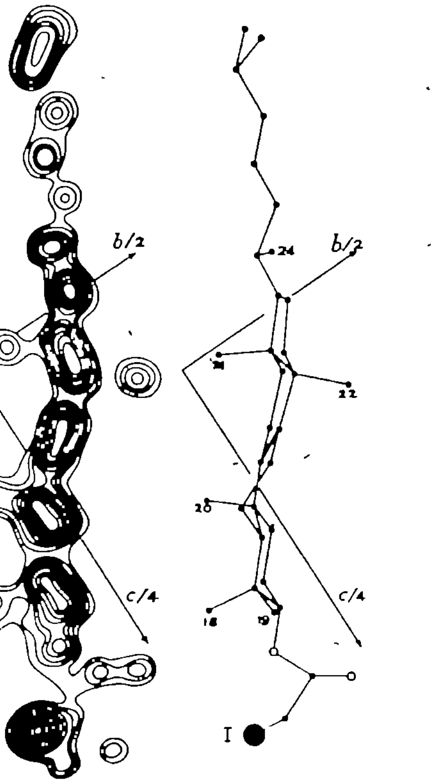

Fig. 1. (*a*) Part of the *a*-axis projection of electron-density distribution, illustrating one molecule. (*b*) Corresponding diagram of the molecule. The double-bond at C(9)—C(10) is shown as a thicker line

A/*B*/*C* and their associated methyl groups, but di proves their suggestion that ring *D* is six-membere In a series of papers[6] on chemical and spectr photometric studies, Ruzicka *et al.* gave structur evidence which agrees with that of Barton *et al.*[5] an McGhie *et al.*[4] regarding the part of the molecule u to ring *C*; in addition, they determined the structu of the long side-chain[7]. In their latest publication Ruzicka *et al.* have proposed a structural formul in which ring *D* is five-membered; but there are thr possible molecular structures, depending on wheth C(23) is linked to C(15), C(16) or C(17). Barton *et al* have obtained supporting evidence for the bas correctness of Ruzicka's[1] structures; but, on the bas of the 'isoprene' rule, they select the point of attac ment of C(23) as C(15) or C(16). From our analysis, has been made clear that the point of linkage is C(17

The structural formula for lanostenol cannot b fitted to the 'isoprene' rule which normally applie to triterpenes. It is of interest in this connexio that this compound co-exists with cholesterol in woo wax and with ergosterol in yeast. The question ther fore arises as to whether lanostenol and the relate compounds with the same carbon skeleton, lanc stadienol, agnostadienol and agnostatrienol, shoul be considered triterpenes or trimethylated sterols.

A more detailed report of the structure analysi and of the stereochemistry of the molecule will b given at a later date.

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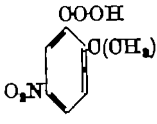
Steric Effect of the tert.-Butyl Group

WHEN *tert.*-butylbenzene is mono-nitrated th main product is the *para* isomer; but toluene give largely the *ortho*[1-3]. Again, when *p*-*tert.*-butyltoluene i dinitrated, 4-*tert.*-butyl-2 : 6-dinitrotoluene is formed Substitution *ortho* to the *tert.*-butyl group is clearl hindered by the steric effect of this large group[1,2].

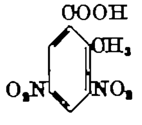
On dinitration of *tert.*-butylbenzene with fuming tric acid[5] or warm mixed acid[6], the product is : 4-dinitro-*tert.*-butylbenzene. Still further nitration ves a trinitro product of unknown orientation[6]. is possible from what follows that this may not 2 : 4 : 6-*tert.*-butylbenzene.

It has now been observed that *o-tert.*-butylbenzoic id can readily be nitrated with nitric acid to give *tert.*-butyl-5-nitrobenzoic acid (I) as colourless eedles (m.p. 170° C.); but further nitration of this id or its ethyl ester with fuming nitric acid cannot accomplished, nor is bromination by the powerful ethod of Derbyshire and Waters[7] effective.

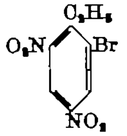
It is clear that in (I) and probably also in 2 : 4-nitro-*tert.*-butylbenzene there is considerable resistance to the entry *ortho* to the *tert.*-butyl group of a cond substituent. No such difficulty occurs with e methyl group, for *o*-toluic acid on nitration gives mixture of the 3- and 5- mono-nitro products, ther of which on further nitration yields 3 : 5-di-itro-2-toluic acid (II)[8]. Nor is 2 : 6-substitution round the ethyl group difficult, for it has been noted at 2 : 4-dinitroethylbenzene is smoothly brominated y the Derbyshire and Waters method to give -bromo-4 : 6-dinitroethylbenzene (III) as a golden-ellow oil (b.p. 190° C. at 15 mm.).



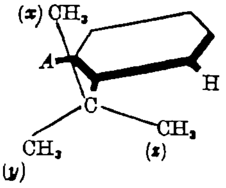
(I)



(II)



(III)



(IV)

It is scarcely to be expected that, if one group can nter *ortho* to the *tert.*-butyl group, another of roughly qual size cannot enter the second *ortho* position. he deactivating effect of the first group can scarcely e very important, for it has been pointed out that itro[9] and probably carboxyl[10] next to large groups re not coplanar with the ring and therefore will xert much smaller electromeric effects.

Some dissymmetry of the *tert.*-butyl group is im-lied. Bending of the C_{ar}–C_{al} bond comes first to ind, but a more likely explanation is possible if he *tert.*-butyl group is likened to a 'blown-out' mbrella. The *ortho* group (*A* in IV) will fit nicely etween two spokes of the umbrella (methyl groups and *y*) but the third spoke (methyl group *z*) will roject towards the other *ortho* position, so inhibiting ffectively the entry of a second *ortho* substituent. Methyl, of course, has the same shape as *tert.*-butyl, ut is obviously too small to block the second *ortho* osition.

Insufficient is known about the transition state in romatic electrophilic substitution to say whether he projecting methyl group acts by preventing the *rtho* hydrogen atom from taking up the position or ejection or by blocking the approach of the ttacking cation.

A fuller description of the new compounds mentioned, together with others, will be given elsewhere. One of us (F. H. C. S.) is indebted to the Ministry of Education for Northern Ireland for a grant.

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Mollusc Control and Fish-Farming in Central Africa

IN Africa, fish-ponds and other waters may easily become infested with large numbers of different snails, including the intermediate hosts of bilharzia[1].

This problem is always kept in mind[2], as well as the objections of medical people and others against large-scale fish-farming over wide areas; but in many places fish-farming is the only possibility of providing the natives with animal proteins. Mollusc control must therefore be worked out without interference with the production of fish, and such methods as the use of molluscicides (copper salts and other antibiotics) have to be avoided[3]. There remains biological control; but this also has its difficulties. There is the possibility of using birds, for example, ducks[4], or amphibians; but fishes only will be dealt with here.

Many mollusc-eating fishes are already known in Africa, for example, *Astatoreochromis alluaudi*, *Synodontis* sp.[5], *Clarias gariepinus*[1], etc.; but they are not yet used in ponds so their practical value remains uncertain.

Work done at this station on a local cichlid, *Serranochromis* sp. (presumably *S. macrocephala*), has given valuable information on snail control. Although the study of the feeding habits of this fish is not yet completed, the data already obtained are worth considering.

In rivers, this fish eats, among other organisms, different species of snails (58 per cent of thirty-five fishes examined). Since the shells are broken, it is often difficult to determine exactly which are the species involved; but we have been able to recognize Planorbidæ, Ancylidæ and Melaniidæ.

This fish eats the different snails that we have found in the rivers from where our specimens were taken. The only exception is the large *Lanistes*, which is not known as a bilharzia host.

In ponds, the feeding habits of *Serranochromis* are slightly different. It eats more molluscs than it does in rivers: out of fifty fishes examined, 72 per cent have fed on snails, principally *Biomphalaria* and *Limnaea*.

A pond of about 0·1 acre, densely populated with *Physopsis* and *Biomphalaria*, was stocked with *S. macrocephala*. During the first month 87 per cent of the fish captured had eaten snails; after two months, this percentage had fallen to 44. A complete drying of the pond after three months did not reveal the existence of any small snails. The fact that some big *Physopsis* specimens survived was probably in relation with the small size of the fish (± 14 cm.). In a spawning pond with big breeders all snails had disappeared. Since this fish does not feed exclusively on snails, the complete disappearance of the latter does not harm his growth. Insect larvæ, crustaceans, other fishes, tadpoles, worms, etc., are eaten in different proportions.

In our ponds *Serranochromis* has already successfully spawned and we have many data about breeding habits, growth, resistance to manipulation, etc. We hope to have enough fingerlings before the end of the year to start distribution.

It may be added that this fish is a good sporting-fish and very palatable.

A few other species of fishes feeding on snails and mussels were studied at the same time. Among other siluroids we should like to mention *Chrysichtys mabusi* which, in its natural environment, feeds on molluscs. Curiously enough, even the thin shells of *Mutela* remain unbroken all through the digestive tract. *Chrysichtys mabusi* seems to be important for mollusc control in large permanent waters.

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Change in the Composition of the Bottom Fauna of the Dogger Bank Area

F. M. Davis[1] has shown that, during the quantitative bottom investigations carried out with the Petersen grab over the Dogger Bank area of the North Sea during 1921–23, there was a pronounced dominance of the bivalves *Spisula subtruncata* (da Costa) and *Mactra corallina* (L.).

The Danish Commission for Fishery and Sea Investigations in May 1950 and 1951 undertook a similar investigation in the area with the research vessel *Dana*, comprising about two hundred samples taken with the 0·2 sq. m. van Veen and Petersen grabs. It was found that the above-mentioned species had decreased considerably in number as compared with the previous investigations. It also appeared that most other species recorded by Davis had increased in number.

Below, the finds made by Davis during voyage 48 (60 sq. m. of samples with the 0·2 sq. m. Petersen grab in October 1922), covering the central and western parts of the bank, are compared with the samples taken in May 1951 in the same area (11 sq. m. of samples with the 0·2 sq. m. van Veen and Petersen grabs). The difference in season of the year between the two investigations may be of some importance. However, during Davis's investigations the general aspect of the composition of the fauna did not change markedly with the seasons. The number per sq. m. of animals of different systematic groups is shown in the accompanying table.

	No. per sq. m	
	Davis (Oct. 1922)	*Dana* (May 1951)
Spisula subtruncata	272	5
Mactra corallina	11	1
Other species of bivalves	4	48
Polychaeta	4	70
Echinoderma	4	28
Other groups	8	65
Total	303	212
excl. *S. subtr.* and *M. cor.*	20	206

The total number of animals per sq. m. has d creased by one-third, though species other tha *Spisula subtruncata* and *Mactra corallina* have, o an average, increased their numbers about ten time This may be due to the presence of a greater amou of O-group animals of summer-spawning species i the autumn investigation than in the spring invest gation. (No marked difference in the efficiency of th two kinds of grabs was found.)

In 1951 the following five species were the mo numerous in the area (unbracketed: number per sq. n in 1951; bracketed: number per sq. m. in 1922):

Tellina fabula Gmelin	22	(0·5)
Ophelia limacina Rathke	14	(0·3)
Ophiura albida Forbes	11	(0·8)
Echinocardium cordatum Pennant	8	(1)
Eone nordmanni Malmgren	7	(0)
– (*Amphipoda* not yet determined).		

Eone nordmanni was not recorded by Davis, bu may have been confused with *Goniada maculat* Ørsted (Davis's voy. No. 48: 0·3; pres. inv. 2·9 pe sq. m.). However, some other species, which ar now present in fairly large quantities, were no found during Davis's voyage 48:

Echinocyamus pusillus (O. F. Muller)	6
Myriochele heeri Malmgren	5
Cerianthus lloydi Gosse	3

Since *S. subtruncata* and *M. corallina*, which hav decreased in number, represent a southern fauna element of the North Sea, the unusually cold winter of 1940–42 and especially 1947 may have influence their occurrence. However, the catastrophic effe of severe winters on stocks of marine animals wit a pelagic larval development will normally soon b counteracted by a heavy spat-fall of the same specie since the amount of larvæ produced by the reduce parental stock is sufficient for a quick renewal o the population[2]. In 1950 and 1951 the greater par of the specimens of *S. subtruncata* and *M. corallin* were obviously very old. This indicates a failure o spat-fall during the later years, showing an interferin of factors other than the effect of severe winters.

What brought about the changed composition o the fauna is still an unsolved question because w know very little of the stability of marine anima communities. In fact, it is not known whether th difference observed between the composition of th fauna during the two periods of investigation i indicative of a fairly constant change from one stat of balance to another, or whether it merely indicate the degree of fluctuation in the said area unde relatively stable conditions of environment.

It is intended to continue the investigations. Late a detailed report will be published elsewhere.

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March 1.

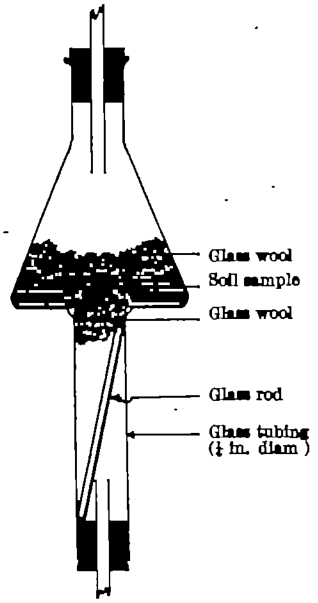
[1] Davis, F. M., *Min. Agric. Fish., Fishery Invest.*, Ser. 2, 6, No. (1923).

[2] Smidt, E. L. B., *Fol. Geogr. Dan.*, 2, No. 3 (1944).

Modification of a Soil Percolation Apparatus for Soils of a High Organic Matter Content

DURING recent investigations of a number of soils e percolation method introduced by Schloesing and untz[1] was employed. The apparatus used was milar to that devised by Audus[2], as modified and scribed by Chase[3].

It was found that the reacting solution did not rcolate through soils of a high organic matter ntent after the first few minutes, even when sterile nd, or glass beads, or glass wool had been mixed ith the soil. It was apparent that a further modifican of the apparatus was required to obtain adequate rcolation with soils of this nature.



In order to permit the expansion of the soil during rcolation the straight glass column was replaced y the apparatus shown in the accompanying diaam. A hole was blown in the bottom of an Erleneyer flask of 125-ml. capacity. A short length of -in. diameter glass tubing was sealed to the opening us made. A pad of glass wool was inserted into is tube so as to protrude slightly into the flask; was held in position by a suitable length of glass d. The soil sample was placed in the flask and vered by a pad of glass wool to prevent excessive sturbance of the soil by the impact of the drops of e percolating fluid.

This alteration in the shape of the column used for ntaining the soil has permitted the investigation soils which could not previously be studied by is method.

One of the authors (T. M. B. P.) wishes to express s thanks to the National Research Council of anada for the award of a scholarship and permission publish this note.

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chloesing, T., and Muntz, A., *C.R. Acad. Sci.*, 84, 301 (1877).

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Colour Change in the Echinoid, *Diadema antillarum*, Philippi

PHYSIOLOGICAL colour change has been but rarely reported in echinoderms[1]. Mortensen[2], in a footnote, makes cautious reference to the possibility of such changes occurring in *Diadema antillarum*; but it is clear that he was not aware of the striking manifestation of the phenomenon reported here, which occurs in young forms of this species. Indications of the existence of a rhythmic change in colour persisting under constant external conditions do not appear to have been reported previously in this form, nor indeed, so far as I am aware, in any other echinoderm.

By day, and in strong light, the young *Diadema* is almost uniformly black (Fig. 1). The spines (which have been cut short so as not to obscure the test) are banded with black and white; but their bases are always black.

By night, the sides of the test and the spine bases become pale grey, and in parts almost white, while aborally the test develops a strikingly brilliant white pattern in the form of a star around the periproct and enclosing the madreporite, extending into five interambulacral rays which bifurcate toward the ambitus (Fig. 3). Remarkable brilliant blue iridescent colours are to be seen at the edges of the white pattern.

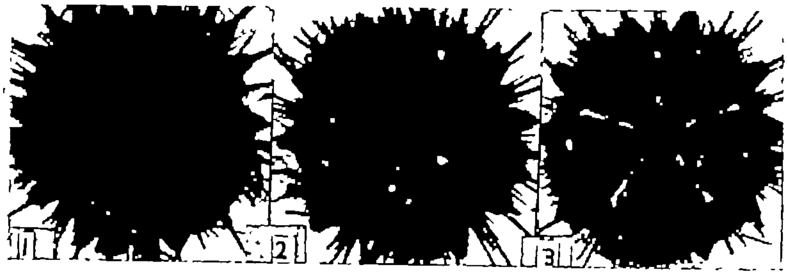
The change from the pale into the dark phase can readily be observed if the animal is placed under a 40-W. lamp, and requires 60–90 min. at 28° C. for the full range. A narrow beam of light projected on to the test brings about a localized development of the dark colour.

Examination under a low-power binocular shows that these changes are largely due to the dispersion and concentration of melanin in superficial chromatophores[1]. As the pigment disperses, there is not only an overall darkening, but also the white pattern becomes invaded by dispersing pigment, breaking up into isolated portions and eventually disappearing. During this time, the whiteness gives place to lilac and then brilliant blue, so that dispersion of light by melanin may also be involved in the play of colours that ensues.

The phenomenon is independent of the central nervous system or deeply situated nerve elements, since it occurs with equal readiness in small isolated pieces of test which have been scraped clean inside. It therefore appears to be due to the direct action of light on the chromatophores; but the possible existence of a localized superficial skin reflex, or the localized production and action of humoral agents, must be admitted.

Indications of a rhythmic colour change, independent of external lighting conditions, can be obtained by keeping an urchin in a light-proof tank. It will be found to darken distinctly during the day, and to assume characteristics intermediate between the pale and dark phases (Fig. 2). Further experiments are required, however, before it can be claimed that the temperature factor has been completely eliminated. Again, this change can be shown to be independent of the central nervous system.

As the young forms age, the colour changes become less striking and may largely disappear—a fact which may be related to the accumulation of melanin in these forms, for the change is still marked in albinotic or partially albinotic forms which are not uncommon in Jamaica. There is thus a morphological, as well as a physiological, colour change.



Photographs of young *Diadema* (diameter of test, 18·0 mm.). (1) Dark phase (photographed at 10.0 a.m. after being in sunlight); (2) intermediate phase (photographed at 10.0 a.m. after being in light-proof tank for 23 hr.); (3) pale phase (photographed at 8.0 p.m. after being in darkness for 3 hr.).

These photographs are of the same animal, using the same camera, illumination and plates. They were developed simultaneously in the same tank, printed on the same paper and given equal exposures both for photographing and printing

Since it has already been shown[4] that the whole surface of *Diadema* is remarkably sensitive to changes in light intensity, and moreover that the sensitivity increases markedly in the pale phase and declines in the dark, the dispersed superficial pigment in strong light may well serve as a protective shield for more deeply situated and widely scattered light-sensitive elements.

A full account of the investigation will be published in the near future.

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The 'Capacitation' of the Mammalian Sperm

It was shown recently[1] that sperms injected into the periovarian sac of the rat after ovulation did not begin to enter the eggs until four or five hours later. In the rabbit, too, sperms introduced into the Fallopian tubes shortly *after* ovulation seldom penetrated the eggs; but if sperms were introduced a few hours *before* ovulation, the majority of the eggs were later observed to be fertilized. Chang[2] reported similar findings in the rabbit, and also showed that sperms, injected into the Fallopian tubes after ovulation, were able to penetrate a larger proportion of eggs if they had first spent about five hours in the uterus of another rabbit.

The conclusion drawn by both workers was that, in rats and rabbits, the sperm must undergo some form of physiological change or capacitation before it is capable of penetrating the egg. The need for such a change in the sperm has not been postulated before on direct evidence, and further confirmation is desirable. In the investigations already mentioned, the animals were necessarily subjected to laparotomy and the sperms to manipulation *in vitro*. Both these procedures may render somewhat abnormal the circumstances in which the penetration of the egg is to take place, and the following results are therefore of interest because they have been obtained with a minimum of experimental interference.

Mature female rats were selecte for œstrus by examining the vaginal smear between 6.0 and 7. a.m. and were placed in cages wit males for 10–15 min. between 7. and 7.30 a.m. That ovulation i normally complete at this tim was shown in a preliminary tes by the recovery of eight or mor eggs from the Fallopian tubes o sixteen out of twenty rats whic were killed between 5.0 and 7. a.m. The females which showe evidence of copulation wer selected, and individuals wer killed at 1, 2, 2½, 3, 4, 5 an 6 hr. later. The Fallopian tube were separated from the ute by severing the isthmus of the tube in order t avoid contamination with sperms from the uteru The distended portion of the ampulla was incise to permit the eggs in cumulus, together with th surrounding fluid, to escape on to a slide. The tub was discarded, and a coverslip with 'Vaseline' o the edges was placed over the preparation. The egg were inspected to see if sperm penetration ha occurred, and the number of sperms in the cumulu and surrounding fluid was counted. Results wer obtained from a total of seventy-five rats (see table)

Mean Number of Sperms Observed about the Eggs, and Tota Number of Eggs and Number of Penetrated Eggs Recovere from Rats Killed at the Specified Hours after Coitus

Hours after coitus	Number of rats used	Mean number of sperms about eggs	Total eggs	Penetrated eggs	Per cent penetrated eggs
1	10	6·6	74	0	0
2	15	20·6	139	1	0·7
2·5	10	33·5	96	21	21·9
3	10	32·1	88	39	44·3
4	10	49·9	94	65	69·1
5	10	55·4	91	78	85·7
6	10	59·6	82	80	97·6

The number of sperms found in the cumulus an surrounding fluid increased from a mean of 6·6 pe tube at 1 hr. after coitus to a mean of 59·6 per tub at 6 hr. In spite of the presence of sperms, none of th eggs examined at 1 hr., and only 1 out of 139 egg examined at 2 hr., were penetrated. At later hour increasingly larger numbers of sperms were see about the eggs and increasingly larger proportion of the eggs were found to contain sperms. At 6 h after coitus, eighty of the eighty-two eggs recovere (97·6 per cent) were penetrated.

Clearly, there is a delay of about two hours befor sperm penetration of the eggs commences, and thi is interpreted as support for the hypothesis that period for capacitation is required by the sper before it can penetrate the zona pellucida. There after sperm penetration proceeds readily.

I am grateful to Miss H. N. Turner for advice o the significance of results, and to my assistant, G. S Thring, for his careful work.

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[1] Austin, C. R., *Aust. J. Sci. Res.*, B, 4, 581 (1951).

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Rediscovery of the Ophiuroid Genus *Ctenamphiura* Verril

N September 10, 1874, H.M.S. *Challenger*, while lging at Station 188, at the western end of Torres ait, obtained from 28 fathoms two specimens of amphiurid which afterwards became the genotype he monotypic genus *Ctenamphiura*, receiving the e *Ctenamphiura maxima* (Lyman, 1879). It is arkable among amphiurids for its robust build, fact that the outer oral papillæ far exceed in the infradental pair, for its very large tentacle es, tumid disk and thick arms bristling with erect -spines arranged in dense comb-like masses. It never since been seen, nor has any related form n discovered so far as I can determine. Of the two specimens extant, one is in the British seum, the other in the Museum of Comparative logy, Harvard.

hrough the courtesy of Captain A. Black, Mr. H. Dawbin, of this Department, was able to dredge Pelorus Sound in December 1951, when he ained three specimens of an amphiurid, the ities of which were not at first obvious. It ered remarkably from any other known New land form. I now find that the Pelorus specimens ich were taken in 25–30 fathoms) conform in t respects with *Ctenamphiura maxima*, differing fly in the fact that the under surface of the is partly naked, and in the presence of only a le very large tentacle scale; also the massive -combs diminish in size on the proximal few es. There seems no doubt that the species must closely related to *C. maxima*, and, as the distinguishing features mentioned are diagnostic, it may e the name *Ctenamphiura dawbini* sp. nov. The e will be placed in the museum of this Department, a full description, with figures, will appear in the ology Publications from Victoria University lege". Fortunately, the species comes from an essible locality, from which, therefore, there is ry likelihood of further material being obtained he near future. It is hoped that at least a limited ount of material will soon be available for distribun to those museums which maintain important inoderm collections.

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Feb. 8.

orrelation Study of Bovine Erythrocyte Antigen *A* and Butterfat Test

ERGUSON[1], in a discussion in a paper entitled eritable Antigens in Erythrocytes of Cattle", ed the possibility that certain of these cellular igens may be used as 'markers' in a study of the eritance of complex physiological characters such milk production. Filmer (personal communication) gested that the most logical antigen production tors to test would be antigen *A* and butterfat test, ause of the direct correlation between high freency of antigen *A* and of high butterfat test in sey, and low frequency of antigen *A* and low terfat test in Friesian cattle. Owen *et al.*[2] reported t 87·6 per cent of a group of Guernsey and 46·1 per t of a group of Holstein Friesian cattle carried igen *A*. Stormont (personal communication) mentioned that the frequency of antigen *A* in Jersey cattle is similar to that of Guernsey cattle. Results from New Zealand showed a frequency of antigen *A* in Jerseys and Friesians of an order similar to, but lower than, Owen's Guernsey and Friesian frequencies.

A survey on the lines suggested by Dr. Filmer was carried out in 1951. From nine herds of pedigree Friesian cattle, 95 blood samples were obtained from the 5 per cent of each herd with the highest butterfat test and the 5 per cent of each herd with the lowest butterfat test. Test records for the season 1949–50 were supplied by the New Zealand Dairy Board.

Results.

Highest 5 per cent of each herd had a butterfat test of 3·9 per cent or more.

Lowest 5 per cent of each herd had a butterfat test of 3·7 per cent or less.

Average test of all cows from which samples received, 3·84 per cent (range 2·8–5·0 per cent).

Number of animals with high butterfat test, 45. Frequency of antigen *A*, 0·27. Average butterfat test, 4·33 per cent (3·9–5·0 per cent).

Number of animals with low butterfat test, 50. Frequency of antigen *A*, 0·22. Average butterfat test, 3·36 per cent (2·8–3·7 per cent).

Overall frequency of antigen *A*, 0·24.

Cows with antigen *A*, 23 cows. Average butterfat test, 3·88 per cent (3·2–4·4 per cent).

Cows with high butterfat test, 4·23 per cent (3·9–4·4 per cent).

Cows with low butterfat test, 3·51 per cent (3·2–3·6 per cent).

Cows without antigen *A*, 72 cows. Average butterfat test, 3·82 per cent (2·8–5·0 per cent).

Cows with high butterfat test, 4·38 per cent (3·9–5·0 per cent).

Cows with low butterfat test, 3·34 per cent (2·8–3·7 per cent).

The test serum (Wallaceville anti-*A*) gives similar reactions to the Wisconsin *A*, kindly supplied by Dr. C. Stormont, but is less sensitive, that is, it does not react to quite so many bloods as does the Wisconsin *A*.

From the results, it appears there is no direct correlation between antigen *A* and butterfat test in the Friesian cattle under test. Even though the number of animals is small, it is likely that these results can be applied to Friesian cattle in general.

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Feb. 12.

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[1] Ferguson, L. C., *J. Immunol.*, 40, 213 (1941).

[2] Owen, R. D., Stormont, C. J., and Irwin, M. R., *J. Anim. Sci.*, 3, 315 (1944).

Toxicity of Methylene Blue to *Leptospira icterohæmorrhagiæ*

Yaniv and Avi-Dor[1] have reported that very low concentrations of methylene blue (0·5 µgm./ml.) inhibit the growth *in vitro* of *Bact. tularense*, but that this dye had no effect *in vivo*; "doses of 0·5 gm. [0·5 mgm. ?] each, applied intraperitoneally for three successive days, did not protect mice infected even with low doses (1–10 LD_{50}) of the bacterium".

So once again methylene blue has been found useless as a chemotherapeutic agent; and yet, in a sense, it may be regarded as the foundation stone of modern chemotherapy. As early as 1871 Ehrlich, the father of chemotherapy, had found that methylene blue preferentially stained malaria parasites, leaving the red blood cells and other tissues unstained; and in 1891 Guttmann and Ehrlich[2] reported that it had a slight anti-malarial action. Their finding was the starting point of the investigation that led to the discovery of 'Pamaquin', the first synthetic antimalarial. Later, Ehrlich and Hata[3] found that *in vitro* methylene blue was very toxic to the spirochætes of relapsing fever, but that *in vivo* it had no effect on the course of the disease in mice.

It seemed of interest to try the effect of methylene blue on a different genus of spirochætes, the leptospires, which have different growth requirements and a different distribution in the body. The test organism was *Leptospira icterohæmorrhagiæ*. *In vitro*, the organisms were immobilized and killed by very low concentrations of methylene blue (2 μgm./ml.); but *in vivo* doses of 10 μgm./gm. intraperitoneally on two successive days failed even to prolong the life of the test guinea pigs. The strain of *L. icterohæmorrhagiæ* used was highly virulent, and killed guinea pigs in four or five days. It is still possible that methylene blue might be effective in clearing the leptospires from the kidney tubules in cases of chronic infection; but this remains to be tested.

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May 26.

[1] Yanif, H., and Avi-Dor, J., *Nature*, 169, 201 (1952).

[2] Guttmann, P., and Ehrlich, P., *Berl. klin. Wschr.*, 28, 953 (1891).

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Phosphorus as a Factor Preventing DDT-Dehydrochlorination

DEHYDROCHLORINATION of DDT by certain chemicals concerns not only agriculture[1] but is also of great importance in anti-mosquito campaigns. A major factor here is the time during which DDT, sprayed on walls of houses, retains its insecticidal power. It has been shown[2] that great differences may exist between apparently identical walls, and that iron and aluminium ions are responsible for rapid dehydrochlorination. The difference in the percentage of mosquitoes killed on wooden and *pisé* walls, as reported by Wilkinson[3], might perhaps be explained on these lines.

In the Katanga Province of the Belgian Congo, I. Vincke also observed a rapid loss of insecticidal power of DDT on the walls of certain African houses. He asked us to investigate the problem. Using a modification of the method of Fleck and Haller, we also found that dehydrochlorination of DDT is related to the presence of iron and aluminium ions.

Analyses of soils from different parts of the Katanga have established the following facts: (1) in positive soils (causing rapid dehydrochlorination) there are ferric ions and few, if any, ferrous ions. Occasionally some slight traces of phosphate are found. (2) Negative soils contain both ferrous and ferric ions; the total iron content is generally higher than in positive soils. There is always a certain amount of phosphate.

Owing to a possible action of phosphate in neutralizing ferric ions by complex building, we have tried to use phosphorus to diminish the action of positive soils.

Laboratory experiments with water-soluble phosphorus salts, such as potassium hydrogen phosphates and ammonium phosphate, have given excellent results. Soils which dehydrochlorinized DDT completely after 12, 15, 17 and 20 min. respectively did not liberate any chlorine after 90 min. when p viously treated with a normal solution of such ph phates. Similar results were obtained with l positive soils which, before treatment, dehyd chlorinized 20 per cent of the DDT after 90 min

Tests on the coating of positive walls also show that a phosphate spray delayed the dehydrochlori tion of DDT for an appreciable time.

Using the biological tests of Downs *et al.*[2], we c conclude that in almost all cases the insectici power of DDT sprayed on walls may be prolon by previous spraying with a normal solution o phosphate.

This method has already been applied on a la scale by Vincke in the Tanganyika district of Congo.

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May 9.

[1] Carne, P. B., *Nature*, 162, 743 (1948).

[2] Downs, W. G., *et al.*, private communication from the Rockef Foundation.

[3] Wilkinson, P. B., *Nature*, 169, 421 (1952).

Counting Soil Algæ by Direct Fluorescence Microscopy

THE dilution technique is not entirely satisfact in studying soil algæ. There is no universal medi for their growth, nor can we assume that all spec will grow on any artificial medium now in use. T slow growth of algal colonies involves delays of to two or three months, causing inconvenience routine work. Filamentous and colonial algæ int duce further difficulties. A single filament or colo can give one or many colonies according to t number of viable pieces formed from it during d persion. Available data on the number of algæ in t soil cannot therefore be regarded as absolutely certa

Only direct microscopy can resolve these di culties. Its use has been limited by the small numb of algæ present (sometimes only a few thousands p gram of soil). This involves counting many mic scopic fields, and the difficulties are increased by t small size of some algal cells and by their freque intimate association with soil particles. A n fluorescence technique is proposed to overcome th difficulties.

All active algal cells are believed to contain least one of the different chlorophylls. (We reser the question of resting stages which can lose th chlorophyll.) The red fluorescence of chlorophy illuminated with blue or ultra-violet light can be us for detecting and counting algal cells by the followi technique. The soil suspension is illuminat through a condenser (1·4 aperture), by a 12-volt 6-volt lamp, the light of which passes through solution of copper sulphate in aqueous ammonia. yellow filter below the eyepiece is used to abs blue light. Objectives of 10× or 20× are used wi a 5× eyepiece. Algæ appear as red spots or lin against a black background. Soil particles are usua invisible, but sometimes give a yellow or gre fluorescence readily distinguishable from that chlorophyll. Using a special slide with a depressi of 0·1 mm. deep, the amount of soil examined is function of the area of the field, and the number algæ per gram of soil can easily be calculated.

his rapid and direct technique requires neither ensive apparatus nor lengthy culture methods. It nts all soil algæ without selection.

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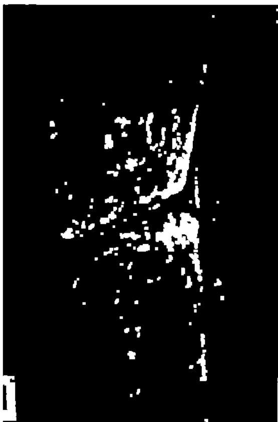
May 29.

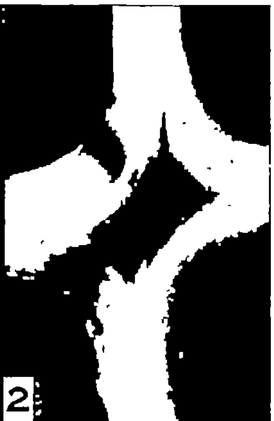
Formation of New Cell Walls in Cell Division

N a recent communication in *Nature*, further dence was presented by Dr. E. Elliot[1] relating the concept of Giltay[2], and supported afterwards Priestley and Scott[3], that at cell division each ighter protoplast secretes a continuous wall und itself. The suggestion was also made that s method of cell-wall formation may prove to be ieral in the higher plants. Recent work in this oratory on cell division in the cambium of angio- rms and gymnosperms further supports this ggestion.

Parts of an enveloping parent wall, apparently sisting after division in the ray initials, were served connecting adjacent cells of a radial file ray parenchyma cells isolated by simple maceration ig. 1). An example, which may perhaps be more portant, was observed in the course of a study of sequence of cell division of the cambium during the development of compression wood in conifer stems. Thin, feebly birefringent membranes, considered to be the remains of the parent cambial cell wall, were detected traversing the well-developed intercellular spaces characteristic of this tissue (Figs. 2 and 3). In normal wood the presence of similar membranes was demonstrated by careful delignification of thin cross-sections by alternate treatments with chlorine water and alcoholic monoethanolamine, with dilute alcoholic acetic acid washes (Fig. 4). Using techniques of simple maceration, demonstration of the parent wall was extremely difficult, as in the mature tissue this wall is not continuous around a radial file of cells and any slight agitation was sufficient to cause the cells to separate. That only fragments of the parent wall can be demonstrated is consistent with the great radial expansion of the cambium daughter cells which occurs during differentiation, following periclinal divisions.



ig. 1. *Grevillea robusta*. Part of two ray parenchyma cells, solated by maceration with hydrogen peroxide and acetic acid, howing part of parent wall of the ray initial. Unstained. × 980



ig. 2. *Pinus pinaster*. Transverse section of compression wood between crossed nicols. Only part of the parent wall traversing he intercellular space is in a position of brightness. × 2,000

ig. 3. *Pinus pinaster*. An example similar to Fig. 2, photographed with ordinary illumination after staining with safranin. × 980

ig. 4. *Pinus pinaster*. Transverse section of normal wood after delignification showing parts of the parent wall (marked by arrow). Unstained. × 430

A further point of interest is that the parent wall could not be demonstrated at the tips of cells by either of the techniques referred to above. This may be an indication of tip growth rather than of symplastic readjustment of the cells following cell division in the cambium.

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Feb. 20.

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Sugarcane × Bamboo Hybrids

Sugarcane × bamboo hybrids were first reported from this Institute by Venkatraman in 1937[1]. In spite of the absence of easily recognizable bamboo characters in the seedlings, Kutty Amma and Ekambaram[2] proved by a critical study of the anatomy and morphology of the seedlings that they were genuine hybrids. This corroborated Janaki Ammal's[3] conclusion arrived at earlier, on the basis of somatic chromosome counts. In these bamboo crosses the pistillate parents employed were the two male sterile Java canes, *POJ*.213 and *POJ*.2725. These were themselves complicated bispecies hybrids —*POJ*.213, involving *S. officinarum* and *S. barberi*; *POJ*.2725, a much more complicated hybrid between a number of *officinarum* and Java *spontaneum* (Glagah). It was felt desirable to repeat the cross, using a simple *officinarum* as the female parent. All the varieties of *officinarum* so far examined show $2n = 80$. For this purpose, *S. officinarum* var. *Vellai* (a local form) was employed and two seedlings were obtained. Examining the mother and the two seedlings derived therefrom through pollination with bamboo, one of the seedlings is very thick, much thicker than the mother, more vigorous and taller. The other is much thinner. Examination of the root-tips revealed a somatic chromosome number of 116 in the thick seedling and 86 in the thin. It is believed that the thick seedling has come into being through the fusion of an unreduced egg of *S. officinarum* (that is, $2n = 80$) with a normal sperm of *Bambusa arundanacea* ($n = 36$). The thin seedling has presumably been formed by the union of an *officinarum* egg having neither, the haploid nor the diploid number, with the sperm of bamboo. Functioning of diploid eggs in interspecific and intergeneric crosses, involving *Saccharum*, especially the species *officinarum* as one of the parents, is not an infrequent phenomenon. Almost all interspecific hybrids between *S. officinarum* × *S. spontaneum* have come into being through the operation of the unreduced egg of *officinarum*. Some cases of intergeneric hybrids are known where both the haploid and diploid eggs have functioned in the same cross. The latest known case is that of *S. officinarum* var. *Vellai* × *Narenga* ($2n = 30$), where hybrids showing $2n = 95$ and $2n = 55$ have been obtained (Raghavan unpublished). Functioning of egg with unexpected chromosome number in the formation of sugarcane hybrids is less common. While one such case is known involving a bicomplex hybrid as the pistillate parent, recent investigations have shown that this feature is shared by simple *officinarum* also. For *Co*.453, which is a cross between *S. officinarum* var. *Zw. cheribon* ($2n = 80$) and *Co*.285 ($2n = 112$), showed a chromosome number of 124, indicating that *Zw. cheribon* has contributed through its egg neither the haploid number (40) nor its unreduced number (80) but an unexpected number, that is, 68 [4]. This report is of interest in three particulars. First, instead of complicated bi-species or tri-species, derivatives such as *POJ*. or *Co*. canes, a simple *officinarum* has been employed as the pistil parent. Secondly, viable embryos are obtained from fertilization of not only haploid gametes, as reported by Janaki Ammal[3], but they are also formed from fertilization of unreduced eggs by normal sperms. This brings these bamboo hybrids into a line with *Saccharum* × *Sorghum* hybrids, in the formation of which also both reduced and unreduced eggs have been known to function[5]. Thirdly, the operation of an egg with unexpected chromosome number in the cross has also been vouched for.

Though the gross resemblance of the seedlings is to the mother, namely, sugarcane, the presence of such characters as arched root eyes above nodal buds of peculiar shape and disposition, extra-vaginal nature of the bud piercing the leaf-sheath, the mode of underground branching—these and other features, taken together with the chromosome number, leave very little doubt as to the genuineness of the cross. Perhaps this preponderance of maternal characters may be explicable on the basis of cytoplasmic inheritance, the existence of which was reported by Raghavan[4] in a number of interspecific hybrids in *Saccharum*.

A study of the intergeneric hybrids of *Saccharum*, which is now in progress, makes one believe that the seemingly conflicting phenotypic configurations obtained in several crosses are a result of the interaction of the plasmon with the genes. They seem to support the theory of the plasmon-sensitive genes in that it offers a reasonable foundation for the interaction of plasmon and genes; the result is that the same genes act differently in different plasmons. It would seem that in sugarcane hybridization more importance should be paid to the mother than to the father in the evolution of economically important seedlings. Also, the absence of fruitful results in the raising of economic seedlings through a particular cross need not be final; for it is just as likely that hybridization in the opposite direction, wherever such is possible, may result, through this interaction of the plasmon and the genes, in the expression of a phenotype answer to our needs.

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Sugarcane Breeding Institute,
Coimbatore.
June 19.

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Sex Mechanism in *Coccinia Indica* Wight and Arn.

SOME of the dioecious species of Cucurbitac have been cytologically investigated by seve previous workers to ascertain whether the morpl logical differences in flowers between the sexes cou be correlated with any observable chromoson differences of their gametes. So far, only t species among members of this family, name *Trichosanthes japonica*[1-3] and *Coccinia indica*[4-6] ha been found to possess well-defined sex-chromosom In *T. japonica*, the male is reported to be the heter gametic sex, whereas in *C. indica* contrary evidenc have been furnished by Kumar and Deodikar[6] a Bhaduri and Bose[4]. The present note is based the results of a critical cytological investigation different sex types, such as the diploid male a female, the gynodioecious form and a triploid ma of *C. indica*.

A careful examination of the somatic compleme in diploid male (Fig. 1,*a*) and female (Fig. 1,*b*) a of meiotic complement in pollen mother cells h definitely established that male of *C. indica* is t heterogametic sex with XY type of sex-chromosome Of this, Y is bigger than X while the latter is morph logically similar to the autosomes. During meios this unequal pair exhibits heteropycnosis, no congression, precocious segregation, etc., whic behaviours are characteristic of sex-chromosome The chromosome constitution of the male and t female of *C. indica* should, therefore, be represent as $22\,A + XY$ and $22\,A + XX$ respectively. T present investigation has definitely established th Kumar and Deodikar's statement[6] that the male *C. indica* is homomorphic and the female heter morphic is no longer tenable.

It has been observed that the chromosome co stitution of the gynodioecious form is similar to th of the normal diploid female ($22\,A + XX$) but, unli it, is highly sterile. In this the anthers are develope but pollen grain formation is impeded, resulting sterility of the plant. This provides an example show that the male organs of a plant can develo

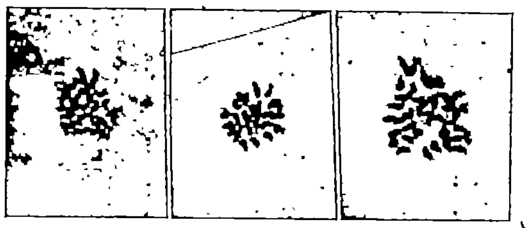

Fig. 1 (*a*), (*b*), (*c*). Somatic complement of diploid male and female a triploid male respectively. (× 1,100) n in the absence of *Y* chromosome. It further ows that there is something in the *Y* chromosome ich is necessary for the production of gametes but ich is absent in the *X* chromosomes and the tosomes.

A clone of a male plant conspicuous for its vigorous d extensive growth, when cytologically examined, s proved to be a triploid with 36 chromosomes (Fig.). Of these, one is large and very similar to the *Y* romosome observed in the diploid male, while all e rest are small and nearly alike. This *Y*, with uch two other chromosomes are associated during iosis, constitutes the *XXY* trivalent. The *Y* is arly distinguishable from the rest of the chromomes on account of its distinct size, shape and haviour. Thus from a knowledge of the chromome constitution in diploids and this triploid 3 *A* + *XXY*), it is quite evident that the influence *Y* is so overwhelming that the triploid, in spite the presence of two *X* chromosomes, has become perfect male plant. This lends further support to e suggestion made that the *Y* chromosome contains me element which is necessary for the formation gametes.

The occurrence of a triploid male reported here the first time shows that polyploidy exists within e species *C. indica*.

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Feb. 20.

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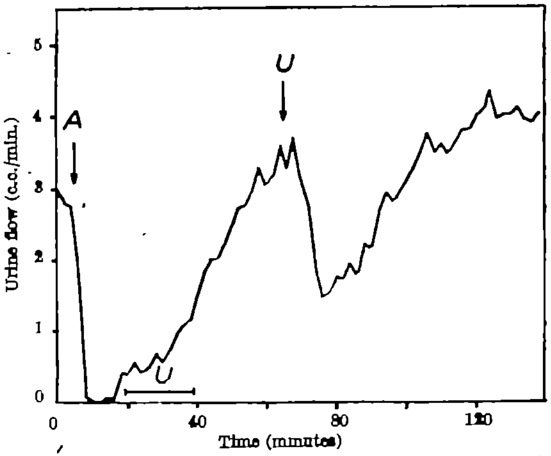
Adrenaline-Antidiuresis in the Water-loaded Dog

INTRAVENOUS injection of small doses of adrenaline s been observed to cause a temporary reduction the flow of urine in water-loaded dogs[1,2]. According Pickford and Watt[2], this action of adrenaline is pendent on alterations in renal blood pressure and w. We believe we have obtained evidence for the lease of the antidiuretic hormone by moderate ses of adrenaline.

After a fasting period of about 18 hr., in the course which water was given *ad lib.*, 30 c.c. of tap water r kgm. of body weight was introduced into the omach of a dog. A similar dose of water was given hr. later. Urine flowing through the inserted theter was collected in graduated tubes and easured every 2 min. After the beginning of steady w, doses of adrenaline varying from 0·008 mgm. 1 mgm. were administered intravenously. The gs were unanaesthetized during the experiments.

Adrenaline in doses of about 0·01 mgm. induced typical short adrenaline-antidiuresis as earlier scribed by Verney[1]. Injection of doses of 0·04–0·2 gm. was followed by a biphasic antidiuresis. First, rapid transitory inhibition of the flow of urine of e adrenaline-type appeared. Thereafter, a more olonged inhibition, resembling that caused by the tidiuretic hormone[1], began and reached the maxium at about 20 min. from the time of the injection.



Water-diuresis curve from the bitch 'Diogenes', in a Pavlov stand. At *A*↓, 0·5 mgm. adrenaline was injected intravenously. Urine was collected at *U*—, and re-injected at *U*↓

If 0·5 mgm. or more of adrenaline was injected, the antidiuresis was either mono- or bi-phasic. In the monophasic reaction, as is seen from the accompanying graph, the rate of flow of urine rapidly decreased to zero, increased gradually, and reached the pre-injection level in about 40–60 min.

The mechanism of this antidiuretic effect of adrenaline is not yet clear. However, the form of the curves suggests the possibility that moderate doses of adrenaline may cause, besides a rapid inhibition of flow of urine typical of this substance, a release of the antidiuretic hormone from the posterior pituitary. To investigate this possibility, urine collected during the period of adrenaline-antidiuresis was intravenously injected into the same dog. This urine was observed to have a pronounced antidiuretic action, as demonstrated in the graph. Control samples collected during uninfluenced diuresis for similar periods did not produce any comparable inhibition of flow of urine. An inhibition of the observed magnitude can be obtained with a dose of 0·1–0·2 mgm. of adrenaline. However, the excretion of some 20–40 per cent of the total amount of adrenaline injected in the course of 20 min. appears unlikely. Adrenaline alone is therefore scarcely likely to be responsible for this antidiuresis. On the other hand, the antidiuretic hormone is in part quickly excreted and can be detected in small amounts of urine, as observed by O'Connor[3], whose technique was adopted in this study. Hence the effect of the urine excreted during the adrenaline-antidiuresis supports the view that the prolonged stage of this antidiuresis is due to the release of the antidiuretic hormone. Direct evidence is, nevertheless, still lacking. In view of the fact that small doses of adrenaline inhibit the release of the antidiuretic hormone as induced by various stimuli[1], the eventual converse effect of larger doses is of special interest.

More detailed description of the results will be published elsewhere.

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Feb. 18.

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT IN STATISTICS—The Secretary, The University, Aberdeen (August 30).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Leicester (August 30).

CHEMIST (Experimental Officer grade) in the Fungicide and Insecticide Research Co-ordination Service in London—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (August 30).

SENIOR ASSISTANT ENGINEER (Chemist) (with an honours degree in chemistry, or a degree with chemistry as a principal subject) for work on the technical aspects of pollution of water-ways of all kinds and the treatment of natural waters for the prevention of slimes and deposits in heat-exchangers—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting AE/274 (August 30).

ASSISTANT BIOCHEMIST to work at the Group Laboratory, Warwick Hospital, and at the King Edward VII Memorial Sanatorium—The Pathologist, Group Pathological Laboratory, Lakin Road, Warwick (August 31).

ASSISTANT EXPERIMENTAL OFFICER (with a degree in horticulture and an interest in horticultural research, especially regarding the preparation and handling of horticultural produce for marketing) to investigate the effects of washing of vegetable produce—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (September 1).

ASSISTANT LECTURER IN PHYSICAL CHEMISTRY—The Secretary, University College, Earlsfort Terrace, Dublin (September 1).

ASSISTANT LECTURER IN MATHEMATICS (with special qualifications in pure mathematics)—The Registrar, The University, Manchester 13 (September 6).

ASSISTANT LECTURERS (2, one of whom at least should have qualifications in general mycology or microbiology) IN THE DEPARTMENT OF BOTANY—The Secretary, University College, Gower Street, London, W.C.1 (September 6).

LECTURER IN ELECTRICAL ENGINEERING—The Assistant Secretary of University Court, The University, Glasgow (September 6).

SCIENTIST III or SCIENTIFIC TECHNOLOGIST I (with a science degree or equivalent qualification) for the assembly, recording and reporting of scientific data on coal seams, at the Coal Survey Laboratory at Birmingham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/518 (September 6).

SENIOR LECTURER or LECTURER IN CROP PRODUCTION, in the Department of Agriculture, University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 6).

LECTURER IN BOTANY (qualifications in plant physiology essential)—The Secretary, The University, Aberdeen (September 8).

LECTURER IN PARASITOLOGY in the Department of Zoology—The Secretary, The University, Edinburgh (September 8)

ASSISTANT (with interests on the physical and inorganic side) IN THE DEPARTMENT OF CHEMISTRY—The Secretary, The University, Aberdeen (September 10)

LECTURER (with an honours degree in physics, with research experience, and interested in the design of optical, electronic and pressure-recording apparatus) IN BIOPHYSICS—The Secretary, The University, Edinburgh (September 10)

DISTRICT (Forest) OFFICERS—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 146/52 (September 11)

LECTURER (Grade I or II) IN PHARMACEUTICAL CHEMISTRY, and a LECTURER (Grade II) IN AUTOMOBILE ENGINEERING AND VEHICLE TECHNOLOGY, at the Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (September 12).

ASSISTANT KEEPER (Geology)—The Director, Museums and Art Gallery, Leicester (September 15).

ASSISTANT LECTURER IN CHEMICAL ENGINEERING, an ASSISTANT LECTURER IN FUEL TECHNOLOGY, and an ASSISTANT LECTURER IN GAS ENGINEERING—The Registrar, The University, Leeds 2 (September 17).

PRINCIPAL SCIENTIFIC OFFICER at the Mechanical Engineering Research Laboratory, East Kilbride, Glasgow, to lead a team engaged on the thermodynamic tables programme of the Heat Division—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting No. S 4161/52 (September 18).

RESEARCH STUDENTSHIP IN MATHEMATICS, and an ASSISTANT LECTURER IN MATHEMATICS—The Professor of Mathematics, University College of North Staffordshire, Keele, Staffs (September 20).

ASSISTANT AGRICULTURAL ECONOMIST (graduate in economics and/or agriculture)—The Registrar, The University, Bristol (September 30).

SENIOR LECTURER and a LECTURER IN ANATOMY, and a SENIOR LECTURER IN BACTERIOLOGY, at University College, Ibadan, Nigeria—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 30).

SENIOR RESEARCH SCIENTIST (with a wide knowledge of physical chemistry and/or biochemistry) for a research post which will also involve a considerable degree of supervision of the work in progress in the Association's laboratories—The Director of Research, Baking Industries Research Station, Chorleywood, Herts (September 30).

LECTURER (Grade II) IN INDUSTRIAL METALLURGY—The Registrar, The University, Birmingham 15 (October 1)

SENIOR LECTURER IN GENERAL CHEMISTRY at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

DEPUTY EXECUTIVE OFFICER (with a recognized degree in agriculture or natural science) OF THE SEED PRODUCTION BRANCH, a REGIONAL TRIALS OFFICER (with a University degree or diploma in agriculture and/or biology) (to be stationed at the Harper Adams Agricultural College, Newport, Shropshire), and an ASSISTANT (with a recognized degree in agriculture or natural science) to the Mycologist—T Secretary, National Institute of Agricultural Botany, Huntin Road, Cambridge.

EDUCATIONAL PSYCHOLOGIST (part-time) (honours graduate psychology)—The Medical Director, Child Guidance Training Cen 6 Osnaburgh Street, London, N.W.1.

ELECTRICAL ENGINEERS (Senior Scientific Officer grade) for w connected with the design and development of remote power c trolled gear and servo mechanisms, at a Ministry of Supply De Establishment near Sevenoaks—The Ministry of Labour and Natio Service, Technical and Scientific Register (K), Almack House, 26 K Street, London, S.W.1, quoting D.329/52A.

EXPERIMENTAL OFFICER IN THE RADIO RESEARCH ORGANIZAT at Toddington, for abstracting scientific and technical articles radio research and development—The Ministry of Labour and Natio Service, Technical and Scientific Register (K), Almack House, 26 K Street, London, S.W.1, quoting D 268/52A

LECTURER IN MECHANICAL ENGINEERING (including heat eng and hydraulics)—The Principal, Faraday House College, Sou ampton Row, London, W.C.1.

MATHEMATICIAN or PHYSICIST (Principal Scientific Officer gra at a Ministry of Supply Design Establishment near Sevenoaks, lead a section dealing with mathematical/physical investigatio including theoretical aspects of design problems—The Ministry Labour and National Service, Technical and Scientific Register (Almack House, 26 King Street, London, S.W.1, quoting A.220/52

MECHANICAL ENGINEERS for research work connected with t preparation of airframe Appendices A at Ministry of Supply Lond headquarters—The Ministry of Labour and National Service, Techni and Scientific Register (K), Almack House, 26 King Street, Lond S.W.1, quoting C.493/52A.

RESEARCH ENGINEER (with B.Sc. or equivalent, and some engineer workshop and drawing office experience essential) for design and testi of experimental equipment—The Assistant Secretary, British C Utilization Research Association (Ref. No. A 19), Randalls Roa Leatherhead, Surrey.

SENIOR SCIENTIFIC OFFICER (Veterinary Research) at the Cent Trypanosomiasis Institute, Sukulu, Uganda, to undertake resear in animal trypanosomiasis—The Director of Recruitment (Colon Service), Colonial Office, Sanctuary Buildings, Great Smith Stre London, S.W.1, quoting Ref 27066/84/52.

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(not included in the monthly Books Supplement)

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NATIONAL PARKS AND LOCAL GOVERNMENT

IN the House of Commons debate on national parks and access to the countryside, held on July 14, Mr. Harold Macmillan, the Minister of Housing and Local Government, announced his agreement to the administration of the Snowdonia National Park for its first three critical years by three county committees with a joint advisory committee instead of the statutory joint board with its planning powers. The agreement was subject to six conditions, which included a fixed office and an independent planning officer; and, with the acceptance of these conditions by the three county councils concerned, only an appeal to the courts can now prevent this dubious decision taking effect. Mr. Macmillan in the debate made no attempt to justify his departure from the terms of the Act. His concession to local feeling does indeed appear to rest on a desire to secure an effective national park and on the recognition that the co-operation of the local authorities is essential if the national parks are to succeed, a recognition, however, which is fully shared by those who, like Mr. Anthony Greenwood and Mr. Blenkinsop, opposed his action.

Nobody, however, proposes, as Mr. Macmillan and Mr. Ernest Marples implied, to ride roughshod over the local interests. What the Minister and his Parliamentary Secretary seem to have overlooked is that it was largely the failure of local planning authorities to pay enough attention to the national interests that made the Act necessary. Opposition of the type displayed by the Merioneth, Caernarvonshire and Denbighshire County Councils was visualized as likely to lead to control of the national parks being taken completely out of the hands of the local authorities.

Moreover, while there is no reason to doubt the genuine desire of the three county councils concerned to establish a national park in Snowdonia, Mr. G. O. Roberts's speech in the debate shows why it is unwise, if indeed it is fair, to entrust policy or administration to local authorities. Where there is a clash between national and local interests, the local authorities are subject to an unfair tension; their financial resources are unequal to the task, and the major threats to national parks come from government departments and the large public authorities with which the local authorities are manifestly unable to contend on equal terms.

These are the critical issues, and they have been consistently passed over by the present Minister of Housing and Local Government and his Parliamentary Secretary as they were, on the Labour side, by Mr. Dalton and Mr. Blenkinsop. Moreover, in his speech on July 14 Mr. Macmillan advanced no satisfactory justification for ignoring the intention of the Act in this replacement of the joint planning board by a joint advisory committee.

Something much more fundamental than mere expediency is here at stake. It is already clear from the course of events since the National Parks Act was passed in 1949 that the populations—and certainly the local authorities—of the districts chosen for the establishment of the national parks are indifferent, if not hostile, to the needs and desires of their urban neighbours and still more to the national considerations which led to the passing of the Act by Parliament. Both populations and local authorities have also shown a remarkable ignorance of the whole conception of a national park in Britain, and, to say the least, neither of the Ministers concerned have seemed prepared to give the National Parks Commission the resources to enable it to dispel ignorance which sometimes appears almost wilful. For evidence of this one need look no further than to the second report of the National Parks Commission or to some of the statements made before the public inquiry on the Minister's Order designating the North Yorkshire National Park. At that inquiry the Minister was urged both to delay confirmation of the Order for three years and to reduce the area from the 600,000 acres designated by the National Parks Commission to 250,000 acres.

Once again the representative of the National Parks Commission had to reiterate that designation of a national park did nothing to increase public access to farmland, and he pointed out further that the opposition of the Whitby, Thirsk and Hull water undertakings, the Blackfaced Sheep Breeders' Association and the Country Landowners' Association to the designation order was based on misapprehensions and misconceptions of the effects of designation which had been refuted at previous national park inquiries.

If opposition is frequently due to misconceptions and misunderstandings, it can be changed into co-operation when there is proper appreciation of the purpose and functions of a national park and the difference between it and ordinary county planning. That much is clear from the work of the Peak District National Park Planning Board. The few months experience of that body has convinced some of its members who were most opposed to a joint board, and anxious for an advisory committee instead, that a joint board can work effectively. The members of the Board have already shown their impartial outlook in considering industry and amenities, and are evidently growing out of a parochial idea of their responsibilities into one that is inspired by the conception of a national park which induced Parliament to pass the legislation.

Here there is evidence that a joint board can function and that its members recognize that success depends on the ability of its members to carry with them the authorities which they represent. Confidence that the joint advisory committee which Mr. Macmillan proposes for the Snowdonia National Park will, in fact, be guided, as he desires, by the National Parks Commission, will not be strengthened by the recent decision of the Dartmoor National Park Committee to sanction the erection of a television mast on North Hessary Tor. Both the Dartmoor Preservation Association and the National Parks Commission have asked the Committee to reconsider its decision, but without effect. In spite of this, neither Mr. Macmillan nor Mr. Marples in the debate on July 14 brought forward any evide to justify their optimism over the surrender national control.

It is clear enough, therefore, that if the co-operati and understanding of the local authorities, on whi Mr. Marples, like his opponents, rightly lays su stress, is to be secured and, still more, if the financ support which he referred to as "quite indispensab in addressing the annual meeting of the Sheffi and Peak District Branch of the Council for t Preservation of Rural England is to be obtain a vigorous educational campaign must be und taken as a matter of urgency. The gravest dou as to the good faith of the Labour Party in th matter were roused by the actions of Mr. Dalton a Mr. Blenkinsop, and in using the adjournment deba on July 9 and the debate on July 14 to attack t Government on party lines. But Mr. Macmillan a Mr. Marples have need enough to establish their ov sincerity and good faith, and it is to be hoped th in its next annual report the National Parks Com mission will no longer have to complain that it unable to conduct essential publicity campaigns f lack of the relatively small sum of £300.

The Minister will doubtless discount or ignore an attacks upon his policy made on party lines. I can scarcely overlook the fact, however, th members of his own party, and that doubts to his intentions have been raised by his ov actions in the minds of many responsible an independent people throughout the country. The doubts were not dispelled by his speech on July 1 and if any progress is to be made with the establis ment of real national parks, some proof, rather tha words, must be forthcoming to show that t Government is really concerned with the claims amenity, of which Mr. Marples spoke so disparagingl It should be noted, for example, that in its annu report this year the Council for the Preservation Rural England reached the conclusion, from a revie of various disputes with the authorities over ele tricity undertakings, and particularly the Malve Hills case, that the tendency among governme departments and local authorities to pay scant rega to the claims of amenity is increasing. Sir Patri Abercrombie, too, has contended that despite co sultation, public inquiries and departmental inquirie these large impersonal organizations have become f all practical purposes above the law and outside t control of planning authorities.

That contention is completely endorsed by t Council for the Preservation of Rural England ar is, as already indicated, one of the fundament reasons for the concern with which Mr. Macmillan departure from the administrative proposals of t National Parks Act is regarded. Instead of harpi on the need for securing the co-operation and unde standing of the local authorities, on the importan of which all are agreed, the Minister should first ta positive action to assist the removal of misconceptio and misapprehensions, to the persistence of which t North Yorkshire Moors inquiry bore witness, an second, inquire himself a little more closely into t reasons for such misapprehensions.

Two such causes have already been indicated : st, the slender resources which the National Parks mmission has at its disposal for publicity ; and ond, there is this question of control of depart- mtal requirements—land needs of the Armed rvices, mineral workings, water supply, electricity dertakings and others. Some independent means assessing such requirements in relation to national eds as a whole is imperative. If we continue to ow departments to be judges in their own cause, ither nature reserves nor parks, national or local, r even cricket fields are likely to survive in Great itain.

But there is a third cause at which Mr. B. Keith- icas hinted in his recent book, "The English Local vernment Franchise" (Blackwell, 27*s*. 6*d*.). The pute over the administration of the national parks a facet of the general problem of the relations be- een central and local government. For many years e powers and responsibilities, obligations and re- urces of local authorities have been getting out of gnment. To a large extent local authorities spend ney which is not their own on policies which are not their making. More and more local expenditure is ed by forces outside the control of the individual thority, and this fixed expenditure tends steadily increase, with consequent limitation of the area of itiative for the local authority. For example, half e gross expenditure of a large county borough may on salaries and wages, in accordance with scales ed by some independent body or by a national nt council.

While the local authority remains free, within nits, to reduce or increase its staff, it has largely st the power to fix conditions of service, except in far as it acts through some national negotiating dy ; in such circumstances it is understandable at local authorities should look askance at any oposals which would extend further the power of tional standards to enforce a certain minimum penditure on the local authorities. Mr. Keith- icas points out that extension of the system of joint ards proposed for the administration of national rks might well constitute a major threat to the dependence of local government in Britain. Whether e system does, in fact, mark the beginning of a new rm of central control of locally elected bodies cannot t be seen. It is not clear, for example, whether the vernment nominees on such committees are free ents or whether they are expected to represent the as of the Government ; but in the context of the neral tendency for central control to go beyond at is justifiable either by present economic diffi- lties or by the financial aid given, the misgivings some of the local authorities in this matter are derstandable even if they cannot be condoned.

From this point of view it is equally clear that the ime responsibility for removing misunderstanding d opposition lies on the Government's shoulders. vernment parsimony has not only impeded the moval of misapprehensions as to the nature of tional parks, but has also accentuated the justi- ble fears of the local authorities as to the effect on eir financial resources. If there is to be a national policy, it must be implemented from national resources : the execution of such a policy should not depend on the ability of a particular local authority to supply the resources. If that were made clear, there would be less question of the willingness of local authorities to co-operate in working out a national policy which took full account of local interests as well as of the wider and long-term national and special interests, with which it is unreasonable to expect local authorities primarily to be concerned.

The abandonment of the Hobhouse principle that national parks should be nationally financed and administered was a mistake for which both political parties share the responsibility. The experience of the Peak District National Park Board, as already indicated, warrants the hope that collective exercise by such a Board of executive control over the whole of a park area may induce in its locally elected members a sense of independent and united purpose, of loyalty to the conception of a national park and of responsibility to the nation as a whole as well as to their own ratepayers. It is even possible to see here one of those fields for enterprise which are so important if local government is to retain vitality, and it should be noted that in a useful report on the scope for enterprise in local government, put out last year by the Research Panel of the National Association of Local Government Officers, some stress was laid on the importance of evolving new patterns of co-operation.

That report gave due weight to all those factors which we have suggested as helping to explain the attitude of local authorities to the national parks In spite of these difficulties, however, and the limitation of experiment which central control and the economic situation place on even the counties and county boroughs, the report took an optimistic view of the scope for enterprise in local government. Particularly in the social services and in amenities, a vast sphere of work is still open to local authorities both in the technical development of services and in the development of systems of co-operation and administration.

National parks or nature reserves were not mentioned in this report ; but the bearing of the conclusions of this report on the national parks question is unmistakable. If, however, local authorities are to respond to the challenge which is offered to them, a large measure of responsibility lies on the shoulders of the Minister of Housing and Local Government : he must no longer allow the educational activities of the National Parks Commission to be hamstrung for paltry sums ; he should dispel such misgivings on the part of the local authorities as are directly due to the Ministry's refusal to provide the planning authorities of particular parks with the financial resources required for effective national planning ; and he should terminate an appeasement policy which threatens to jettison the declared intentions of the Act in the face of misinformed opposition based on misconceptions for which the Ministry's policy is in part responsible.

Action in these matters will provide the best test of the Minister's belief in the idea of national parks and his desire for the efficient administration which he has admitted is to be secured by a single authority such as a joint board. Mr. Macmillan has, moreover, indicated his acceptance of the principle that, in the areas designated as national parks, amenity is to be regarded as the overriding national interest; though the whole trend of his speech suggested that at the present time he attached rather a low importance to amenity as compared with other national interests. The danger is, of course, that irreparable damage may be done to amenity in the meantime if in some areas that interest is not supreme even at the present time.

For all that, there is evidence in Mr. Macmillan's speech of his ability to see the problem as a whole and to put the question of national parks in its proper perspective. It is his actions that have aroused doubts as to his intentions; but fortunately there is other and more reassuring evidence of his energy and initiative, such as his direction requiring all fresh applications for granting permission to extend or open quarries in the Peak District to be made to the Peak District National Park Planning Board in the first instance, and more particularly in that larger question of local government to which the question of national park administration is related. How close is that relation, and how large an opportunity for the invigoration of local government the wise administration of national parks by such devices as a joint board offers, are well brought out in a recently published study by Mr. D. N. Chester of the financial and administrative relations between central and local government. Two chapters, in particular, of this book—that in which Mr. Chester sets forth the assumptions on which his study is based and that in which his criticisms and proposals for improving such relations are detailed—deserve attention as much from the point of view of the administration of national parks as of the reform and reinvigoration of local government. They could well contribute to effect the closer co-operation and understanding, on the necessity of which in an effective national parks system all are agreed.

HISTORY OF BOTANICAL EXPLORATION IN MALAYSIA

Flora Malesiana

Being an Illustrated Systematic Account of the Malaysian Flora, including Keys for Determination, Diagnostic Descriptions, References to the Literature, Synonymy and Distribution, and Notes on the Ecology of its Wild and Commonly Cultivated Plants. (Published under the auspices of the Botanic Gardens of Indonesia, Bogor, and of the Rijksherbarium, Leyden.) General Editor: Dr. C. G. G. J. van Steenis. Series 1: Spermatophyta, Vol. 1: Malaysian Plant Collectors and Collections; being a Cyclopædia of Botanical Exploration in Malaysia, and a Guide to the Concerned Literature up to the Year 1950. By Mrs. M. J. van Steenis-Kruseman. Pp. clii+639. (Djakarta and Groningen: Noordhoff-Kolff N.V., 1950.) 55.50 fl.

THE "Flora Malesiana" now in progress of publication is a magnificent effort designed to give a detailed and systematic account of the botany and vegetation of 'Malaysia', including the Mala
Peninsula, Indonesia, the Philippine Islands, Briti
Borneo, Portuguese Timor and New Guinea. It wi
we are told, be preceded by three volumes of
general character, of which the present one is th
first to be published. This volume has been writte
by Mrs. M. J. van Steenis-Kruseman and has as
separate title, "Malaysian Plant Collectors an
Collections; being a Cyclopædia of Botanic
Exploration in Malaysia, and a Guide to the Co
cerned Literature up to the Year 1950". It is eviden
that much bibliographical and biographical researc
spread over a period of approximately twelve yea
and involving the immense task of consulting
world-wide literature on the subject, has gone in
the preparation of this volume. The result has bee
the building-up of a fully comprehensive an
informative work, the most complete contribution
our knowledge of the history of botanical exploratio
in Malaysia ever published.

The introduction to the volume, forming Chapter
covers more than thirty pages and outlines the ai
and history of the work and its purpose as part
the "Flora Malesiana". It goes on to deal wit
private collections of Malaysian plants, gives copiou
notes on mislabelled botanical collections, and includ
an annotated list of the literature for the use
explorers, ending with an account of the etymolog
of vernacular names for the plants. All those wh
intend to collect in the tropics will find the direction
contained in the chapter on the technique of plan
collecting invaluable. The dangers encountered, th
equipment needed, what and how to collect, th
dispatch of living plants, and many other matte
are described in a full and detailed manner. Indee
the information will doubtless be found useful
many people other than botanists, and the wide fiel
covered by the volume should result in a demand fo
it by those with interests in the history of oth
branches of science such as zoology, etymolog
agriculture, horticulture, medicine, forestry, ethno
graphy, geography and so on.

In Chapter 3 the delimitation of Malaysia and i
main geographical divisions are dealt with an
include unpublished data, while diagrams and figur
are given to illustrate distribution. Attention is pa
to the inner divisions of the flora, and the theori
and arguments of Earle, Sal. Müller, Zollinge
Miquel, Wallace, Merrill, Malm and Dickerson a
discussed. Reference to the collections is made in th
next chapter, which gives a complete list of th
voyages and expeditions in chronological order an
also provides a useful geographical survey. Desiderat
for future exploration are next considered, an
attention is given to the work of future botanic
collecting. Another chapter contains references
important sources of information used in compilin
the list of collectors and also includes other inform
tion relating to herbaria where collections of Malaysia
plants are to be found. There are also sevent
specimens of facsimile handwriting of well-know
botanists, which will no doubt be found extremely us
ful in identifying handwriting on herbarium sheets.

The rest of the volume, consisting of 639 pages,
devoted to a very valuable cyclopædia of collector
This contains brief biographical sketches of som
three thousand people who have been concerned
some time or other with the botany of Malaysi
Itineraries, collecting localities, collections an
literature follow the sketches, and many portraits a
included. Here many celebrated men are dealt wit

as Solander, Banks, Thunberg, Commerson, k, Korthals, Koorders and so on. In many cases, biographies have hitherto been available or were to be found in special or obscure publications. book ends with a select index which has evidently n carefully compiled.

ne can have nothing but praise for this book, ch is a veritable mine of information. To all anists interested in or visiting Malaysia it will be te indispensable. H. S. MARSHALL

ONTROL OF PUBLIC EXPENDITURE IN BRITAIN

e Control of Public Expenditure
ancial Committees of the House of Commons. By il Chubb. Pp. viii+292. (Oxford: Clarendon es; London: Oxford University Press, 1952.) . net.

R. BASIL CHUBB'S scholarly survey of the financial committees of the House of Commons concerned not, as the original Public Accounts nmittee, with unauthorized spending, but with e spending—the most efficient use of public ney. Nor are controls of the type which are here isidered a substitute for efficient administration. at is the first and indispensable safeguard, and system of control which Dr. Chubb reviews in s book might be described essentially as one of aining *prima facie* evidence that administration is fact sound. This study shows what care has been en to avoid infringing departmental responsibility l to secure the co-operation of the departments in viding the information essential for the formation a balanced opinion upon their activities.

uch co-operation and the provision of adequate ormation are the essential conditions for inde- dent control of this type. There are others which . Chubb also puts forward as necessary if a Select mmittee is to examine expenditure effectively: ticable and clear-cut terms of reference; an propriate organization; means of ensuring that tice is taken of its recommendations; and liaison d co-ordination arrangements with the Public counts Committee. Given these, and there is no son why the essentially amateur character of such Select Committee's inquiries, in contrast to the re professional probing of accounts by the Public counts Committee, with the expert assistance and idance of the Comptroller and Auditor General and Audit Department, should not yield extremely ful results. Even such a complicated and technical estion as the national organization for scientific d industrial research has been usefully probed in s way, as the third report of the Estimates Com- ttee for the session 1946–47 shows.

The work of the Estimates Committee and of the blic Accounts Committee appears, in fact, already have shown the lines along which control is to be ected. The task confronting us to-day is to termine exactly what new type of information is quired regarding such bodies as the University ants Committee and the Department of Scientific d Industrial Research for an accurate appreciation the efficient performance of their services and the dom of their expenditure. With this there may o be required, indeed, something more than a ancial scrutiny—a scrutiny of method, based on the investigation of departmental practice and organization. Largely this will be a matter of departmental administration, though in part it may be stimulated by the inquiries and activities of the Select Committee.

How far any really radical change in this respect is necessary cannot easily be judged from Dr. Chubb's review. Seldom, if at all, does he indicate the outcome of the recommendations of the Select Committee on Estimates, and we are given no means of judging whether or not there exist at present adequate means of ensuring that notice is taken of the recommendations of the Estimates Committee. This, however, is vital if the work of the Committee is not to be in vain, and public control is to be a reality and not a sham.

Dr. Chubb's book gives a clear historical account of the development of a system that has already served us well. His book is also to be welcomed as a pointer to the directions in which fresh thought and study are required if we are to adapt the system to serve still more closely the conditions of to-day, and particularly to solve such problems as those of the control or investigation of the great public corporations and of the formation of an educated public opinion which is not only satisfied that money is wisely spent, but also understands the relation of such expenditures to national welfare clearly enough to be immune from hysteria at a time of economy. Such problems involve scientific study by some at least of the Departments of State: they equally involve co-operation and hard thinking among scientific workers and technologists, as well as administrators, by whom and on whom some of these large sums will be spent. R. BRIGHTMAN

CLAY MINERALS

X-Ray Identification and Crystal Structures of Clay Minerals
Edited by G. W. Brindley. Pp. vii+345. (London: Mineralogical Society, British Museum (Natural History), 1951.) 35*s*.

THIS is an indispensable reference work for the scientific workers who are trying to bridge the gap between the well-crystallized minerals and those fine-grained and generally less well-ordered ones generically termed clays. Clay was one of the first raw materials to be used by man, and the numerous and sometimes beautiful surviving achievements of early potters in many lands testify to the extensive deposits of useful clay that have been discovered in the past. In Great Britain we have been fortunate in possessing good deposits of kaolinite and of fuller's earth (montmorillonite) that have been known and widely used for centuries. The foundation of the Clay Group of the Mineralogical Society of Great Britain in 1947 indicates a resurgence of interest of scientific men and women in clay and a welcome *rapprochement* of workers from industrial, university, government and other laboratories.

The monograph now under review is the first of its kind to appear in Britain and is a tribute to the inspiration and industry of the editor and his team of French, American and British experts who have given so generously of their time to the collection and dissemination of useful knowledge. Identification is an essential preliminary to all crystallographic studies. X-ray diffraction has proved to be the most powerful method of identifying clay minerals, and due acknowledgments are made to the Bragg school, Ross and Kerr, Pauling, Hendricks and Nagelschmidt for their pioneer work. The value of auxiliary techniques is emphasized, and well-balanced accounts are included of chemical, optical and thermal studies. Mechanical analysis, aided by the centrifuge, is a necessary prelude to the application of X-ray diffraction, chemical and thermal techniques to the quantitative study of clay, soil and ocean deposits. Chapters of a more advanced nature describe crystal structure studies of montmorillonite, halloysite, fireclay and chamosite, and X-ray studies of interstratified and disordered layer lattice minerals. A knowledge of the silicon-aluminium oxygen layer framework and where the layers of water molecules are located can often be extended to a more detailed account of where additional elements—potassium, sodium, magnesium, iron, etc.—are also situated. Thus are explained many of the known properties of clay minerals. It is not too much to expect that more exact crystal structure analyses will lead to the prediction of unsuspected properties, some of which may be useful to science, art and industry.

F. A. BANNISTER

CHEMISTRY OF LIGNIN AND WOOD

The Chemistry of Lignin

By Friedrich Emil Brauns. Pp. xv+808. (New York: Academic Press, Inc., 1952.) 14.50 dollars.

Chemistry of Wood

By Erik Hägglund. Pp. x+631. (New York: Academic Press, Inc., 1951.) 13.50 dollars.

THESE two books have much in common. Each has as author a prominent member of a pulp and paper research organization—Brauns being of the Institute of Paper Chemistry, Wisconsin, and Hägglund of the Swedish Forest Products Research Laboratory—and both authors are prominent authorities on the subject-matter covered. Both books, too, are essentially documentary in character and contain some 2,200 and 1,400 references to the original literature, respectively. Peculiarly enough, the same (and indeed, only) adverse comment applies to both—namely, that they are, if anything, too documentary and perhaps insufficiently critical of the work recorded, including the author's own.

The chemistry of lignin is in effect largely the chemistry of wood, so that overlaps are to be expected and indeed make comparison a matter of some interest. For example, sections on the structure of lignin and its formation and role in the plant are common to the two volumes. Both books adopt an essentially chemical approach to their subject, although the wider industrial implications are duly recognized, even if they are not fully discussed as such. Thus, Brauns emphasizes how the academic chemical approach to the problem of lignin structure via its chemical reactions should lead to the solution of that major problem of all pulping industries, namely, the economic utilization of lignin instead of its disposal as a highly objectionable effluent. Similarly, Hägglund's book has chapters on the chemistry of the acid and alkaline pulping processes used for the manufacture of wood pulp for paper and rayon manufacture.

As might be expected, Brauns's book is the m
restricted in scope although, in consequence, ea
section is correspondingly more detailed. Aspe
covered are the analysis of lignin, its isolation, a
its physical, biological and chemical properties a
reactions, together with its role and formation in t
plant. A long chapter deals, of course, with t
various theories of the structure of lignin. Unf
tunately, it leads to the conclusion that it is premat
to suggest a constitutional formula for lignin, althou
there is strong evidence that lignin is a high polym
comprising at least 75 per cent of phenylpropa
'building stones'. The structure of these 'buildi
stones' and the mode of their combination are, ho
ever, still unknown, and indeed Brauns regards o
knowledge of the structure of lignin as compara
with that of cellulose more than a hundred years a

Hägglund's book is a revised edition of "Ho
chemie", first published in 1928 (second Germ
edition, 1939), now, significantly enough, appear
in English although printed in Sweden and publish
in the United States. The ground covered includ
wood tissue and formation, the physical and chemic
properties of wood and its various constituents, t
chemistry of wood saccharification (Rheinau proces
and the sulphite and alkaline pulping methods a
associated bleaching processes. The carbonizatio
caustic fusion, storage and natural decomposition
wood are also dealt with.

It is noteworthy, and a tribute to both the autho
and publishers, that although the books are print
in Vienna and Sweden, respectively, the standard
production bears very favourable comparison wi
the best of similar books published in Great Britai
These two books, though similar, can be high
recommended as full, authoritative and up-to-da
accounts of our present knowledge of wood and
constituents. On the whole, they are complementa
to, rather than substitutes for, one another; a
studied together they should meet every need of
workers on the subjects of wood and lignin.

JULIUS GRANT

ABSTRACTING FOR PHYSICISTS AND ELECTRICAL ENGINEERS

Physics Abstracts

Section A of Science Abstracts. Vol. 54, 1951. P
vii+1460.

Electrical Engineering Abstracts

Section B of Science Abstracts. Vol. 54, 1951. P
xii+737.

(London: Institution of Electrical Engineers, 195
£2 10s. each section; £4 10s. both sections.

IN 1948 the Royal Society Scientific Informatio
Conference in London discussed among oth
topics the question of improvement of abstracti
services; in 1949 Unesco convened a conference
Paris to discuss the co-ordination of the variou
science abstract journals, and in 1950 the results
an extensive and detailed study, undertaken by t
American Institute of Physics with the financi
assistance of the U.S. Office of Naval Research,
the opinions of physicists on *Physics Abstrac*
(*Science Abstracts A*) were published (*Amer. J. Phys*
18, 417; October 1950. See also *Physics Today*,
18; August 1951). The principal object of the latt
inquiry was to ascertain for what purposes physicis
use abstracts, their opinion of the abstracting servic

available to them and what, within reason, they would like to have in the way of physics abstracting. The result showed that physicists regarded "wide coverage of periodicals" as the primary requirement. "Prompt publication of abstracts", "abstracts written by subject experts" and "extensive indexing" were considered of equal importance but a very poor secondary requirement. Recommendations to implement these requirements were submitted to the management committee of *Physics Abstracts* and were readily accepted. Indeed, it stands to the credit of the editor (Dr. B. M. Crowther) and the committee that nearly all the suggested improvements had been anticipated and in many cases put into effect before the results of the above inquiry were made public. Subscribers to *Science Abstracts* will have noted with satisfaction the considerable expansion and gradual improvement generally of both *Physics Abstracts* and *Electrical Engineering Abstracts* (*Science Abstracts B*) during the past few years.

Commenced in 1898 when it was the first journal of its kind, *Science Abstracts* is now the major abstracting journal covering articles with a physical interest in mathematics, astronomy, astrophysics, geodesy, physics, physical chemistry, crystallography, geophysics, biology, technical materials and photography in Section A, and articles of interest to electrical engineers in engineering, electrical engineering, electronics, telecommunication and technology in Section B. The journal is controlled by a management committee consisting of council members of the Institution of Electrical Engineers, the Physical Society, the Royal Society, the British Electrical Authority and an observer from the American Physical Society. The executive officers are the Secretary of the Institution and the Editor of *Science Abstracts*. Facilities and administration are provided by the Institution; but the financial responsibility is borne jointly by the Institution and the Physical Society. The circulation of Section A is very large, greater than 12,000. Until quite recently more than half the number of copies sold were purchased by the American Physical Society for distribution to its members automatically as a privilege of membership and without extra cost; every member of the Physical Society receives a copy; a copy for personal use may be purchased at a considerably reduced rate by members of the Institute of Physics and members of the Institution; and a large number of copies are sold to the general public, mainly libraries and organizations. Though Section B, with a circulation of 4,000, has not such a wide appeal as Section A, its circulation is still quite good. It could, however, be improved among physicists, for more than half the copies issued are distributed to members of the Institution and a large part of the remainder sold to libraries and organizations.

The price of *Science Abstracts* is remarkably low, and although it has had to be raised recently, the increase is by no means in proportion to the expansion in the journals which has taken place since 1945. For example, the 1951 volumes (*A* and *B*) contained 9,908 (1160 pages) and 4,650 (624 pages) abstracts respectively and indexes covering approximately 300 and 100 pages respectively, whereas in 1945 the corresponding figures were 3,148 (339 pages), 2,744 (292 pages) and indexes of approximately 60 and 50 pages respectively.

The corresponding increase in price, however, has been only about 50 per cent. Furthermore, the time-interval between the appearance of an article and the publication of the abstract in *Science Abstracts* has been reduced considerably. The speedy publication of the annual indexes is most important, and before the Second World War the annual indexes appeared regularly in February. For many years since, however, this was not possible and when, therefore, in 1950 the pre-war practice was resumed many people doubted whether it could be maintained. However, they were to receive a pleasant surprise, for the annual indexes for 1951 were distributed to subscribers in mid-January 1952, a feat of which the editor and his staff must feel justly proud.

It is difficult to review Vol. 54 of Sections A and B without making a few comments and suggestions, though admittedly these are of minor importance and are naturally the reviewer's own personal views. It is irritating to find only a supplement to the list of journals abstracted at the beginning of Vol. 54 and to have to refer to an earlier volume for the main list. Books, in addition to articles in scientific journals, are sometimes abstracted, but it is difficult to ascertain on what basis these books are selected, and in any event how does one abstract a book? The varied styles of the book abstracts reveal some of the difficulties the abstractors have had in this regard, whether to go to the one extreme of a review or the other extreme of a mere copy of the contents list. There are still too many abstracts in which the title of the article is repeated as the opening sentence, though this fault is more or less confined to author abstracts. The onus here is really on the editor of the journal in which the article abstracted appeared; but it perhaps would be a good thing if *Science Abstracts* were ruthless in revising such abstracts. Referees of scientific papers should be encouraged to comment on the abstracts as well as on the contents of the papers submitted to them.

The remarkably few misprints, the clear type and lay-out of the abstracts, the detailed author and subject indexes and the ease with which one can find one's way about the abstracts, in addition to the consistently high standard of the abstracts and arrangement, are praiseworthy features. The Universal Decimal Classification system of classification is excellent for arrangement, but it is doubtful whether the time and labour involved in printing the U.D.C. numbers is worth while. Complete coverage of all periodicals is, however desirable, obviously impracticable, and the close co-operation between the various abstracting journals to make use of each others' abstracts is to be encouraged. *Science Abstracts* now includes many abstracts prepared by other abstracting journals.

In accord with recommendations of the Royal Society the abstracts are "written concisely and in normal rather than abbreviated English", but abbreviations of words are used and in some cases these may not be familiar to the reader; for example, a physicist may not recognize that 'o.h.' stands for 'over-head'. So far as possible, abstracts should be easily read and should be self-explanatory, so that abbreviated words (except, of course, recognized units) should be avoided. There remains but one last comment and plea. If the editor of *Science Abstracts* sees fit to increase still further the number of abstracts a year in *Physics Abstracts*, he is asked to bear in mind that *Abstracts A* is now as large as can be conveniently bound in one volume and that if it were bound in two separate parts, though naturally more costly, it would be easier to handle, and the binding would not be so highly strained. S. WEINTROUB

SCIENTIFIC THOUGHT THROUGH THE AGES*

By Dr. NAZIR AHMAD
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THE rudiments of scientific thought must have started as soon as man began to think for himself. When he saw the natural phenomena with which he was surrounded, the rising and setting of the sun, the phases of the moon, the twinkling of the stars, the rain, the wind, the lightning, the change of the seasons, the growth of plants and crops, he must have begun to wonder about their causes; and that wonder was the starting point of the scientific thought in him—the seed from which the tree of knowledge was ultimately to grow. In the distant past, man tried to reproduce natural phenomena by imitating Nature. He conceived the idea that if he imitated any aspect of Nature, he would be able to reproduce it. For example, he associated the croaking of frogs with the oncoming of rains; and he concluded that, if he imitated the frogs, he might bring down rain on earth. There are numerous instances of such imitation on the part of early man with the object of reproducing natural phenomena, which have come down to us in the form of dances and rituals. This attempt on his part to reproduce natural phenomena by imitation led to what is now called 'imitative magic'. This form of magic, associated with what is known as 'contagious magic', was man's earliest attempt, in a crude way, to comprehend and explain some of the natural phenomena. However, whether it was 'imitative magic' or 'contagious magic', it was slowly transformed either into scientific thought, when an effort was made at a rational explanation, or into a religious belief, when natural phenomena were explained in terms of deities, gods and goddesses or a supreme being. According to one school of anthropologists, magical conceptions led to religious beliefs on one hand, and scientific thought on the other; while a second school of anthropologists holds the view that the transition was from magic to religion and from religion to science. Be that as it may, this intermingling of magical concepts and religious beliefs with scientific thought, which started right in the beginning, remained one of the dominant features for many centuries; and was, and perhaps still is, responsible for the slow victory of rational thought over superstition and out-moded belief.

Coming to the development of scientific thought, as we understand it to-day, we find its rudiments in the civilization of Babylon, where their mathematicians developed a mixture of the duodecimal and decimal systems—from the ten fingers and two hands; and, because the number 60 was the first common multiple of 10 and 12, it acquired a special significance, which it has managed to preserve even to the present time. It is from there, indeed, that we get divisions like 60 seconds to a minute, 60 minutes to an hour, 60 seconds to a minute in the measurement of an angle, etc. With this useful discovery of the rudiments of arithmetic, magical ideas got strangely inter-woven; this retarded the progress of scientific thought, especially when the Chaldean astrologers acquired the upper hand. Apart from this discovery, the Babylonians were the first to undertake the cultivation of cereals; this compelled them to devise some kind of a calendar, which is one of the earliest in the world. From their astronomica observations, they were able also to calculate the relative positions of the sun and the moon, and predict solar and lunar eclipses; but, instead of pushing forward the bright science of astronomy they turned aside into the dark regions of astrology and evolved a curious conglomeration of both.

From Babylon the scientific development passes on to Egypt, where we find the first use, on a large scale, of the wheel as a scientific tool. Great stride were made in the science of land measurement, because when the River Nile, which is the life-line of the Egyptian cultivators, was flooded, the fields and the farms got terribly mixed up; and the Egyptians found that the science of land measurement was necessary to enable them to know to whom a particular plot of land belonged. Apart from these advances, other great advances, for which the old Egyptians were responsible, were in the fields of physiology and surgery, which resulted from their art of mummification. They, for the first time, performed fairly complex surgical operations, and discovered certain physiological principles. Contemporary with the civilization of ancient Babylon and Egypt was the civilization of India, where memorable advance was made in the theory of numbers; in fact, where for the first time the numerals one to ten, as we know them, were used extensively, which later on were taken by Arabs from India and passed on to Europe, and hence they came to be known as Arabic numerals. In India, the science of medicine also made fair progress—especially under the influence of the Buddhistic teachings, which laid great emphasis upon love, fellow-feeling and sympathy. But the advancement of science and the progress of scientific thought in India were retarded by the conflict with such philosophical concepts as the transitoriness of earthly existence and the evanescence of life. The Indian philosophers were more concerned with the life hereafter, and they regarded life on this earth as *maya*, a shadow, a fleeting moment, which did not deserve serious consideration.

Such was the intellectual background of the civilizations of ancient Babylon, Egypt and India, until the blossoming of scientific thought, as we understand it, took place in Greece about the fifth century B.C. The ancient Greeks revealed themselves as amazing people with an unquenchable thirst for truth; and the freedom of thought witnessed among them had not been equalled anywhere before their time. Indeed, their freedom of thought was so unfettered that their great dramatists wrote satires and comedies on subjects which the common people venerated; and these were actually produced on the stage. This freedom of thought among the ancient Greeks was one of the motivating forces for their great scientific and philosophical advance. Pythagoras was the first philosopher who developed the abstract idea of numbers, which he probably took from the ancient Indians, as he was acquainted, to some extent, with their philosophy. He was also responsible for the concept of four primary elements hich constituted the basic materials for all the other ountless objects of this world; these four elements eing earth, water, air and fire. The Greeks were he first people who paid serious attention to the roblem of matter; and tried to find out whether he great variety of objects, which constitute the naterial world, could be explained in terms of a ingle element. They were not successful in this ynthesis because their efforts were more flights of magination than scientific theories based upon solid lata. However, in this process, a group of philoophers, known as Atomists, rose among them, who, y a wonderful insight, were the first people to express he idea that matter is ultimately made up of small articles, which they called 'atoms'. The philosopher rho gave the final touches to this hypothesis was emocritus, and his exposition has been handed own to us in a fine poem by Lucretius. However, he hypothesis was not supported by any experimental facts, as was the case with Dalton's hypothesis nany centuries later; and therefore, when it was ttacked by other philosophers, like Plato and ristotle, it could not withstand their criticism.

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* Substance of a public lecture given before the Fourth Pakistan Science Congress at Peshawar on March 17.

Nevertheless, the philosophical inquiries, which rere begun by the early Ionians, were pushed forward ntil we come to Socrates who, for the first time, egan to question openly and relentlessly beliefs and leas commonly held by his contemporaries. He did ot originate any system of philosophy; but he was he founder of what is called the Socratic system by rhich beliefs, notions and views commonly held by eople are analysed and cross-examined until one egins to see the fallacies underlying them, and thus he ground is prepared for building a more stable tructure. His work was carried a step forward by is great pupil, Plato, who, however, denied reality o individual objects, and put forward the view that bjects, as we see them, are unreal because they are ontinually changing; while reality lies in abstract types', of which the visible objects are mere shadows. Because of his emphasis on 'reality' in certain 'ideal' ypes, Plato's philosophy is sometimes known as Realism and sometimes as Idealism. This philosophy ctually proved a setback to the development of cientific thought, because it took man's attention rom nearby objects on earth, and riveted it upon bstract and ideal types, which existed only in magination.

Reaction against Plato's philosophy occurred soon n the teachings of his famous pupil Aristotle, who ut forward the idea of dual reality, according to rhich a certain measure of reality attached itself to he individual objects, though the thoughts and ideas rhich the human mind perceived from those objects rere also equally real. This dualism in reality, which ristotle postulated, helped to bring back men's ninds to the objects of this earth for scientific study; nd it persisted in the philosophical field, in one form r another, for centuries until it blossomed forth in he teachings of Immanuel Kant. However, Aristotle's reat achievements were not in the fields of physics, nathematics or astronomy, in which he held rather antastic notions, but rather in the fields of medicine nd deductive geometry, in which he made notable ontributions. His success in deductive geometry led im to found deductive logic, in which one argued rom general principles to particular cases. The eductive logic, which really represents half the icture, was, to Aristotle's mind, almost the complete ogic; and he applied it vigorously to the explanation f natural phenomena, with the result that he was responsible for several fallacies, which, under the weight of his authority, persisted for many centuries. He was also responsible for the rejection of the atomic theory, as propounded by the early Greek Atomists; and he went back to the ideas of the Pythagorean school that all matter is ultimately made from four primary elements. However, he went a step further, and instead of defining the so-called elements in terms of earth, air, water and fire, he defined them in terms of four primary qualities, namely, hot, cold, wet and dry. He developed the theory that these four cardinal qualities, in their various combinations in different quantities, were responsible for the numerous objects which we see around us. Some reaction against Aristotle's philosophy was set in motion by Epicurus, who taught that 'reality' is essentially sensation and sense-perception, and thus tried to turn man's attention to the study of objects as one became aware of them with one's senses; but unfortunately the finer aspects of his philosophy were submerged in a baser interpretation, and the theory failed to achieve its objective.

As against these great philosophers, who freely mixed scientific thought with philosophical notions and scientific observation with flights of fancy, we have the brilliant example of a true scientist—Archimedes—who did not begin with any preconceived philosophical notions, but approached Nature from the point of view of an experimental scientist. He was the founder of the science of mechanics, the discoverer of the principle of the lever, the designer of engines of war which kept a numerically superior army at bay; and in his various researches he showed the scientific spirit by going cautiously from step to step and proving the validity of every step he undertook. The ancient world holds few examples of such marvellous combination of the qualities of imagination, deduction and verification as shown by Archimedes, who fell under a Roman sword.

After Archimedes the study of science shifted mostly to the famous school of Alexandria, which contained well-organized sections devoted to the advancement of biology, physics, chemistry, mathematics, etc. But the greatest strides in this school were made in astronomy; and it was there that for the first time the old notions about the movements of the earth and the heavenly bodies were examined, and a working theory known as the Ptolemaic system, in which the earth was made the centre of the universe, was put before the world. In spite of its obvious drawbacks and complicated explanations, this theory held the field for several centuries for two reasons. In the first place, it made man and his abode the centre of the universe, which greatly pleased his vanity. Secondly, it was considered to be in accord with the teachings of the Scriptures, and in fact enjoyed the blessings of the Christian Church. We have here another example of the way in which a scientific theory can get mixed up with personal considerations and religious conceptions, and derive its strength not from scientific data but from the backing which an extraneous agency can give to it.

After the rise of the Roman Empire, the service of science naturally passed on to the Romans; but one has to confess that very little advance was made by them in the fundamental sciences. They were a practical people, and they concentrated on applied science, such as agriculture, engineering and irrigation, while neglecting in general the study of pure science. A notable exception, however, was the famous physician Galen, who, though of Greek origin, flourished in Roman times, and who made substantial contributions to the sciences of physiology and medicine.

The fall of the Roman Empire was followed by a long period of decline of learning in Europe, attributed generally to the hostility which the organized Church offered to the Greek learning handed down to the people. According to the teachings of the Church at that time, the ultimate 'reality' was spirit and the ultimate values were spiritual; and, therefore, any study which took away people's minds from spiritual values and the ultimate 'reality', namely, the spirit, was to be eschewed. As a result of this attitude, the so-called Dark Age descended upon Europe and lasted for nearly four hundred years. At this time the torch of learning was, however, grasped by the Arabs, and it was kept aloft by them, burning brightly. The first task of the Arabs, when they took over the service of science, was to re-discover the hidden treasures of Greek learning. They translated the books of Greek philosophers and scientists, Plato, Aristotle, Galen, Hippocrates and others, and wrote commentaries upon them. But that was not all. They went far beyond it. They made very considerable progress in almost all the different branches of science. In chemistry, led by the motive of discovering the elixir of life, they made great strides. Their knowledge of the human body and the functions of its various organs excelled the past, and they went far ahead of the Greeks in medicine. In mathematics, they founded a new branch known as algebra. In physics, especially in optics, they made very remarkable original contributions. They made accurate charts of the heavens, and navigated the seas as had never been done before. But in spite of these original contributions to different sciences, the underlying scientific thought remained largely Aristotelian. Deductive logic held the field, and the Arab scientists and philosophers had only a vague conception of the principles of inductive logic; so that, like the Greeks, they also argued from the general to the particular. They accepted many Grecian fallacies, and did not bother to perform experiments to verify them. In one essential respect, however, Arab thought differed fundamentally from the Greek point of view. The Greek conception of the universe was more static than dynamic; they were inclined to regard the universe as a complete entity in which no fundamental change was possible. Many of the Arab philosophers, on the other hand, took a dynamic view of the universe, which, according to them, was constantly undergoing change and development, even by a process of trial and error.

Among the many Arab philosophers who made a real contribution to scientific thought the name of Ibn-i-Rushd, known in Europe as Averroes, stands out prominently for a remarkable thesis on the relationship between religion and philosophy. He stated that religion was essentially a personal experience, which could not be demonstrated; while science, on the other hand, was knowledge the results of which could be demonstrated by one man to another. He further pointed out that theology was a mixture of religion and science, and as such a source of evil to both, because it corrupted religion with pseudo-science and imposed fallacious notions on science in the name of religion. It is a great pity that this profound lesson, which was taught by Ibn-i-Rushd nearly a thousand years ago, has not been fully appreciated by later thinkers, especially in Islamic countries, where the tendency to superimpose one branch of knowledge upon the other persists to the detriment of both. Another thinker who exercised a great influence on the development of scientific thought in the Muslim world was Ghazali, who was considered a master of learning in his time. He was originally a professor of philosophy in the Nizamia University, but when he saw the shortcomings of the Aristotelian deductive logic, he became disgusted with it; and without realizing that the Aristotelian logic, as inherited by the Arabs, was incomplete and, therefore, unable to explain all or even most of the phenomena, he turned his face away from it, and launched a vigorous attack upon philosophy and science in general. His forceful personality and wide learning carried great weight with his contemporaries; and his attack upon philosophy is regarded by some people as the beginning of the decline of philosophical and scientific studies in the Muslim world. In any event, the pendulum swung in the other direction, and in the thirteenth century the pursuit of learning and development of scientific thought passed again to the Western countries.

This revival of learning in Europe at this time took a curious shape. The hold of the Church on the people was still very strong, and full freedom of thought and expression was not permitted. But, as the writings of the Greek philosophers, especially of Aristotle, and the contributions of Arab philosophers were studied, it was found that they contained many ideas and notions which went against current thoughts and beliefs. As these contradictions between the two accepted authorities created intellectual conflicts, St. Thomas Aquinas tried to harmonize the religious concepts of the time with the postulates of Greek learning as handed down to Europe by the Arabs. This notable attempt at reconciliation of religious concepts with philosophical ideas, called Scholasticism, held the ground for more than two centuries. Such attempts are not peculiar to Europe; they have been made in other countries as well. In the history of Islam, similar attempts were first made by the M'otazalin in the early days of the Abbasid Caliphate, later by the Mutakallimin, still later by Ibn-i-Tameea and his disciples, and even in our own time it is being made by many people.

However, in Europe, there were a few thinkers who saw that this attempt at the synthesis of religious beliefs with scientific thought was not always successful. Notable among them was Roger Bacon, who was one of the first to realize the ineffectiveness of this approach. According to him the four great obstacles to learning were: (1) regard for authority; (2) force of habit; (3) prejudice; and (4) false conceit of knowledge. It is really remarkable that a man, who lived nearly seven hundred years ago, was able to put his finger precisely on the principal causes which can hold back the advance of learning in any age. Due to the writings of men like Roger Bacon and others who followed him, Scholasticism gradually declined in Europe, and gave birth to the Renaissance in the fifteenth century. A great deal has been written upon the revival of learning in Europe, in which science ultimately comes into its own, and parts company, on one hand, with philosophy and, on the other, with religion. But we must not forget that, apart from the intellectual activity, which was going on at that time, there were certain material factors which helped considerably the Renaissance ovement in Europe. These were, first, the use of per, originally invented in China, which made arning more accessible to the masses. Secondly, ere occurred at that time the invention of printing, ducing greatly the laborious art of writing books hand, which could thus reach thousands instead hundreds of people. Perhaps even more important an these two factors was the development of the ience of navigation, in which the Arabs had made eat progress and which was learnt from them first the Portuguese and the Spaniards, who happened come in greater contact with them. The development of navigation opened up new lands to European tions, which not only stimulated their imagination it also increased their power and material prosrity. The judicious investment of surpluses enabled em to make still larger profits, and the wealth thus rned gave a tremendous impetus to the expansion trade and industry.

As a result of the intellectual activity of men like oger Bacon, assisted by the impact of physical rces like the invention of printing, and the accelered means of communication and contact, Europe oduced a number of thinkers who can be regarded the precursors of modern scientific thought. One the first great figures among them is Leonardo Vinci, who although not responsible for any great ientific discovery himself was yet able to demolish large number of fallacies by approaching each bject with an open mind. His approach to any fficult subject was generally from the practical side. hen he formulated a theory, he first tried to test it making models. He made models of tanks, aeroanes, and even submarines. These, of course, were workable, because his knowledge of detail was sufficient; but they go to show his eminently actical approach, so essential to scientific progress. e then have Copernicus, who studied the planetary otions carefully, and found that the geocentric eory of Ptolemy was not able to explain these otions so easily and elegantly as the heliocentric eory. This discovery was a great blow not only to cient learning, but also to the attempts made to haronize scientific thought with religious beliefs. About e same time came Harvey, who discovered the rculation of the blood, and, thereby, upset another eat fallacy—the fallacy of 'humours'—which had evailed among men of science since the time of the reeks. The same period saw Gilbert, the father of agnetism, who by his researches helped the further evelopment of navigation, and who gave us new eas regarding terrestrial magnetism.

Along with these experimental scientists, who went demolishing one fallacy after another with their iscoveries, we have Francis Bacon, who formulated early the principles of inductive logic. In his ritings he stated that the task of a philosopher is e collection of facts, the formation of a hypothesis, d the verification of the hypothesis by further perimentation and observation. For the first time e principles of inductive logic were clearly stated; nd as if to show that the hour was ripe, great ientists like Kepler, Galileo and Newton appeared the scene, and made noteworthy advances in the fferent sciences by the practical application of these rinciples. Kepler took Tycho Brahe's carefully llected data and deduced three famous laws of lanetary motion, thus exemplifying the first two rinciples laid down by Francis Bacon. Galileo was living example of the inductive method personified one man. He approached his manifold problems with a perfectly open mind. He would start by collecting as many facts as possible, often making wonderful improvizations, such as using his pulse for recording the movements of a pendulum. When sufficient data had been collected, he would draw a hypothesis from them, but he would not be satisfied with it. He would go a step further, and draw conclusions from his hypothesis which he would test by further experiments. If the conclusions were not confirmed by the results of his experiments, he would abandon the hypothesis and start afresh. His greatest contributions were in the fields of dynamics and astronomy, though he left his mark on other sciences as well.

The year of Galileo's death coincided with the birth of the greatest scientist of the seventeenth century Newton. His contributions in the fields of astronomy, optics, mathematics, mechanics, etc., are so many that it is not possible even to summarize them here. His discovery of the law of gravitation alone, which seemed to apply from the macroscopic to the microscopic, was monumental. The discovery of the differential calculus placed a powerful weapon in the hands of the mathematicians. The mechanics, which came to be known by his name, became the framework in which all new discoveries for the next two centuries fitted so well, and in which no chinks were observed until the theories of quanta and relativity made their appearance on the scene. More important than all, Newton's work and the discoveries of his successors helped to give science a philosophy of its own in the succeeding centuries.

The eighteenth century saw discoveries in practically all the branches of science. They helped to upset many old fallacies that had persisted up to the time, and they laid the foundations for the great scientific theories which were to follow. In mathematics, Laplace took Newton's work further and also attempted a theory of the cosmos. In chemistry, the outstanding work of Lavoisier ended the false concept of 'phlogiston', and thus laid the foundations of the modern theory of heat. Another fallacy of the old times, namely, that water was one of the four elements, was thrown overboard by the work of Cavendish, who showed that it could be split up into gaseous elements, namely, oxygen and hydrogen. There were, similarly, advances and discoveries in the fields of botany, zoology and physiology, too numerous to relate, but all of which helped to give a clearer and truer picture of Nature to man. As a result of the success with which Newtonian mechanics was able to explain numerous phenomena of Nature which were apparently not connected with one another, and as a consequence of the great discoveries which were made one after the other in the different branches of science, the belief grew stronger that the universe was governed by fixed laws; that it was possible to discover these laws with the help of science; and that ultimately science would be able to explain all natural phenomena including man himself. This belief in the rigid working of the laws of cause and effect, which could be discovered by scientific research, gave birth to the school of thought known as determinism or materialism. However, while the scientific discoveries in the eighteenth century were giving enormous confidence to scientists in the efficacy of the scientific method in explaining natural phenomena, the philosophers were not idle, and they attempted to show the shortcomings of this particular line of approach. Locke emphasized the necessity for continual adaptation to varying needs and requirements of the time; and, thereby, inculcated a healthy scepticism against any fixed outlook. Berkeley reacted strongly to the materialistic view held by some of the scientists, and denied reality to matter. Hume went one step further and denied reality even to mind. Immanuel Kant, however, took a middle course, and attempted a synthesis of scientific discoveries with philosophical concepts in which, while admitting the necessity of the study of Nature by observation and experiment, he tried to show the limitations of the knowledge gained in this fashion.

The cautious or even negative approach of philosophers like Kant, Berkeley and Hume, however, could not stem the great tide of scientific discoveries, which continued with ever-increasing force and widening scope in the nineteenth century, which may be called the 'scientific age'. Since reliable experiments could not be performed without exact units of measurements, a great deal of work of fundamental importance was done on the primary units of length, mass and time, and the secondary units derived from them. Dalton tackled the problem of the ultimate constitution of matter, and, reviving the work of the ancient Greek Atomists, built up the ground floor of the modern atomic theory in which subsequent advances in chemistry were made. A great deal of work was done on the imponderable fluids, namely, the ether, electricity and heat, and the phenomena connected with them. Young, Fresnel and Huygens revived and developed the wave theory of light, which had been suppressed by Newton's opposition and which postulated the existence of an all-pervading ether. Faraday took up the study of electricity and magnetism, and not only brought about revolutionary changes in our concepts, but also made possible the tremendous advances in electromagnetism which took place after his time. Clerk Maxwell developed the electro-magnetic theory of light, which bridged the gulf between electricity and light, and thus acted as a brilliant pointer to the ultimate oneness of scientific knowledge. Joule, by his researches on the relationship between heat and work, laid the foundations of the modern theory of thermodynamics, which was taken many stages further by Carnot. These discoveries in the experimental and theoretical fields no doubt produced deep changes in the scientific outlook, and confirmed the earlier confidence of the eighteenth century in the ability of science to explain all natural phenomena. None of them, however, produced such revolutionary currents of thought as Darwin's theory of evolution, which by its nature and implications came into conflict with the current theological ideas on such fundamental questions as free-will and moral behaviour.

The relationship between science and philosophy has been undergoing a remarkable change. In the beginning, as a legacy of the Scholastic School, philosophy dominated science. The philosophers, with their training for the search of 'reality' and with their ability for analysis of material phenomena and mental processes, took the leading place. They attempted to synthesize scientific discoveries into complete systems. Later on, however, science and philosophy parted company. The separation became pronounced after Hegel, who under-rated the role of experiment and taught that 'reality' could be achieved by abstract thought. Science could not accept this position without sacrificing some of its great principles and discoveries. Still later, science attempted to develop a philosophy of its own, the first attempt of the kind being made by Ernest Mach. The attem on the part of science to have its own philosophy h been stimulated greatly by discoveries in the field biology. So far a great majority of the revolutiona discoveries had been in the field of physics, chemistr astronomy and mathematics, which did not seem have a deep impact on life or on man's concept himself. But Mendel's laws of inheritance, t statistical study of heredity, and the biophysical a biochemical discoveries which took place in t nineteenth and twentieth centuries had a profou effect on scientific thought. The construction of lar telescopes, which took man's vision into the dista reaches of the skies, and the manufacture of micr scopes, which gave him an insight into the constit tion and function of the micro-organisms borderi on the molecules, gave further support to science developing its own philosophy. All these discoveri strengthened belief in the ability of science to sol ultimately the mystery of matter, energy and li with analytical methods based upon Newtonis mechanics.

When we come to the twentieth century, howeve the picture begins to assume a somewhat differe shape; and the tremendous confidence of the nin teenth century is assailed by many doubts a uncertainties. We have first the discovery of t quanta and the development of the quantum theor which represents a break with Newtonian mechanic We then have the discovery of the electron, t behaviour of which could not be explained on t classical lines. Then came the development of t theory of relativity, which rejected the concepts absolute time and space. The hard indivisible ato was found to be a small world, with electro revolving around a nucleus, while quantum mechanic and not the classical mechanics, was able to expla the phenomena of radiation emitted by atoms in t excited state. Even so, the explanation, if it can called one, was partial; for an element of uncertaint seemed to be inevitable, and became greater t more we probed into the innermost nature of matte The epoch-making discoveries of J. J. Thomso Rutherford, Röntgen, Curie and Becquerel, and t theories of Planck, Einstein, Niels Bohr, Schrödinge and others, while enlarging our vista a hundred-fol unfolded a thousand new problems. Radiatio presented a double-faced appearance. In certa respects it behaved like continually expanding waves in others like discrete particles of energy which ke their entity regardless of time and distance. Ultim ately, in the hands of Heisenberg, even materi particles remained no more than wave systems. Now all these discoveries of the twentieth century whic deny the existence of absolute time and space, whic inform us that we can either determine the motio of an electron or its position but not both, which te us that change is not always continuous but ofte takes place by fits and starts, which state that w know what happens when an electron jumps fro one orbit to another, but we do not know wha happens to it in the meantime, which advise us tha matter and energy are interchangeable and that bot can be represented by wave-systems—these hav re-orientated our attitude towards that determinis which characterized the eighteenth and nineteent centuries. Some scientists are now not so sure tha scientific method alone can solve all the mysteries c life, or can be successful in giving us a perception o the 'reality'. But, notwithstanding these misgivings we may say in the words of Sir William Dampie at, “in spite of ignorance, folly and passion, the ientific method has won field after field since the ys of Galileo. From Mechanics it passed on to hysics, from Physics via Chemistry to Biology, from iology to Psychology, where it is slowly adapting self to unfamiliar ground. There seems no limit research, for as has been well and truly said, e more the sphere of knowledge grows, the rger becomes the surface of contact with the nknown”.

This brief survey has revealed three salient features. the first place, the spirit of inquiry, which is ssential for scientific advance, is latent in the human ind. This spirit of inquiry has made its appearance different times, in different lands and among ifferent peoples. Secondly, this seed will not grow, is spirit will not blossom, in an atmosphere of ppression, inhibitions and restrictions. It must ave freedom—freedom to think, freedom to speak, eedom to discuss, freedom to exchange ideas with thers. If restrictions are imposed upon it, if it is ttered with chains, which may be those of authority, perstition, habit or prejudice, the spirit of inquiry ill remain dormant, and ultimately it may even be xtinguished. In order that the spirit of inquiry implanted in our souls may blossom fully and flourish, freedom of thought, freedom of speech and freedom of expression are essential. Science can recognize only its own ideology. If attempts are made to impose any other ideology upon it, it can only be to the detriment of scientific advance and progress. The third salient feature which should be apparent from this historical survey is that all attempts to formulate a comprehensive system, aimed at explaining everything, have failed in the past when human knowledge was not so vast. Now that the bounds of knowledge have been vastly extended, such attempts, if made now or in the future, are bound to be even bigger failures. Those who claim to offer comprehensive systems, complete in themselves, as explanations for everything there is to be explained, are ignorant of the nature and extent of our knowledge; and unless they are themselves mistaken, they are attempting to mislead others. Although all knowledge is fundamentally interlinked, progress is possible by making advances on its different sectors. This progress, though it may not be spectacular, is sure and certain. Only thus may we look forward to the gradual lifting of the mists which hide ‘reality’ from our vision.

NEWS and VIEWS

ew York Zoological Society

A NUMBER of changes in the staff of the New York oological Park have been recently announced by he New York Zoological Society. The title of director f the Zoological Park, vacant for a number of years, as been revived by the appointment to that position f Mr. John Tee-Van, executive secretary of the Zoo nd Aquarium since 1942. Mr. Tee-Van, who has een connected with the Zoological Society for forty-ne years, started work as an assistant keeper in the ird Department in 1911, at the age of fourteen, and ve years later became an assistant in the new epartment of Tropical Research, working with Dr. illiam Beebe in research stations in the West Indies, ritish Guiana, Venezuela, the Galapagos Islands, he Sargasso Sea, Haiti, Bermuda and off the coasts f Lower California, Mexico, Central America and olombia. His scientific work has been done chiefly n ichthyology, a field in which he has published many apers, and he is a vice-president of the American ociety of Ichthyologists and Herpetologists. Since 940 Mr. Tee-Van has been editor-in-chief for a series f books on “Fishes of the Western North Atlantic”. e is a fellow and recording secretary of the New ork Academy of Sciences, a member of the Boone nd Crockett Club and president of the Explorers lub.

Other changes are as follows. Dr. Leonard J. Goss, eterinarian since 1939, has been made assistant irector of the Zoological Park and will continue as eterinarian. Mr. Lee S. Crandall, general curator ince 1943, is retiring from active administration of he mammal and bird collections, although he will ontinue to maintain an office at the Park and will e engaged in the preparation of books on the care, eeding, maintenance and exhibition of wild animals n captivity, based on his experience of forty-four ears with the collections of the Bronx Zoo. Mr. obert M. McClung, who has been assistant curator of mammals and birds under Mr. Crandall since 1949, has been appointed acting curator of the department. Mr. McClung is a graduate of Princeton and Cornell Universities and is the author of several animal books for children. Dr. William Beebe, who is retiring with the title of director emeritus of the Department of Tropical Research, is the only member of the staff of the Zoological Park who was connected with it before the actual opening of the Zoo in 1899. He was curator of birds during 1899–1920 and since then has been director of a separate Department of Tropical Research, under which field-stations have been maintained in many parts of the American tropics, and oceanographic work in both the Atlantic and the Pacific has been undertaken. One of Dr. Beebe's best-known exploits was the descent in the bathysphere to the record depth of 3,028 ft. off Bermuda on August 15, 1934. Dr. Beebe expects to go to Trinidad later this year and to resume research in the ecology of the Arima Valley, on which he has been engaged for the past two years. Miss Jocelyn Crane, a member of the staff of the Department of Tropical Research since 1930 and research zoologist since 1942, has been made assistant director of the Department. Miss Crane, who is a graduate of Smith College, is at present engaged in a study of the biology and behaviour of various invertebrates and sense perception in insects.

Jacobus Henricus van't Hoff (1852–1911)

ONE of the founders of modern physical chemistry, whose work also profoundly influenced physiology, biology, geology and mineralogy, Jacobus Henricus van't Hoff was born at Rotterdam a century ago, on August 30, 1852. Educated at Delft, Leyden, Bonn and Paris, he obtained his doctorate at the University of Utrecht in 1874, after having already published a pamphlet which laid the foundations of stereochemistry. An amplified version in French, “La chimie dans l'espace”, appeared in 1875. Van't Hoff showed that optical activity and the existence of two optically active isomers, differing merely in the sign of their rotations, occurred only when an asymmetric carbon atom was present. A short period as *Dozent* in physics at the Utrecht State Veterinary School was followed by a move to Amsterdam, where at the age of twenty-six he became professor of chemistry, mineralogy and geology at the newly created University. In his classic "Études de dynamique chimique" (1884) he successfully applied the laws of thermodynamics to the problems of chemical equilibrium and affinity, and two years later he evolved his famous theory of solutions, which helped to develop the theory of electrolytic dissociation and modern electrochemistry. In 1896 he accepted a research professorship in chemistry at the Royal Prussian Academy of Sciences in Berlin. Among his many-sided investigations his study of oceanic salt deposits inaugurated a new era in experimental mineralogy. His numerous honours included the Nobel Prize for Chemistry (1901), the foreign membership of the Royal Society (1897) and the German order *Pour le mérite*. Van't Hoff was a simple, friendly person, the last years of whose life were clouded with illness, necessitating periods of rest in sanatoria. He died at Steglitz on March 1, 1911.

Pharmaceutical Society : Research and other Awards

THE Pharmaceutical Society has awarded its research scholarship of £300 a year for two years to L. E. Coles, who will be engaged in the School of Pharmacy, University of London, in completing work on the synthetic analogues of the adrenal cortical hormones. Wellcome Pharmaceutical Research Fellowships, each of £350 a year, have been awarded to J. Thomas, for work in the Department of Pharmacy, University of Manchester, on the chemical synthesis of biological activity, particularly bactericidal action, of a new series of quaternary ammonium compounds, and to G. L. Willey, for research at the University of Leeds on the possibility of selectivity of action of nicotine-like stimulant compounds. The Society also made the following awards : Jacob Bell Memorial Scholarship (£150 with £5 worth of books), to T. M. French, of Northampton ; Manchester Pharmaceutical Association Scholarship (£45), to R. A. Alcock, of Ormskirk ; and the Devon and Cornwall Exhibition in Pharmacy (£25), to A. James, of Tiverton.

Courtauld's Scientific and Educational Trust Fund : Awards

THE trustees of the Courtaulds' Scientific and Educational Trust Fund have announced the award for 1952 of the following postgraduate research scholarships in a branch of science related to the textile, plastics and allied industries, which are worth £375 (except where otherwise stated) and are tenable for one year at the institute shown : D. W. Bannister and P. T. Speakman, University of Oxford ; H. W. W. Brett, University of Adelaide ; C. S. Chadwick, Manchester College of Technology ; E. S. Hill, University of Liverpool ; J. W. Ladbury, Imperial College of Science and Technology, London ; D. C. Blackley (renewal of 1951 award), C. J. Pearce, B. D. Stead and C. N. Turton, University of Birmingham ; J. Russell (renewal of 1951 award), Bradford Technical College ; J. Saunders (£93 15*s*., renewal of 1951 award for autumn term only), University of Bristol ; A. E. Somerfield (renewal of 1951 award), Trinity College, Dublin. Postgraduate researc scholarships in textile technology, worth £300 a yea for two years, have been awarded as follows : I Attle and S. L. Fitton, Manchester College o Technology ; C. S. Bruce, D. Hardisty, Miss I Harris and J. A. Leathley, University of Leeds.

Common Names of British Insect Pests

IN 1944 the Conference of Advisory Entomologist and the Pests and Diseases Committee of the Associ tion of Applied Biologists set up a joint sub-committe to prepare a list of common names of the insect an related pests of garden plants, domestic animal stored products and timber as they occur in Britai The first part, dealing with slugs and snails, eelworm beetles, hymenopterous insects and flies, was pul lished in 1947. The second part, dealing with lic thrips, plant bugs, aphids, and scale insect Lepidoptera, fleas, mites and ticks, has recentl appeared. Both parts consist of alphabetical lists o the accepted British common names (often with th American equivalents) and the corresponding scientifi names ; and alphabetical lists of the scientific name (under genera) and the recommended common name These lists will be of great value to all applie entomologists in Great Britain in enabling them t secure some degree of uniformity in the names o their pests. Not all the names will have equall ready acceptance by everyone. It is interesting t find the editor admitting quite frankly that "by th very nature of the International Rules governin Zoological Nomenclature the scientific names mus constantly be subject to revision". It is intended t publish revised lists from time to time. Copies o the list can be obtained from Miss Barbara M. Stokes Entomology Department, Rothamsted Experimenta Station, Harpenden, Herts (Part 1, 2*s*. ; Part 2, 3*s*.)

Scientific Papers Published in the Middle East

LIST No. 6 (December 1950) of "Scientific Paper published in the Middle East", issued by the Unesc Middle East Science Co-operation Office, Cairo, cover papers published in Cyprus, Egypt, Iran, Iraq, Israel Lebanon, Pakistan, Sudan, Syria and Turkey, an received by the Office between March 1 and Novembe 1, 1950. Publications from Pakistan are included fo the first time, and the issue includes more tha thirteen hundred titles, arranged under the Universa Decimal Classification. There is also a list of period icals included, arranged by country of origin, and list of abbreviations used. Roughly two-fifths of th entries fall under the medical sciences, one fifth i engineering and various industries, and one fifth i agriculture, forestry or stockbreeding. An autho index covering the first six lists published by th Office at Cairo (pp. 27) has also been issued. Wit regard to Arabic names, only the last (according t Egyptian usage) has been retained as surname, and whenever possible, only one spelling has been selecte in the transliteration of Arabic sounds.

British Interplanetary Society

THE annual report of the British Interplanetar Society for 1951 (pp. 18 ; from the Society, 15 Friary Road, London, S.E.15 ; 1951) shows remarkable enthusiasm among its fellows an members, and also a keen public interest, judgin from the number of lectures delivered during the 1950–51 session. Although the Society has bee in existence for only six years, it appears that it expansion has been such that a full-time clerica orker is necessary. Membership is open to all, no chnical or other qualification being required, and w numbers about fifteen hundred—a remarkable hievement in six years. Fellowship is restricted o those who possess some relevant scientific, technical or professional qualifications", and its requireents are specified under seven categories which ngo from a degree, from a recognized university, mathematics, engineering or medicine, to "conderable contributions to the development of tronautics". A recent issue of the *Journal* of the ciety (11, No. 1, January 1952) contains a number articles, including one by Oscar Schachter with the tle. "Legal Aspects of Space Travel". It is suggested that there will be a demand that the use of ter space for military purposes should be outlawed, d Mr. Schachter seriously states that it does not em to be too early for governments to give conderation to this aspect of the problem.

useum of Applied Science of Victoria : Annual Report for 1950–51

THE annual report for 1950-51 of the Museum of pplied Science, Victoria (pp. 13 ; from the Museum, elbourne, 1952), includes some interesting remarks ncerning policy. When the Museum was estabhed in 1870, its main functions were twofold, to ve guidance to artisans and to accumulate a comete record of technological achievement in the form exhibits. The former function has long since ssed to organized technical education, and to some tent the latter has collapsed under its own weight. he past half-century has been one of unparalleled ientific achievement, with the consequence that ience museums of moderate means have experienced fficulties in keeping abreast with modern knowledge. ut the Museum staff are viewing their responsilities in a new perspective and now tend to conntrate their attention on the presentation not of an ncritical accumulation of scientific material, but on lected facets that give the layman an understanding the impact of science on society, preserving a reful balance between the historical and the modern, d exploiting new ideas of display.

ritish Internal Combustion Engine Research Association : Elections

AT the recent annual general meeting of the British nternal Combustion Engine Research Association, e following elections were made : *President*, Visunt Falmouth ; *Vice-Presidents*, Air Commodore . R. Banks, Dr. S. F. Dorey (chief engineer surveyor, loyd's Register of Shipping), Sir Lynden Macassey ndependent chairman of the British Internal Comustion Engine Manufacturers' Association), Vicedmiral (E) the Hon. Sir Denis Maxwell (engineer-iniief of the Fleet), Major-General H. E. Pyman lirector-general, Fighting Vehicles Division, Ministry Supply) and Lieutenant-General Sir Frederick Wrisrg. At the same meeting, a new and smaller reprentative Council was elected as follows : Mr. H. N. G. llen (*chairman*), Mr. Miles Beevor, Mr. G. W. Bone, r. F. A. Perkins, Mr. C. G. Tangye and Mr. A. C. eates, with Mr. C. A. Spencer as the representative the Department of Scientific and Industrial esearch.

nternational Geographical Congress

THE Seventeenth International Geographical Coness, held at Washington, D.C., during August 7–15, tracted a record number of nearly 1,500 registrations, of whom 1,200 were actually present. More than five hundred delegates came from the forty-one countries adhering to the International Geographical Union. At the concluding General Assembly, Prof. L. Dudley Stamp (Great Britain) was installed as president in succession to Prof. G. B. Cressey (United States), who becomes vice-president, and Mr. G. H. T. Kimble (American Geographical Society of New York) was re-elected secretary-treasurer. The remaining six vice-presidents to be elected were His Excellency Dr. Hans W:son Ahlman (Sweden), Prof. Hans Boesch (Switzerland), Prof. George Kuriyan (India), Prof. Orlando Ribiero (Portugal), Prof. Max Sorre (France) and Prof. H. O'R. Sternberg (Brazil). By a large majority the Assembly accepted the invitation of Brazil to hold the eighteenth Congress in Rio de Janeiro in 1956. Prior to the Washington meeting, many of the delegates had participated in the centenary celebrations of the American Geographical Society, at which J. M. Wordie, president of the Royal Geographical Society, received the Daly Gold Medal.

Chemistry of Cement : Symposium in London

THE Cement and Concrete Association, in conjunction with the Building Research Station, is organizing an international symposium on the chemistry of cement, to be held in the Royal Institution, Albemarle Street, London, W.1, on September 15, and in the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, during September 16–19. The symposium will be under the presidency of Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, with Sir Francis Meynell, director of the Cement and Concrete Association, as vice-president. The five sessions, to be held on successive days, will be devoted respectively to the following topics : introductory addresses (followed by two papers and discussion) ; the constitution of Portland cement ; the setting and hardening of Portland cement ; special cements ; and applications of research. The sessions will be mainly devoted to the reading of papers and subsequent discussion. A number of excursions have been arranged (with one on September 14 and several on September 20) and these include visits to the Building Research Station and to the Research Station of the Cement and Concrete Association. Attendance at the symposium is by invitation only. Further information can be obtained from the organizing secretary, Philip Gooding, Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

French Metallurgical Society : Autumn Meeting in Paris

THE Société Française de Métallurgie will hold its 'Journées Métallurgiques d'Automne' during October 20–25 at the Maison de la Chimie, 28 bis rue St. Dominique, Paris 7^e. The two main subjects to be discussed will be : faults and fractures observed in metals during service ; and methods of effecting economies in metals in short supply, including the rational use of alloys and the substitution of different varieties or qualities of alloys or methods of fabrication to ensure the best possible use of scarce elements. A few communications on other subjects of particular interest will be allowed at some of the sessions. The programme will include communications by metallurgists from many European countries and from the

United States. A number of visits, including one to the new laboratories of the Institut de Recherches de la Sidérurgie, at Saint-Germain-en-Laye, will also be arranged. Other visits and a banquet will be held during the week. Those desirous of attending the meeting should write to the secretary of the Society at 25 rue de Clichy, Paris 9e, from whom all further information can be obtained.

Colonial Service : Recent Appointments

THE following appointments have recently been made in the Colonial Service: D. R. N. Brown (agricultural officer, Uganda) and D. F. Stewart (senior agricultural officer, Uganda), assistant directors of agriculture (field), Uganda; J. C. K. Marshall and F. S. Walker (senior assistant conservators of forests, Federation of Malaya), conservators of forests, Federation of Malaya; W. H. Reeve (chief geologist, Northern Rhodesia), director of the Geological Survey, Northern Rhodesia; Dr. J. A. Simpson (biochemist, Federation of Malaya), chief biochemist, Federation of Malaya; R. A. Robinson, plant pathologist, Kenya; R. J. Isaacs, livestock officer, Nyasaland; I. A. D. MacKenzie, assistant conservator of forests, Nigeria; J. G. McGregor and B. Woodacre, assistant meteorologists, West African Meteorological Service, Nigeria.

The Night Sky in September

FULL moon occurs on Sept. 4d. 03h. 19m., U.T., and new moon on Sept. 19d. 07h. 22m. The following conjunctions with the moon take place: Sept. 9d. 03h., Jupiter 7° S.; Sept. 21d. 02h., Saturn 7° N.; Sept. 21d. 14h., Venus 6° N.; Sept. 25d. 18h., Mars 3° N. In addition to these conjunctions with the moon, Venus is in conjunction with Saturn on Sept. 15d. 23h., Venus being 1·6° S. Mercury is a morning star, rising at 3h. 55m. and 4h. 50m. at the beginning and middle of the month, respectively, in the latter case about fifty minutes before sunrise, and after this it becomes more difficult to observe. On Sept. 6d. 20h. it is in conjunction with Regulus, Mercury being 0·9° N. Venus, an evening star, sets at 19h. 20m., 18h. 55m. and 18h. 25m. on September 1, 15 and 30, respectively. Its stellar magnitude is − 3·3, and more than 90 per cent of its illuminated disk is visible. Mars, an evening star, sets at 21h. 10m., 20h. 45m. and 20h. 25m. at the beginning, middle and end of the month, respectively, its stellar magnitude varying from 0·4 to 0·6. At the beginning of September the planet is a little south of β Scorpii, and about a week later it is north of Antares, magnitude 1, with which it could be confused owing to its ruddy colour; but Mars is a little brighter than the star. Jupiter is visible throughout the night, its times of rising being 21h. 05m., 20h. 10m. and 19h. 10m. on September 1, 15 and 30, respectively, stellar magnitude − 2·2. Saturn, an evening star, is too close to the sun for favourable observation, setting less than an hour after the sun during the greater portion of the month. No occultations of stars worth observing occur at Greenwich during September. Vernal equinox occurs on Sept. 23d. 02h.

Announcements

PROF. F. BLAKEMORE, professor of veterinary medicine in the University of Bristol, has been appointed a member of the Agricultural Improvement Council for England and Wales in succession to Sir Thomas Dalling, who is taking up a post in the United Nations Food and Agriculture Organization.

DR. G. P. CONTRACTOR, acting director of tl National Metallurgical Laboratory, Tatanagar, Indi has been appointed to the additional post of ex-offic director of inspection (metallurgy), Tatanagar, in th Directorate General of Supplies and Disposals, of tl Ministry of Works, Housing and Supply, India.

THE Alvarenga Prize for 1952 of the College Physicians of Philadelphia has been awarded to D Norbert Wiener, professor of mathematics in th Massachusetts Institute of Technology, for his co tribution to the field of cybernetics. The Prize is a annual award and was established in 1883 by th will of Pedro Francisco DaCosta Alvarenga, of Lisbo Portugal, an associate fellow of the College.

THE annual exhibition of the Amateur Entom logists' Society will be held at Buckingham Ga Central Schools, Wilfred Street, London, S.W.1, o September 27, starting at 2 p.m. The Society we comes anyone interested in entomology. Furth particulars can be obtained from K. H. Bobe, 1 Hengist Avenue, London, S.E.12.

THE fourth exhibition and symposium of th Electrical and Electronics Section of the Scientifi Instrument Manufacturers' Association will be hel in the Examination Hall, 8–11 Queen Squar London, W.C.1, during September 2–5. Furthe information can be obtained from the secretar A. G. Peacock, Scientific Instrument Manufacturer Association, 20 Queen Anne Street, London, W.1.

THE firm of W. Watson and Sons, Ltd., is holdin an exhibition on "The Microscope in Industry an Research" in the Lecture Room of the New Horti cultural Hall, Westminster, London, S.W.1, durin September 15–19 (September 15, 2–6 p.m.; Septem ber 16–18, 10 a.m.–6 p.m.; and September 19 10 a.m.–4 p.m.). A brochure referring to the exhibitio can be obtained from W. Watson and Sons, Ltd. 313 High Holborn, London, W.C.1.

THE Third International Congress on Astronautic will be held in Stuttgart during September 1–6 Further information can be obtained from th Gesellschaft für Weltraumforschung, Greutterstrass 18, Stuttgart-Weilimdorf.

A SYMPOSIUM on "The Applications of Photograph to Research at the University" will be held by th Scientific and Technical Group of the Royal Photographic Society on October 4 in the Zoology Department, Downing Street, Cambridge. The wide variety of uses made of photographic techniques in th research work carried out in the University of Cambridge will be considered, including the topics o high-speed photography, electron microscopy, colou photography and flash cinematography. Brief paper will be read, with time for discussion after each Further details can be obtained from the honorar secretary, Mr. D. H. O. John, c/o May and Baker Ltd., Dagenham, Essex.

IN the obituary appreciation of Prof. H. Kramer published in *Nature* of July 19, we inserted th description "professor of theoretical physics in the Technical University of Delft". Prof. L. Rosenfeld writes: "from 1936 until his death, Kramers's main position was that of professor of theoretical physics in the University of Leyden. It is true that he also held concurrently a so-called 'special professorship' at the Technical University of Delft, but this was a secondary position, involving only very slight duties."

MEDIUM-ENERGY NUCLEAR PHYSICS

CONFERENCE IN PITTSBURGH

THE University of Pittsburgh sponsored a conference on medium-energy nuclear physics which et in Pittsburgh during June 5–7. There were five essions at which invited papers were given, followed y informal discussion. The first paper was that by . Scharff-Goldhaber (Brookhaven National Labor- tory) under the title "Excited States of Even–Even uclei", in which she discussed the energy-level parations and the spins of the excited states of these iclei. Regularities in these quantities are found hen the nucleus is thought of in terms of the shell odel, where most nuclear properties are ascribed to e nucleons outside the 'closed shells'. An instructive odel showing the excitation energy of the first xcited states of nuclei, based on the General Electric otope chart, was also shown. This paper was llowed by one by R. F. Christy (California Institute Technology) with the title "Selection Rules and oupling Rules in Light Nuclear Reactions". Dr. hristy proposed that there may be parameters scriptive of nuclei which are almost good quantum umbers for light nuclear reactions. Among these are e isotopic spin T and the partition numbers (p, p', ") of Wigner. Finally, he mentioned certain reactions hich are consistent with Russell–Saunders coupling n nuclei and not with j–j coupling.

At the second session of the conference papers were ead by M. E. Rose (Oak Ridge National Labor- tory), S. Ridgway (Princeton University) and S. T. utler (Cornell University). Dr. Rose, speaking on e "Angular Correlation of Nuclear Radiations", id that he was particularly interested in the effect n angular correlations of external perturbations cting on the nucleus. These lead to quenching of he angular correlation. He also described the rinciples which enable one to deduce the value of he magnetic moment of a nucleus in the state etween the emission of two successive gamma-rays. r. Ridgway reported on studies of the angular orrelation between beta-rays and subsequent gamma-ays. This correlation has been investigated eoretically and depends on the Coulomb correction ctor in the spectrum. Experiments have been done n several nuclei, including arsenic-76 and antimony-24. The third speaker, Dr. Butler, outlined the hysical principles underlying his calculations of the ngular distributions resulting from stripping re-ctions. A stripping reaction is one in which a euteron is incident on a nucleus, the nucleus bsorbing either the proton or the neutron from the euteron and making a direct transition to its final tate, the other constituent of the deuteron going ast. The energy and angular distribution of the nabsorbed particle give information about the state f the absorbed particle in the final nucleus. Dr. Butler then showed how the effect of the Coulomb nteraction between the incident proton and the ucleus could be taken into account, both when the eutron and when the proton is absorbed.

H. W. Fulbright (University of Rochester), H. J. Richards (University of Wisconsin) and H. E. Gove Massachusetts Institute of Technology) were the peakers for the third session of the conference. Discussing "Observations of Angular Distributions in ome (d,p) and (d,n) Reactions", Dr. Fulbright said hat the study of the beta-decay of certain elements, notably carbon-14, does not lead to complete understanding of the states of the nuclei involved. The theory of Butler, described above, provides an alternative approach to this problem. If the measured angular distribution from a stripping reaction fits one of Butler's theoretical curves, the angular momentum state of the absorbed particle can be inferred. Good enough agreement with such curves has been found to allow the inference, for example, that carbon-14 and nitrogen-14 ground-states have even parity. Dr. Richards, in the next paper, gave a detailed account of the assignments of spins and parities to the energy-levels of boron-10. He showed how the information from many kinds of experiments can be fitted together to yield a consistent assignment, and indicated the sources of some ambiguities. Dr. Gove then presented some results obtained with the cyclotron at the Massachusetts Institute of Technology. These included some energy-levels obtained by the inelastic scattering of protons and by stripping reactions. The angular distributions from stripping reactions were compared with those predicted by Butler and by Tobocman and Friedman. There appears to be a systematic angular displacement towards larger angles than those predicted.

For the fourth session of the conference there were three prepared contributions by, respectively, D. R. Inglis (Argonne National Laboratory), and by A. de-Shalit and E. P. Wigner (both of Princeton University). Dr. Inglis spoke on the subject "Departures from Nuclear Models in the p-Shell". He started by discussing a situation in atomic spectra where two different perturbations, the spin-orbit coupling and exchange effects, cause splitting of the energy-levels. In nuclei this spin-orbit coupling leads to the shell model of the nucleus, while the exchange splitting can be described by the Russell–Saunders coupling. Dr. Inglis then showed how complicated things can become in the intermediate region and discussed the light nuclei in the light of this 'intermediate coupling'. Dr. de-Shalit then pointed out some regularities in the deviations of magnetic moments from the Schmidt lines, in particular the fact that a nucleus with one odd proton has a moment farther from the Schmidt line than the corresponding nucleus with an odd neutron. He proposed an explanation of this in terms of j–j coupling. This paper was followed by that of Prof. Wigner, who started by reminding his audience of several well-known "queer facts" about nuclei, consisting of accurate numerical sequences or equalities. He then proceeded to discuss the possibility that spin-orbit coupling nuclear has as its origin the operation of a tensor force between pairs of nucleons in nucleus. Dr. Feingold has made calculations which give, in light nuclei at least, qualitative agreement between theoretical and experimental values of the magnetic moment and the quadrupole moment. The admixtures of states produced by the tensor force are small, so that Russell–Saunders coupling holds to a good approximation.

The three papers given at the concluding session of the conference were by W. W. Buechner (Massachusetts Institute of Technology), R. S. Bender (University of Pittsburgh) and Katherine Way (National Bureau of Standards). Dr. Buechner described the apparatus used for both low-energy and high-energy precision determinations of energy-levels, using for the latter the new Van de Graaff generator at the Massachusetts Institute. Results have been obtained for a variety of elements, in many places checking with those obtained elsewhere at low energy, and adding many new ones at high energy. Dr. Bender described the unique high-resolution beam analysing system used with the University of Pittsburgh cyclotron. He then summarized the results so far obtained by its use. These consist of energy-levels obtained from (pp'), (p,α) reactions; many old levels have been found, some with new precision, and many new highly excited levels have been located. Finally, Dr. Way reported a new set of values for the binding energies of the nuclei above lead, and also in the region around neutron number 50 and atomic number 50. These were obtained by considering closed cycles involving alpha-decay and beta-decay. On the basis of the existing experimental data, differences in binding energies at both the neutron and proton 'magic' numbers showed up clearly.

Discussion leaders for the sessions included Dr. Maria Mayer (Argonne National Laboratory), Dr. Maurice Goldhaber (Brookhaven National Laboratory), Dr. S. T. Butler (Cornell), Dr. G. C. Wick (Carnegie Institute of Technology), and Dr. T. Lauritsen (California Institute of Technology).

PHILIP M. STEHLE

ISOTOPES IN MEDICINE

THE application of isotopes in medicine is a subject which shows signs of dangerous over-popularization, with the consequent unjustified simplifications of the problem. A recent publication, entitled "Isotopes in Medicine"*, must therefore be very welcome since this series of articles, a number of them reviews, by acknowledged authorities in their respective fields demonstrates clearly the limitations as well as the possibilities of the clinical and biochemical applications of isotopes. The title "Isotopes in Medicine" is misleading, since only a few of the direct applications of isotopes in medicine are discussed and a number of papers are devoted to reviews of biochemical investigations which are unlikely to exert much influence on clinical medicine for some time. This, however, is not meant as a criticism of the standard of the material, which is high, and the editor is to be congratulated on his choice.

Isotopes represent an important new weapon in the armoury of the clinician and the biochemist; but it is clear that they rarely provide a short cut to the solution of a given problem, and their use demands not only considerable technical resources but, above all, a wide knowledge and experience of the particular field in which they are to be applied. The use of radioactive isotopes in radiotherapy can only be based on a wide experience of orthodox methods of radiation therapy, as is clear from the contribution to this volume by Ralston Paterson and his colleagues. In biochemical research the use of isotopes has in a number of fields raised rather than solved problems, and advances in the applications of isotopes will, to a very large extent, depend on advances in general biochemical theory and technique.

The basic problem in the clinical application of radioactive isotopes is that of obtaining adequate localization of the isotope within the required tissue. A degree of localization is required for both ther peutic and diagnostic applications, but in therapeut work a much higher degree of localization is neede in order that the healthy tissues of the body shou not suffer too great damage. The concentration iodine by the thyroid has been made the basis many diagnostic and therapeutic studies, which a well reviewed in this volume; but it must admitted that the popularity of thyroid studies wi iodine is largely due to the fact that iodine alone all the elements will achieve by metabolic process a high degree of localization within the body.

Increasing use is being made in radiotherapy radioactive isotopes in the form of discrete sourc used either externally or within the body. No pape on this aspect of the subject are included, which perhaps reasonable since the problems are basical technical ones, and the clinical applications follo along the lines of treatment with X-rays and wi radium sources. Other methods of providing localized irradiation of the required tissues are bei developed, and two of the recent techniques are di cussed. A description is given of the treatment malignant bladder conditions by a radioacti solution enclosed in a rubber balloon in the bladde and of irradiation of the pleural and peritone cavities by the injection into these cavities of radi active gold in colloidal form.

The diagnostic application of isotopes involves a large extent radiation measurements made exter ally to the patient and thus must depend basical on instrumentation. An application is described scintillation counting in an attempt to diagnose bra tumours following administration to the patient fluorescein labelled with iodine-131. So far, in Gre Britain, the results with this technique have not be very promising.

One of the most simple and direct applications radioactive isotopes in diagnosis lies in the study blood flow. Here a measure is required only of t rate of transport of radioactive material injected in the blood, and valuable clinical applications ha been found for this technique, described in seve papers of this volume.

On the technical side the volume contains a numb of extremely useful articles, in particular that L. H. Gray entitled "General Principles of Ass and Standardisation of Radioactive Isotopes". report is also given by members of the staff of t Radiochemical Centre, Amersham, on the ava ability of labelled compounds, with details of t methods of synthesis of a number of compoun labelled with carbon-14.

L. F. LAMERTON

* *Brit. Med. Bull.*, 8, Nos. 2–3, 111–300 (1952). 18s.

NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING

OPEN DAYS

THE National Institute of Agricultural Engine ing, at Wrest Park, Silsoe, Beds, held op days during July 22–24, when exhibits were stag to illustrate to visitors the work of the Institu The exhibits did not cover the whole programme the work in hand at Wrest Park (which is report more fully in the recent report for 1949–51 [1]); b even so, they were quite comprehensive a representative of many aspects of the activities the departments.

Noticeable features were the use made of instrumentation, comprising standard, modified or specially esigned apparatus for use not only under laboratory onditions but also in the field ; of techniques devised o meet the great variety of investigations underaken ; and of the experience and facilities of the nstitute for developing machinery and equipment rimarily for use by other research institutes. Examples of the last were the fertilizer placement machines shown by the Mechanical Engineering Department to meet the needs of research workers t Rothamsted Experimental Station and the Macaulay Institute for Soil Research ; the combine arvester, using a new principle of threshing, for arvesting crops grown on plots ; an elevator-oader for handling potatoes into covered storage, tted with a sprout depressant dust-feed, for he Potato Storage Investigation Team of the Agricultural Research Council ; and a press for the xtraction of protein from macerated leaf which has een developed in association with Rothamsted and he Grassland Research Station.

The Mechanical Engineering Department is reponsible for carrying out official tests of tractors nd accessories, grain cleaners and driers, and grass riers. A full-scale test of the last was demonstrated, nd included a specially designed mobile laboratory. A good deal of equipment has been developed for ractor testing, and that exhibited included a hydraulic loading car, drawbar dynamometers, a mobile belt-dynamometer and a power take-off dynamometer ; a mobile trailer weighbridge used for grass-drier tests was also shown.

Research into the design and operation of tractors is proceeding with the help of the foregoing equipment, and a single-wheel tester which has been under development is now completed and will also be used or tractor testing. Research is chiefly concerned with the factors affecting the efficiencies of the engine, ransmission and driving wheels ; attention is also being given to the possibilities of using hydrostatic ransmission, and an experimental motor built into he driving wheel of a tractor was on view.

Tests of agricultural machinery other than that already mentioned are the concern of the Agricultural Testing Department, and examples of the methods and equipment used were to be seen. These included a ploughing-depth recorder ; portable weighers for wheels, sacks, bales, etc. ; apparatus for collecting he complete contents of a potato ridge *in situ* and or sorting and grading them, for the measurement of the power requirements of machines and the dirt and top tare of sugar beet, and for the calibration and testing of seed drills and fertilizer distributors ; and the method used for the detection of mechanical damage to potatoes. The work of this Department also includes investigations into the spring mechanization of sugar beet—a Dixie down-the-row thinner was at work—and the loss of sugar and dirt in field lamps of sugar beet.

The activities of the Horticultural Engineering Department cover a wide field ; those displayed elated to overhead irrigation, spraying, frost prevention, glasshouse heating and ventilation, tractor teering, the washing of vegetables and the harvesting of onions. Modern techniques such as those employing electronic apparatus have been brought into use ; both irrigation and spraying for plant protection call or the production, control and distribution of roplets, and the assessment of the resulting patterns. A high-speed camera is used for the study of spray formation by nozzles of different patterns, and the apparatus and photographs were shown ; a dye is used in many of the sprays, and spray patterns were on view—the dye serves both for visual inspection and for colorimetric and gravimetric estimation. In co-operation with the Research Branch of the Post Office Engineering Department, photoelectric scanning apparatus and electronic counters have been adapted for studying spray patterns and providing data as to the number and sizes of the droplets deposited ; the apparatus was demonstrated in use[4].

Methods of frost prevention include fans and water sprays, and equipment and results were to be seen.

The apparatus used in the study of glasshouse heating and ventilation was shown, and included instruments for measuring and recording soil moisture, soil and air temperatures, air flow, carbon dioxide concentration, solar radiation and heat losses ; the results of this work to date and also those of steam sterilization of soil were displayed.

Research work has been commenced into the problems arising from the design or adaptation of a tractor to meet the exacting requirements of market garden crops. Steering is receiving attention as a primary consideration, and a steering-deviation recorder and a speed and torque recorder were open to inspection. Adaptation has involved reversing the normal driving position and transmission of a tractor and mounting the implements ahead of the front driving-wheels of the reversed tractor in full view of the driver.

Research and development on ploughs and other tillage implements and on potato harvesters have revealed the need for more information about soil conditions, and a section of the department concerned has been formed which is devoted to soil physics ; it is now known as the Soil Department. Known methods and new ones have been devised for obtaining, especially in the field, the data required. A soil penetrometer and torsion shear box were shown, and a demonstration was staged to illustrate the effect of compaction of the soil by tractor wheels.

Strain-gauge equipment in conjunction with a mobile laboratory was exhibited, by which the forces acting on a plough, on a tine or on the linkage of direct-mounted implements are recorded.

The development of a satisfactory potato-harvester has engaged the attention of the Institute for a number of years ; the experience gained has been incorporated in the latest development, which takes the form of two separate units—a digging unit on a rear-mounted toolbar and employing a disk share for digging, and a rotating spider for separation ; the crop can be left on the ground or an elevator can be fitted to deliver into a trailer, which can be fitted with a detachable picking conveyer. The separation of functions makes the arrangement suitable for the small grower.

The drying, handling and storage of cereal crops are the principal interests of the Grain Department ; investigations have been carried out to improve the efficiencies of the installations developed—many of which are now in use on farms—and to extend their application, for example, to green crops and overseas products. Experimental plant of different types was on exhibition, including ventilated silos of concrete and fabric, a grain elevator, grain cleaner, platform sack drier used also for green crops, and special apparatus for measuring air flow, temperature, humidity, pressure drop, moisture content, etc.

Field surveys are carried out by the Field Investigation Department, and an independent survey of tractor utilization is in hand. Potato planting and harvesting, sugar beet and grain harvesting, and hay-making are under investigation. Present farming practice is studied, and planned trials, so far as practicable under controlled conditions, are undertaken. Results, methods and equipment were to be seen. A portable windrow weigher has been devised; but much of the apparatus used is that already mentioned in connexion with testing.

The main laboratories, forming the Instrumentation Department, are at the service of all departments. There special investigations are carried out, for example, on the specific heat of soils, ploughshare wear and precision drilling, besides routine calibration and analyses. Moisture content determinations are a prominent feature for which standard methods are not always suitable, and special apparatus has to be devised to cope with a wide variety of products—for example, apparatus was in use dealing with grass, with coffee beans and with tomatoes.

Considerable use is made of photography, including ciné-films; two ciné-films with tape-recorded commentaries were shown in the Conference Room each day; the Library, which handles not only books, bulletins and periodicals but also manufacturers' catalogues and Institute photographs and slides, was open to visitors.

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[1] Nat. Inst. Agric. Eng. and Scottish Machinery Test. Stat.: Report October 1, 1949–September 30, 1951. (Silsoe: the Institute, 1952.) 3s. 6d.

[2] See *Nature*, 169, 519 (1952).

SPORTS TURF RESEARCH INSTITUTE

MACHINERY EXHIBITION AND OPEN DAY AT THE ST. IVES RESEARCH STATION

THE combined machinery exhibition and open day of the Sports Turf Research Institute, held during July 15–16 at the St. Ives Research Station, Bingley, proved to be a very successful event of great interest to all users of sports turf. Manufacturers combined to put on show a wide variety of implements used in turf production and maintenance, and to many people it was a revelation to see the amount and variety of machinery called for to uphold modern turf standards in face of the increasingly heavy demands being made on playing areas. Mowing machines of very many types naturally were much in evidence; but there were also, among other things, tractors, fertilizer distributors, line-marking machines, compost shredders, turf-cutting implements, watering tackle, weed sprayers of all sizes and a variety of implements for piercing turf in order to relieve soil compression and facilitate easy ingress of air and water. A wide range of hand- and power-drawn machines was demonstrated. A recent development has been the use of the three-point hydraulic linkage of tractors for operating spiking equipment, while a new power-driven spiker, shown for the first time, roused much interest.

The variety of sprayers on view may be taken as a measure of the interest taken in weed control. On the experimental ground, where a number of current trials were demonstrated, the subject of weed control
also received attention. Weedkillers based on 2 : 4 I
(2 : 4-dichloro-phenoxyacetic acid) and M.C.P.A
(2-methyl-4-chloro-phenoxyacetic acid) have prove
a great boon, but some weeds have proved somewha
resistant and work on these is proceeding. On sho
were experimental plots treated with 2 : 4 : 5
(2 : 4 : 5 trichloracetic acid) at various rates wit
and without admixture with 2 : 4 D and M.C.P.
Results obtained against clover were very promisin
indeed, but yarrow control did not appear so goo
There were also trials of exfoliated vermiculite f
turf establishment and maintenance and on the u
of bitumen for toughening turf to withstand hea
wear. Further field trials on view included a numb
on grass-seed mixtures for various purposes a
others on fertilizer treatment. Among the latter mu
be mentioned a series which must be about the olde
of its type existing, since in it individual plots ha
received their own particular kind of fertilizer trea
ment for a period of more than twenty years. T
effects of these treatments on botanical compositio
pest and disease invasion, drought resistance and t
like were easy to see.

Much interest was displayed by visitors in t
laboratories which were open to them. The increasi
demand for scientific advice is well shown here, sin
only last year a new chemistry laboratory had to
fitted out to cope with the increasing demand f
analytical work, while this year visitors were able
see for the first time the new Biology Departme
Though its laboratory space is somewhat limited, t
Department has an ambitious programme and
already making its presence felt.

This new Department undertakes routine exami
tions of diseased turf, the identification of turf plan
and turf pests; in addition, both short- and long-te
schemes of research, mainly in the realms of t
diseases, are being conducted. In Great Britain th
is not the great variety of turf diseases which may
found in, say, the North American continent,
there are definite problems in need of soluti
Improved methods of control of *Fusarium* pa
disease are being sought, and new fungicidal materi
are on test in the laboratory and in the field for t
purpose.

A study is being made of the biology of 'fa
rings' as a necessary preliminary to the devising
methods for their elimination. In the popu
literature on turf management much has b
written on the control of 'fairy rings'; but tr
with reported curative treatments seldom seem
have been conducted under adequately contro
conditions.

STANFORD RESEARCH INSTITU
CALIFORNIA

REPORT FOR 1951

IN an address, "Research and Industry—Part
in Progress", to the board of directors of
Stanford Research Institute, California, on
occasion of the fifth anniversary of the foundin
the Institute, Brigadier-General D. Sarnoff, chair
of the board of the Radio Corporation of Ame
said that the Institute is an outstanding exa
of the natural partnership between research
industry. That partnership, he believed, offers

greatest hope of solving the world's problems and industry's problems. It has always been true that the things men live with largely determine the ideas men live by, and the kind of economy and the kind of government we enjoy are determined mainly by the things industry produces and the use that is made of them. This is not a materialistic doctrine, he said, for there is also a spiritual factor which is possibly the most important, and research itself contributes to this: besides its creative and constructive value, its contribution to economic security and thus to peace, and its challenge to competition, research contributes such values as objectivity and the patient, persistent search for the truth to the partnership on which industrial progress depends. Business, for its part, should contribute understanding and encouragement, as well as finance, and General Sarnoff was emphatic that industry rather than government should bear a main responsibility for the finance of research: government control might destroy the very qualities that enable the research worker to make his most important contribution to society. The future of the Stanford Research Institute, he said, is bright because it recognizes the dependence of applied research on the new knowledge revealed through basic research and maintains a close relation with other research centres throughout the United States.

Some details of the growth of the Stanford Research Institute since 1947 and of its work during 1951 are given in the fifth annual report of the Institute*, which includes a quotation from General Sarnoff's address. Its full-time staff (scientific, technical, managerial and service) increased by 65 per cent during 1951 to 425, and, of the 214 projects on which the Institute was engaged, 184 were for commercial and government sponsors. Expenditure totalled 3·6 million dollars, compared with 1·99 million dollars in 1950, and close affiliation with Stanford University continued to be a vital factor in the development of the Institute.

In the Department of Chemistry, which with a staff of more than seventy-five now conducts research costing 1·2 million dollars annually, among the research projects mentioned in this report are those on the development of a method for the continuous large-scale separation of ionic substances, the efflorescence of latex paint films, the evaluation of ceramic materials, the oxidation of xylenes and the industrial uses of coconut oil derivatives. During the past four and a half years the Air Research Laboratories of the Institute have spent more than 2 million dollars in studying air-pollution problems in different parts of the United States. Besides developing much special equipment, the laboratories have intensified efforts to spread information on air-pollution dangers and their prevention. In the Applied Physics Department an ion-scattering analyser is under construction, and the radiation laboratory is attacking the primary objectives of developing processes using large quantities of radioactive material as a source of penetrating gamma-rays and providing all branches of the Institute with staff and facilities for experimental work with radioisotopes. The Division of Geophysics and Geology is continuing its programme on the development of the Poulter seismic method of surveying underground structures and is undertaking seismic exploration in Western Texas.

A staff of 125 is engaged on engineering research, and projects specifically mentioned in the report include studies on aircraft antenna theory and design, automatic assembly techniques for miniature electronic equipment, the development of the three-colour picture-tube system of television based on the Geer principle, and the response testing of pulse transformers. The Department of Industrial Economics, with a staff of sixty-five, has conducted a techno-economic survey of the hard-board industry; economic studies of Cuba and of a proposed crude-oil pipe-line from Edmonton, Alberta, to Vancouver, British Columbia; an investigation, for the United States Atomic Energy Commission, of the technological and economic questions involved in the industrial use of radioactive fission products; and a co-operative survey, with the South-west Research Institute, the Armour Research Foundation and the Battelle Memorial Institute, of fundamental and applied research activities in Western Germany. Biological research continued to expand; and in the biochemical field particular attention was given to problems of nutrition, toxicity, cancer and the effects of radiation, including studies of the effect of fluoride intake on the general health of cattle, the toxicity of chemicals used to prevent mould growth in citrus products, and the effects of X-radiation and radioactive isotopes on normal tissue and tumours.

The Institute continued to publish its "Chemical and Economics Handbook", and investigations sponsored by the Institute itself included a fundamental study of chemical reactions in aerosol systems, the design of a special still-head which eliminates the need for a separate receiver changer, a study of Goetz molecular filter membranes for the removal of pyrogens from aqueous media, the development of a fractionating column efficient at low pressures, the development and application of paper-chromatographic techniques, the reactions occurring between polymer molecules and the free radicals present during the formation of vinyl polymers, and a study of the applications in analytical chemistry of ion-exchange resins.

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* Stanford Research Institute: Annual Report, 1951. Pp. 48. From the Institute, Stanford, California; 1952.)

HOUSING IN THE U.S.S.R.

A BRIEF survey of housing development in the U.S.S.R. from 1917 until the present day by Dr. E. M. Chossudovsky (Housing and Town and Country Planning, Bull. 5, United Nations Publication) shows that the material difficulties with which the Government has had to deal have been formidable. The housing resources taken over by the Soviet authorities after the Revolution were both quantitatively inadequate and in appallingly poor condition. Very little new construction took place until the late 1920's, and it was not always possible to devote sufficient attention to repair work, so that the pre-revolutionary level of housing was restored less quickly than that of the other branches of the economy.

With the beginning of the era of the Five Year Plans (1928–29) the situation improved; altogether before the Second World War about 113 million square metres (approximately 1,216 million square feet) of urban living space had been constructed since the inception of the Soviet regime. Much was done by way of improving the quality of housing, developing and improving municipal services and providing communal buildings of all kinds.

Two hundred new cities were built between 1926 and 1939, in conformity with the changing character and distribution of the population and the development of the country's eastern areas. Yet, despite all this progress, it proved impossible to bridge the gap between population growth and housing; housing construction lagged behind the rate of industrialization, and the urban population increased at an exceptionally rapid rate. Further, much of the pre-revolutionary housing proved to be beyond repair and had to be scrapped, thus slowing down the net growth of the total housing fund.

The war-time destruction of housing amounting to some 30 per cent of the total amount of urban housing, and the extensive and frequently complete destruction of rural housing proved a serious setback. The over-fulfilment of the total urban housing programme of the post-war Five-Year Plan has, however, more than offset the tremendous losses and led to a far-reaching, even revolutionary, modernization of the building industry (especially in the application of express and even-flow methods of erecting houses), which should make it possible to step up housing construction in subsequent five-year plans to a marked extent. The pace of the country's house-building has been appreciably increased by the financial and material assistance accorded to individual house-building by the authorities.

In the present stringent housing situation, the Government has controlled the distribution of available housing resources, taking into consideration the priority claims of ex-servicemen, the dependants of war casualties and invalids, the partisans and their families. The relationship between work (type, quantity and quality) and the allocation of limited housing resources, already recognized before the War, has now been further strengthened; it is possible to ensure that the housing requirements of such key workers as the miners are promptly met. Special housing facilities also are provided to meet the needs of workers who settle in newly developed regions. Housing is thus regarded as one of the instruments for increasing the productivity of labour and building up permanent staffs in industry.

MUSEUMS ASSOCIATION

ANNUAL CONFERENCE IN OXFORD

THE fifty-eighth conference of the Museums Association was held at Oxford during July 21–25 under the presidency of Mr. S. D. Cleveland, director of the City Art Gallery, Manchester, and was attended by more than three hundred and fifty delegates from both national and provincial museums. This was the third occasion on which the Association has visited Oxford, the previous time being in 1919.

In his presidential address, on "The Inevitability of Museums", Mr. Cleveland stated that it is necessary to correct a prevailing misconception by which museums are regarded as educational institutions only. It is true, he said, that education must be an integral part of their work; but it should take its place with the other functions of collection, conservation, interpretation, research and service to the community.

Dr. H. J. Plenderleith, keeper of the Research Laboratory at the British Museum, in a paper on "Fakes and Forgeries", described his subject as a very human study in which the man of science can help the scholar. In fact, the intimate co-operation of these two is essential, and there must be complete sympathy with each other's aims and methods. He enumerated some of the physical and chemical methods used at the British Museum, and spoke of the difficulties encountered when it is necessary to form an opinion without even marking the object.

Sir Philip Hendy, director of the National Gallery, stressed that the primary function of museums and art galleries is to be a Temple of the Muses and that no secondary function should be allowed in any way to interfere. Museums are guardians of a high standard of quality. He spoke in favour of the production of good reproductions of first-class paintings and pleaded for a more liberal interpretation of the function of art galleries.

In a session of a rather more domestic nature, the story of museums in Oxford was told by the five directors concerned. In all the papers, and in the subsequent discussion, it was apparent that the pendulum is swinging once again with regard to the amount of material that should be displayed in museums. From showing everything, the general tendency a few years ago was to show almost nothing. Now a compromise has been made, and it is realized that the arrangement as seen in the windows of the departmental stores is not the ideal prototype for museum cases. The apathy of the University of Oxford towards its museums was commented upon by several speakers, and the hope expressed that one result of the conference on the part of the University would be an increased interest in the value of its great collections. The hope was also expressed that the City of Oxford would consider the establishment of a museum to illustrate its own history.

Speaking on "Changing Fashions in Museum Teaching", Mr. Peter Floud, of the Victoria and Albert Museum, London, emphasized the value of making use of the galleries in addition to the children's rooms which are now established in so many museums. There is a distinct danger that museum work may become simply an extra-mural function of the school. He also dealt with the three-dimensional didactic displays which produce indirect museum teaching, and illustrated his remarks with actual examples of exhibition work. Dr. C. H. V. Sutherland, of the Ashmolean Museum, Oxford, said that there is a real public interest in numismatics and that museums should make every effort to satisfy this. He agreed that there are few trained numismatists in Great Britain, and stated that a British association of the various numismatic societies would probably be formed in the near future. He hoped that the Museums Association would co-operate in this matter. Mr. J. W. Y. Higgs, of the Museum of English Life, Reading, described this new museum of English rural life and stated how, as a nation, England is deeply conscious of its rural history.

At the annual general meeting of the Association, held during the conference, a protest was made against the cuts in Treasury grants to national museums and art galleries. The Association decided to send to the Chancellor of the Exchequer a resolution deploring the cuts as "gravely endangering the safety of the national treasures and curtailing the educational, æsthetic and scientific facilities provided".

Dr. F. J. North, of the National Museum of Wales, Cardiff, was elected president for the Conference in 1953, which will be held in York during June 22–26.

IONIZING AND LUMINOUS EFFICIENCIES OF METEORS

By Dr. J. S. GREENHOW
and Dr. G. S. HAWKINS
drell Bank Experimental Station, University of Manchester

THE amount of ionization produced in the trail of a meteor of given visual brightness has been e subject of much discussion. Early workers[1] sumed that most of the kinetic energy of the eteor would be transferred to ionization ; but in a cent review Herlofson[2] considered that the available idence indicated that the fraction of the kinetic ergy converted to ionization was only about ·0001, and the fraction converted to visible radiation out 0·01. On this basis Herlofson estimated that e density of ionization produced by a meteor on e limit of naked-eye visibility (zenithal magnitude 6) would be 10^{10} electrons per centimetre path, d by a very bright meteor (zenithal magnitude 1) 10^{12} electrons per centimetre path. The preminary combined radio echo and visual observations ade by Prentice, Lovell and Banwell[3] in 1947 ggested that these estimates were approximately rrect. The theoretical estimates depend on a owledge of the transition probabilities in the llision of heavy ions, and in this respect data plicable to the conditions in meteor trails remain ry inexact. Thus, any new information on the easured electron densities in trails of meteors of own visual magnitude is of particular interest. ecent work on the mechanism by which radio waves e scattered from the ionized trails has led to much ore certain measurements of electron density. The rpose of the present communication is to discuss ese measurements, which indicate that the actual minous and ionizing efficiencies must be markedly ifferent from those assumed by Herlofson.

The original measurements of electron density ade by Prentice, Lovell and Banwell[3], and Lovell, anwell and Clegg[4], were based on the theory of attering developed by Lovell and Clegg[5]. This eory, which predicts that the amplitude of the echo proportional to the linear electron density α, sumes that the initial radius of a meteor trail is nall compared with the wave-length, the electron ensity being sufficiently low so that the electrons in ny cross-section scatter independently and in phase. nder these conditions, Herlofson[2] has shown that e echo duration to $1/e$ of the initial amplitude is dependent of the electron density, and is given by

$$T = \lambda^2/16\pi^2 D, \qquad (1)$$

here D is the diffusion coefficient for the ionized atter in the trail, and λ the wave-length. Although is theory seemed to account satisfactorily for many f the observations, the existence of echoes of long uration has provided a major difficulty[6]. This ifficulty has now been resolved, and recently[7,8] it as been shown that when the linear electron density ppreciably exceeds 10^{12} electrons per centimetre, the odel assumed by Lovell and Clegg breaks down, nd the cylinder in the meteor trail inside which the lectron density exceeds the critical value N_c may be onsidered to behave as a total reflector for radio aves. Under these conditions, the amplitude of the adio echo increases only as the fourth root of the electron line density, α, but the echo duration is now proportional to α, being given by[7]

$$T = \alpha/4\pi D N_c. \qquad (2)$$

It is the overdense trails of this type which give rise to the meteor echoes of long duration. Evidently equation (2) provides an accurate method of determining α, from measurements of the duration T, provided the diffusion coefficient D can be determined. In the present work, D has been determined from trails of low electron density which obey the Lovell–Clegg formula, and which decay exponentially according to (1). In order to obtain a satisfactory mean value of D, it is desirable to make measurements on a number of meteors ionizing in a narrow height-range, such as those in a homogeneous shower. The value of D may then be substituted in equation (2), so that the electron line densities in meteor trails which give rise to long-enduring echoes may be obtained directly from the echo durations, independently of the parameters of the apparatus.

The most extensive observations relating the magnitudes of visual meteors to the appearance of the corresponding radio echoes have been made by Millman and McKinley[9], operating on a wave-length of 9·1 m. From a mean of several hundred visual meteor–radio echo correlations obtained during the Perseid meteor shower, these workers found the relationship between the echo duration and apparent meteor magnitude shown in Fig. 1. The measurements of luminosity are in terms of apparent visual magnitudes, and these may be corrected to zenithal magnitudes by reducing the ranges of the observed meteor trails to 100 km. The mean range of Millman and McKinley's[10] radio echo and visual meteor correlations was 155 km., giving a ratio of apparent intensity to zenithal intensity, for an average meteor, of 1 : 2·4. This corresponds very nearly to one stellar magnitude, and this correction has therefore been adopted. The revised experimental curve relating zenithal magnitude to duration of radio echo is shown as a broken line in Fig. 1.

The conversion of these echo durations to electron densities has been made from equation (2) by using the value of D (4×10^4 cm.^{2}/sec.), determined from the measurements on short-duration Perseid echoes as described above[7]. The final relation between linear electron density and zenithal magnitude is given in Fig. 2 (line AB). Extrapolation of AB shows that a meteor of zenithal magnitude + 6 would produce

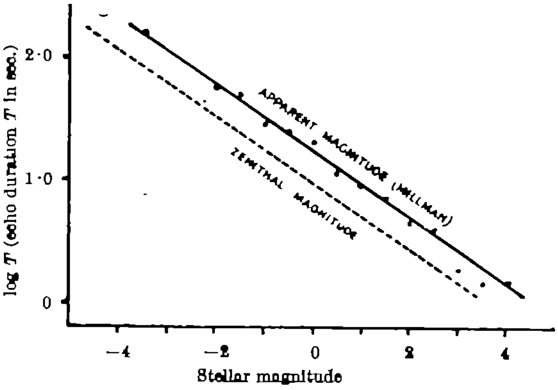

Fig 1. Relation between meteor magnitudes and radio echo duration on a wave-length of 9·1 m

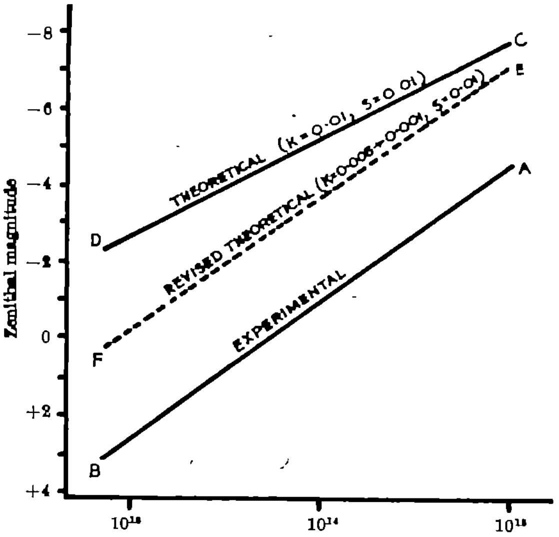

Fig. 2. Theoretical and experimental relations between the zenithal magnitudes and electron line densities of meteor trails

approximately 10^{12} electrons per centimetre path. This is one hundred times greater than Herlofson's estimate, and leads to a discrepancy of roughly 5 stellar magnitudes between the theoretical and experimental determinations of the electron line densities in meteor trails. The experimental points obtained by Prentice, Lovell and Banwell[8] for the relation between echo duration and magnitude during the 1947 Perseid shower agree with the relation found by Millman and McKinley in Fig. 1, when corrected for the difference in wave-length. The conversion to line density by these workers was made from the amplitude of the echo, on the assumption that the Lovell–Clegg formula applied to these trails. It is now evident that these trails were overdense, and that equation (2) should have been used for obtaining the electron density from the echo duration. The approximate agreement of their results with Herlofson's estimates was therefore fortuitous.

In view of the large disagreement between theory and experiment, it is of interest to search for any adjustments in the theory which could bring the results into agreement. The theoretical relationships between zenithal magnitude M and electron line density α, used by Herlofson, may be written as

$$M = 80{\cdot}4 - 2{\cdot}5\,(\log V^{3} + \log K/S + \log \alpha), \quad (3)$$

where V is the meteor velocity, S is the probability that an evaporated meteor atom will produce an electron by collision with air molecules, and K is the fraction of the kinetic energy of a meteor atom which is transformed into visible radiation. Originally, values of $S = K = 0{\cdot}01$ were adopted, producing the theoretical relation between zenith magnitude and electron line density given by CD in Fig. 2. The discrepancy between the theoretical and experimental relations in Fig. 2 suggests that the values assumed by Herlofson for S and K are incorrect.

A more exact theoretical estimate of the luminous efficiency for meteors with a velocity of 6×10^{6} cm./sec. has been made by Öpik, who obtained $K = 0{\cdot}001$ for faint visual meteors, and $K = 0{\cdot}005$ for very bright meteors (negative magnitudes). The luminous efficiency may also be estimated from th photographic observations by Whipple[11] and Jacchia[1 who obtained the following mean values from eleve bright Perseid meteors:

Velocity (V cm./sec.)	Deceleration (a cm./sec./sec.)	Zenithal magnitude (M)	Height (km.)
$6{\cdot}01 \times 10^{6}$	$8{\cdot}1 \times 10^{5}$	$-3{\cdot}0$	$92 \pm 1{\cdot}3$

For a meteor, the rate of loss of kinetic energ dE/dt is:

$$\frac{dE}{dt} = \frac{\tfrac{1}{2}\,dm}{dt}\,V^{2}\ \text{ergs/sec.} \qquad (4$$

The rate of loss of mass dm/dt may be obtained fro the deceleration of the meteor, a, and atmospher density ρ using Whipple's equation[11]:

$$\frac{dm}{dt} = 5 \times 10^{-18}\,\rho^{2}a^{-2}\,V^{7}\ \text{gm./sec.} \qquad (5$$

For the rate of radiation of luminous energy I, b an object of stellar magnitude M, Öpik[13] gives th expression:

$$2{\cdot}5 \log I = 24{\cdot}6 - M. \qquad (6$$

At a height of 92 km. the atmospheric density i approximately 6×10^{-9} gm./cm.^{3}, and when th observational data are inserted in equations (4), (and (6), the luminous efficiency $K = I \Big/ \frac{dE}{dt}$ is found t be 0·01. Because of the spread in the results, th value could be in error by a factor of 2, and it i therefore in fair agreement with the theoretic estimates of Öpik for bright meteors. The results c the photographic observations thus add weight t Öpik's estimates, and his values, when inserted i equation (2), produce the relation between magnitud and line density shown as EF in Fig. 2, and th discrepancy between the theoretical and experiment curves is reduced.

The probability of ionization, S, may be estimat from the direct correlation of radio echoes with visu meteors. From AB in Fig. 2 a Perseid meteor o magnitude $-3{\cdot}0$ produces $2{\cdot}4 \times 10^{11}$ electrons/se The rate of loss of mass for meteors of this brightne has already been determined from the photographi results, and, assuming the meteor to be composed o iron, corresponds to a release of 8×10^{11} atoms/sec This gives the probability of ionization as 0·3; bu the spread in the original data will give values lyin between 0·1 and 1·0. The remaining discrepanc between EF and AB is accounted for if $S = 0{\cdot}16$ which lies within the limits of this experimenta estimate.

In conclusion, it seems that the best values for th luminous efficiency of Perseid meteors are 0·005 fo bright meteors and 0·001 for faint meteors, and more reasonable value for the probability of ionizatio is approximately 0·2. Meteors therefore produce mor ionization than was originally estimated. Instead o the kinetic energy of a meteor being divided betwee heat, light and ionization, in the ratio $10^{4} : 10^{2} : 1$ the ratios are probably $10^{4} : 10^{2} : 10$ for brigh meteors, and $10^{4} : 10 : 10$ for faint meteors. The revised estimates imply that the visual magnitud corresponding to an echo of given characteristics i some 5 magnitudes fainter than that given b Herlofson. This means that the majority of radi echoes of short duration must arise from meteor which are below the limits of naked eye visibility, and conversely that all visible meteors must produce radio echoes of long duration—a well-known observational effect. [June 20.

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PHOSPHORYLATION OF XYLOSE BY EXTRACTS OF *PSEUDOMONAS HYDROPHILA*

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THE most generally accepted view of the pathway of xylose metabolism has been that of the splitting of the molecule into a C_3 and a C_2 portion[1]. The formation of xylonic acid from xylose by *Pseudomonas fluorescens* has been demonstrated by Lockwood and Nelson[2]. Lampen and Peterjohn[3] believe that xylose degradation occurs via a ribose phosphate, since only ribose-5-phosphate but not xylose-5-phosphate or arabinose-5-phosphate is metabolized by extracts of xylose-grown *Lactobacillus pentosus*.

That phosphorylation of xylose may take place in rat intestinal mucosa homogenates was recently suggested by the work of Hele[4]. No distinction was made, however, between the glucose- and the xylose-phosphorylating enzyme.

Evidence has now been obtained in these laboratories showing that xylose is phosphorylated at the expense of adenosine triphosphate by extracts of *Pseudomonas hydrophila* grown on a synthetic medium with xylose as the only source of carbon. In crude extracts, the initial rate of phosphorylation of xylose has been found to be much higher than that of glucose. Hexokinase activity has been successfully removed from the extract, leaving the xylose-phosphorylating enzyme intact in the final preparation. The latter enzyme has been shown to be specific for D-xylose among all the pentoses of known biological significance and will, therefore, be referred to as 'xylokinase'.

Culture conditions and preparation of cell-free extracts. *Pseudomonas hydrophila* (N.R.C. 492), originally isolated by Reed and Toner[5] from pike with 'red sore' disease, was grown on a synthetic medium composed of 20 gm. of D-xylose, 6 gm. diammonium hydrogen phosphate, 0·2 gm. potassium dihydrogen phosphate, and 0·25 gm. crystalline magnesium sulphate per litre of solution. Sugar and salts were sterilized separately and mixed aseptically before use. The *p*H of the medium after sterilization was 6·6, and this value dropped to 6·0 following a 24-hr. period of growth of the organism. The average yield of cells from 24-hr. shake cultures was 5·4 gm. per litre of culture medium.

The cells were washed three times with 0·85 per cent sodium chloride solution and were centrifuged off each time at 11,000 r.p.m. They were then ground in a mortar (mounted in an ice bath) for 30 min. in the presence of 3·5 times their wet weight of alumina[6] ('Alorco F-20', minus 80 grade) and sufficient saline to result in a smooth, batter-like paste. After grinding, more saline was added to give a 4 : 1 ratio of saline volume (ml.) to wet cell-weight (gm.). The suspension was then centrifuged at 9,000 r.p.m. for 10 min. and the upper, cell-free, opalescent layer was used for the subsequent experiments.

Phosphorylation of xylose and glucose with adenosine triphosphate. Phosphorylation of xylose and glucose was studied with the aid of the manometric technique of Colowick and Kalckar[7] and by the disappearance of acid-labile phosphate following phosphorylation with adenosine triphosphate. The rate of carbon dioxide output was measured in the conventional manner using a Warburg apparatus.

The experimental system in which evidence of xylose phosphorylation was obtained was composed of: sodium bicarbonate 0·023 *M*; magnesium chloride 0·0033 *M*; sodium fluoride 0·02 *M*; D-xylose 0·02 *M*; cell-free extract 1·0 ml. and adenosine triphosphate 0·0033 *M* (added at zero time from the side arm, dissolved in bicarbonate). The adenosine triphosphate used was the sodium salt assayed at 89 per cent purity. Xylose was freshly recrystallized from aqueous ethanol before use. Measurements were made at 27° C. in 95 per cent nitrogen + 5 per cent carbon dioxide in a total volume of 3·0 ml.

Control experiments which contained (*a*) no sugar and (*b*) no extract were always run. The resultant values from the controls were subtracted from the experimental figures to correct for the small adenosine triphosphatase activity of the extracts and the slight change in gas volume produced on tipping the adenosine triphosphate into the main compartment of the manometric vessels.

The results of phosphorylation by an extract from *Pseudomonas hydrophila* obtained following the fourth transfer of the organisms into fresh synthetic medium are given in Fig. 1. It was found that the initial rate of xylose phosphorylation was always greater than that of glucose, and that upon repeated transfers of the organisms into fresh medium the xylose-phosphorylating activity remained unchanged, whereas the hexokinase activity decreased slowly to a relatively constant value.

The disappearance of acid-labile phosphate resulting from phosphorylation was measured by the method of Fiske and Subbarow[8]. Assuming that the reaction product was an acid-stable phosphate, the determinations were carried out on filtrates obtained by treatment with 10 per cent trichloroacetic acid of the reaction mixtures following 40 min. of active phosphorylation under the same conditions used for the experiment presented in Fig. 1. Typical results following 7-min. hydrolysis in *N* hydrochloric acid are given in the accompanying table.

Removal of hexokinase activity from extracts containing xylokinase. Hexokinase activity was removed from the cell-free extracts of *P. hydrophila* by the

DETERMINATION OF ACID-LABILE PHOSPHATES

Contents of reaction mixtures*	Acid-labile phosphorus in sample (x)	Acid-labile phosphorus per vessel (ν)	Phosphorus transferred to the sugars (γ)
Adenosine triphosphate (ATP)	18 7	561	—
Extract	1 3	39	—
Extract + ATP	19 9	597	—
Extract + ATP + D-xylose	9·6	288	309
Extract + ATP + D-glucose	13 7	411	186

* This includes also sodium bicarbonate, magnesium chloride and sodium fluoride at the concentrations given in the text

preparation of acetone-dried powders of these extracts without, however, affecting the activity of the xylokinase. Seven volumes of cold acetone were used[6], and the resulting precipitate was washed five times with cold acetone. The precipitate was then dried quickly on a Büchner funnel for a few minutes, followed by drying for an hour *in vacuo* over calcium chloride. The resulting fine, white powder was found to be stable in the refrigerator when kept in a desiccator over calcium chloride at 4° C.

When suspended in water, the acetone-dried powder was devoid of hexokinase activity but contained the xylokinase in undiminished activity (Fig. 2). This preparation did not phosphorylate D-ribose (0·02 *M*), D- or L-arabinose (0 02 *M*) or L-lyxose (0·02 *M*). The results using D-arabinose or L-lyxose are not shown in Fig. 2, since the total carbon dioxide output in 30 min. was not more than 2 c.mm. Iodoacetate (0·01 *M*) inhibited xylokinase activity most strongly, and it was found necessary to add magnesium ions in order to obtain maximum activity. The addition of 0·02 *M* glucose to the acetone-dried powder which phosphorylated xylose had no effect upon the xylokinase activity. The results shown in Fig. 2 are net effects, since the appropriate controls for each vessel without any added sugar have been subtracted. Xylokinase is therefore specific for the phosphorylation of xylose and appears to require free sulphydryl groups and magnesium ions for activity.

The Michaelis constant for xylokinase was determined using a quantity of 40 mgm. of acetone-dried powder per vessel in the presence of the required reactants (described above) and was found to be 0·0023 *M* (for xylose).

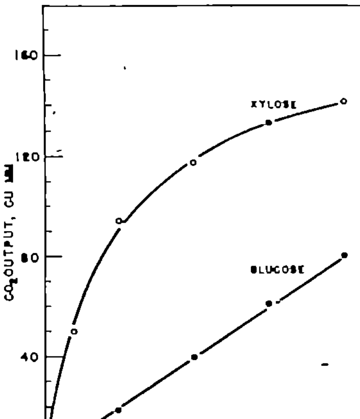

Fig. 1. Manometric estimation of the phosphorylation of D-xylose and D-glucose by a cell-free extract of *Pseudomonas hydrophila* in the presence of adenosine triphosphate

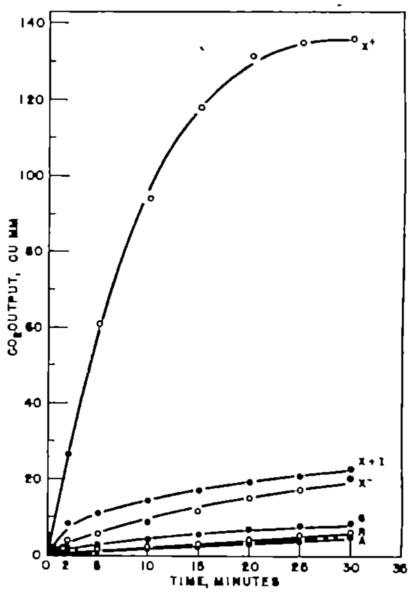

Fig 2. Manometric estimation of xylokinase activity, the effects of a variety of sugars, iodoacetate and magnesium ions. Quantity of acetone-dried powder used (per vessel), 30 mgm. *X*+ = D-xylose, *G* = D-glucose, *R* = D-ribose. *A* = L-arabinose; *X* + *I* = D-xylose plus iodoacetate; *X*⁻ = D-xylose without added magnesium ions

Nature of the phosphorylation product. The phosphate could be attached to the xylose molecule in one of several positions. On the basis of hydrolysis data given by Meagher and Hassid[10] and Levene and Raymond[11], it is established that: xylose-1-phosphate is 100 per cent hydrolysed when heated at 100° C. in *N* sulphuric acid for 10 min., whereas xylose-5-phosphate is only about 25 per cent hydrolysed when heated for 30 min. under the same conditions. Furthermore, the latter authors[11] were unsuccessful in their attempts to form a xylose-3-phosphate, since the ester always formed in the 5-position.

For purposes of the phosphate analyses reported here, heating was carried out at 100° C. in *N* hydrochloric acid for 7 min. and the reaction products kept in the form of trichloroacetic acid filtrates before the analyses were done. It would therefore appear likely that xylose-5-phosphate is the product of the xylokinase reaction. However, attempts to isolate and identify the end product and to elucidate the pathway of its metabolism are now in progress.

The technical assistance of Mr. Raymond Lapointe is gratefully acknowledged.

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LETTERS TO THE EDITORS

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Electron Microscope Studies on Thin Sections of Human Erythrocytes

LITTLE is known about the inner structure of red blood cells. There are two main theories. One considers that the interior is a sponge-like network formed by structural proteins with the hæmoglobin n its intermicellar spaces. The other considers the erythrocyte as a balloon, containing free hæmoglobin n solution. Theoretical considerations, however[1,2], have shown that the blood pigment must be densely packed, and its degree of freedom is small, as follows from X-ray diffusion studies[3].

Direct observations by means of polarization[4,5] and especially electron microscopy[6-10] were successful for investigations of the membrane from 'ghosts' (hæmolysed cells) but failed to reveal the intact interior architecure. On one hand, no birefringence can be found there except in special cases[11,12], where hæmoglobin seems o exist in a *para*-crystalline or crystalline state; on he other hand, the non-hæmolysed erythrocyte is oo thick to be examined under the electron microoope. The only way to study these cells was to obtain sections thin enough to be penetrated by the electron beam. But whereas sections of 0·4–0·2 µ commonly used in electron microscopy are transparent enough to study epithelial or mesenchymal cells, all the erythrocytes in the blood vessels of the ame specimens remain homogeneously black or darkgrey. In a new series of experiments fresh blood clots fixed in 2 per cent osmic acid and embedded in Esterwax' were cut with a special microtome ('Rockng' Special Microtome, Cambridge Instrument Co., Ltd., Cambridge) at regular intervals without mechanical advance (4–5 movements for one tooth of the atchet wheel), according to a technique described lsewhere[13].

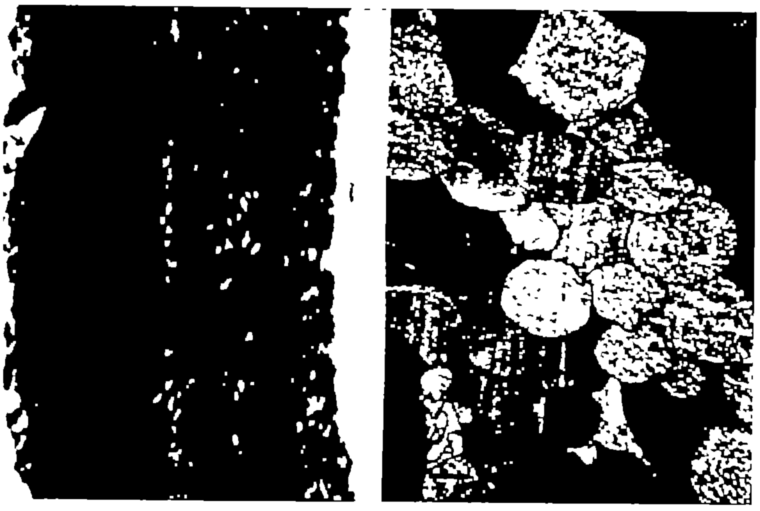
Though the 'Rocking' microtome is constructed or 0·2-µ thick sections only, after some attempts we were often able to get much thinner ones (0·1–0·025 µ, measured with latex-particles on shadow-cast grids). These specimens, the thinnest of which reached a hundredth of the normal red cell thickness only, were now transparent enough for our studies. Summarizing the observations, we can state that:

(1) *Without shadow-casting*, the osmium-fixed, non-hæmolysed human erythrocytes appear to be mostly homogeneous, densely packed without any visible structure. Some of them, however, show isolated denser irregularly dispersed spots. A very fine membrane of more definite osmiophilic character may be seen on the same fragments.

(2) *On shadow-cast sections*, the dense, homogeneous structure is of a granular (40 per cent), mostly filamentous (60 per cent) appearance (Fig. *a*). The filaments are 150–300 A. thick and show special orientation: on about half of the micrographs they are perpendicular, on one-tenth parallel, to knife incidence, on one-fifth they take an intermediate position, and the last fifth of the patterns show filamentous bundles crossed by others at certain angles (90°–150°). It has not been possible until now to find any constant relations between the direction of the filaments and the surface of the red cell. Though the high orderliness of the sub-microscopic structure is evident in the cut fragments, the architecture of the whole erythrocyte still remains to be elucidated, because ultra-thin sectioning generally breaks the red cell into fragments and it is almost impossible to say to which part the isolated fragment belongs, and at which level it has been cut. No findings, however, indicate entirely different zones in inner or outer parts of the red-blood cells, nor could isolated globular hæmoglobin molecules be distinguished, though they should become visible within these magnifications (38 A. of diameter, 75 A. of intermolecular distance after Ponder). When granules appeared, their diameter was about 200 A.; but it may be that they are, in fact, cross-sections of filaments representing a whole hæmoglobin lipoprotein complex.

(3) The membrane of the non-hæmolysed erythrocyte seems to be thinner than that of the ghosts, but its real thickness is very difficult to evaluate. The thinner the section, the less visible is the membrane. Nevertheless, it was not possible to show anything resembling the well-defined nuclear membrane of tissue cells. Measurements of the thinnest parts of the peripheral fragments show it to be 160 A. thick; on other areas it measures up to 320 A. No special structure, whether in the membrane itself or in the layers beneath, was visible. Sometimes the surface did not show any membrane at all.

(4) As soon as osmotic hæmolysis begins, the dense structure of the interior becomes clear and easily transparent. A very fine regular network appears and becomes coarse and irregular as the process proceeds (Fig. *b*). All the corpuscles are then delimited by a clearly visible sheet of 300-800 A. in thickness. The inner structure does not always lose its hæmoglobin with regularity. Some parts,



(*a*) (*b*)

) Thin section (about 0·05 µ) of a red cell fragment. *m*, Membrane. Filamentous ructures parallel to knife incidence. Shadow cast with gold-palladium. (× 31,000).
) Fine section of a blood clot. Partial hæmolysis (dist. water) with all the intermediate states from intact to almost empty cells. (× 3,800)

especially the thickened circumference, remain denser than others and disappear only when hæmolysis is complete. The erythrocyte is then entirely empty.

(5) From these observations, we can conclude that the intact red-blood cell has an extremely dense internal structure of granular or filamentous appearance, when fixed with osmic acid. There often exists a striking orderliness in its architecture. A spongy network and a well-defined membrane appear only when hæmolysis sets in. The completely hæmolysed erythrocyte is empty and balloon-like. Further details will be published elsewhere.

I am indebted to Dr. E. Ponder and Dr. D. G. Derwichian for an interesting discussion which encouraged me to continue the first investigations.

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Feb. 25.

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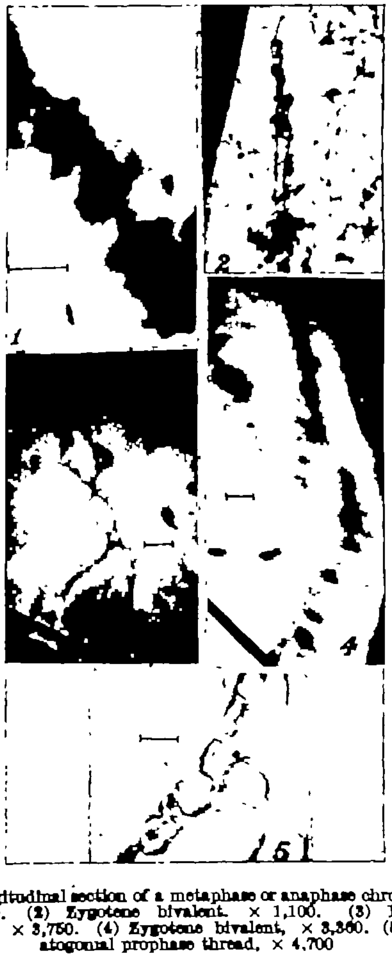
Electron Microscopic Study of Grasshopper Chromosomes

THE various methods used so far in preparing chromosomes for electron microscopy can broadly be classified into the following three categories: (1) cutting ultra-thin sections, (2) isolation of chromosomes, and (3) making squash preparations. Electron micrographs of the chromosomes of grasshoppers have been made by employing all these techniques. The material consisted of the spermatogonial cells and spermatocytes from the testes of adult male grasshoppers. The micrographs were taken by means of the new electron microscope installed in the Institute of Nuclear Physics, Calcutta, details of which have been published elsewhere[1]. Comparatively low magnifications were used purposely because we did not like the chromosomes to be magnified beyond recognition in our first attempt.

Fig. 1 is an electron micrograph from a sectioned preparation of the testes made after the method described by Pease and Baker[2]. The section has passed longitudinally through a portion of a compact, cylindrical, helically coiled chromosome probably of the metaphase or anaphase stage and the transverse disks are consequently interpreted as the gyres of the spiral. The coiled chromosome seems to possess a conspicuous coating of a substance much more transparent to the electron beams than the disks themselves. Fig. 2 is a similar micrograph of a pair of isolated chromosomes in the zygotene stage obtained by following the technique of isolation similar to that suggested by Claude and Potter[3]. Although they were extracted from the spermatocytes by a rather drastic procedure of crushing the cells with sand particles, the identity of the chromosomes in the micrograph is beyond any reasonable doubt. The comparatively large dark bodies on the threads are due to the adherent sand particles which could not be removed by washing. The individual chromosomes show distinct chromomeric structure in the portion which is comparatively free from sand particles. The chromomeres on the homologous chromosomes are more or less similar in size, thus indicating their homologous nature. The paired chromosomes appear to be split at one end, where four distinct threads with chromomeres are seen. The future development of better technique for the electron microscopy of chromosomes might be of great use in deciding not only between the conflicting points of view regarding the reality or otherwise of ultimate chromomeres but also regarding the determination of the number of chromonemata present in a chromosome in the different stages of the division cycle.

While trying to use the technique proposed by Schultz *et al.*[4] we developed some modifications which gave us consistently good micrographs. The testes of male grasshoppers were dissected out in isotonic sodium chloride solution and fixed in Carnoy's fluid before storing them in 70 per cent alcohol. When preparing a specimen for the electron microscope, one of the lobules was stained either in aceto-carmine or in Feulgen's stain. The stained specimen



(1) Longitudinal section of a metaphase or anaphase chromosome, × 8,000. (2) Zygotene bivalent. × 1,100. (3) Diplotene bivalent, × 3,750. (4) Zygotene bivalent, × 3,360. (5) Spermatogonial prophase thread, × 4,700

was transferred to 45 per cent acetic acid before making the squash, which was done on glass slides previously coated with a thin layer of collodion diluted 1 : 6. The cover-glass was at first gently pressed with the thumb, followed by a pressure with a C-clamp for the maximum stretching of the chromosomes. The slide with the cover-glass in position was placed on an ice block and, when sufficiently chilled, the cover-glass was prised off with a dissecting needle. This chilling helped in the retention of materials on the collodion film, which was then stripped off. In order to mount the desired part on the specimen grid, the stripped film was mounted on a clear slide with a film of water in between the film and the slide. The useful portion was selected under the optical microscope and separated with a sharp blade of a scalpel. The film was again floated on water and finally mounted on the specimen grid of the electron microscope.

Several electron micrographs were taken from squashes prepared by this method. Fig. 3 is a micrograph of a diplotene bivalent and it is clear that the structural details are more or less faithfully preserved. Fig. 4 represents a zygotene bivalent showing the chromomeric structures. A portion of the bivalent remains unpaired, and the structure of the chromomeres indicates the non-homologous nature of the unpaired portion. Fig. 5 perhaps represents an early prophase thread of spermatogonial divisional stages. The spiral structure seems to be the relic coiling, and an indication of longitudinal split in the chromosome is quite evident. The absence of differentiation into chromomere and interchromomere regions, in contrast with the prophase threads of meiosis, is a characteristic of the early mitotic chromosomes of the grasshoppers. Further work is in progress.

We wish to thank Prof. M. N. Saha and Dr. N. N. Das Gupta for their interest in the work, and to the Ministry of Education, Government of India, for financial assistance.

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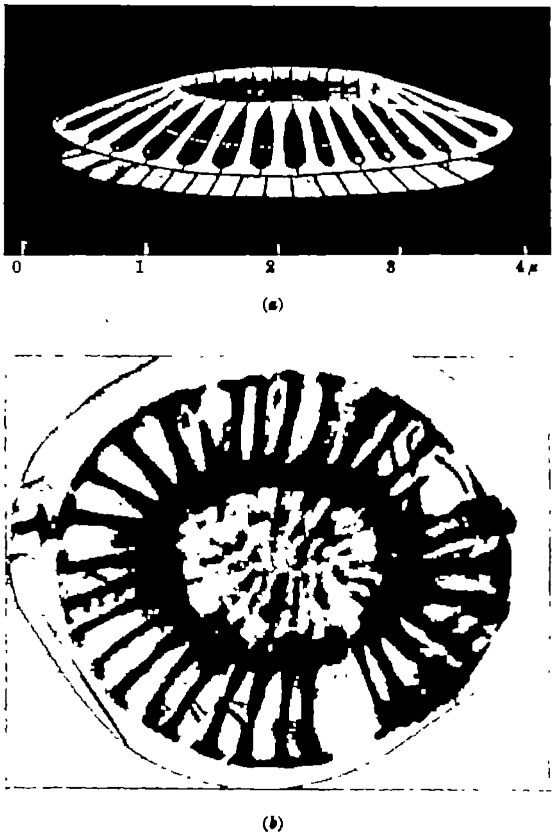
Coccoliths of *Coccolithus huxleyi* seen in an Electron Microscope

THE taxonomy of Coccolithophoridaceæ is based upon the morphology of the coccoliths. On account of the minute size of most of the coccoliths it has not been possible to obtain satisfactory pictures of them, even with the best optical equipment. This has caused confusion in the classification of coccolithophorids. It is illustrative that the most abundant and common species, *Pontosphæra huxleyi* Lohm., has been shown to include three taxonomical units with different coccoliths[1]. One is referred to the new genus *Gephyrocapsa* Kamptner, the others to *Coccolithus* Schwartz.



(a) Diagram of coccolith of *Coccolithus huxleyi*. (b) Coccolith seen from above. Photomicrograph by means of the electron microscope. (Photo. T. Markali)

In collaboration with Mr. Toar Markali, of the Central Institute of Industrial Research, Oslo, we have been able to study the coccoliths of *Coccolithus* (*Pontosphæra*) *huxleyi* (Lohm.) Kamptner in an electron microscope. The coccoliths came from a unialgal culture of this species, started by the junior author during a stay on board weather ship *M.* off Norway last summer.

Fig. *a* shows a diagrammatic drawing of a coccolith, according to information obtained by means of the electron microscope and a Leitz phase-contrast microscope. Fig. *b* is a photomicrograph taken in the electron microscope of a coccolith seen from above. The thin lower disk can be seen through the central opening in the upper disk. The picture shows the following new details in the structure of the coccolith. (1) The upper disk consists of a large number of radial elements, which, on their inner end, also form a cylindrical connexion with the lower disk. (2) The lower disk does not have a central opening corresponding to that of the upper one. This last feature is of special taxonomic interest, since it is in contradiction to the definition of the tremalith, the coccolith type which includes the placoliths of *Coccolithus*.

A further study of a number of coccolithophorids by this method may be expected to necessitate a redefinition of the various types of coccoliths and possibly also a reclassification of Coccolithophoridaceæ.

A more detailed description of the coccoliths in *Coccolithus huxleyi* and *Syracosphaera carterae* is being prepared by us in collaboration with K. Ringdal Gaarder and T. Markali for publication in *Nytt Magasin for Botanikk*.

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Statistical Theory of Atomic Nuclei

STATISTICAL methods have been applied to the explanation of the properties of atomic nuclei for quite a long time[1]. Hitherto, the energy of nuclei could be represented only in such a way that, according to the choice of the empirical parameters in the interaction energy of the nucleons, either for light nuclei or for heavy ones, the calculated values show noticeable discrepancies from the experimental values.

The purpose of the present communication is to calculate the binding energy of nuclei according to the statistical theory, assuming a scalar Yukawa potential for the nucleon interaction. The calculations are carried out on the general principle of the minimization of energy with the help of Ritz's method, without any arbitrary assumptions. We have supposed that the part of the interaction energy which depends only on the mutual distance of the nucleons is the same for the neutron–proton, neutron–neutron and proton–proton interaction and has the form:

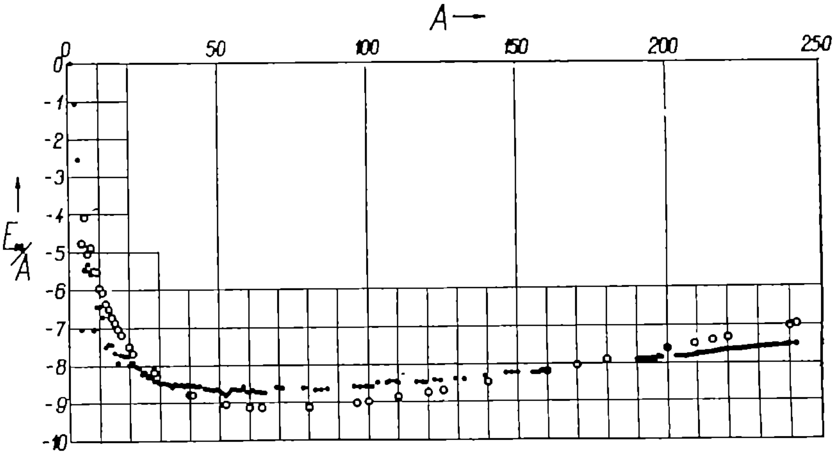
$$J(r_{ik}) = -\gamma\,\frac{\exp(-r_{ik}/r_0)}{r_{ik}}, \qquad (1)$$

where r_{ik} denotes the mutual distance of two nucleons, r_0 the Compton wave-length of the π-mesons and γ an empirical constant. If for the mass of the π-mesons, M_π, the value of 285 electron masses is chosen—a value experimentally obtained by Powell and his collaborators[2]—one has

$$r_0 = \frac{h}{2\pi M_\pi c} = 1{,}355 \times 10^{-13}\ \text{cm.}, \qquad (2)$$

where h denotes the Planck constant and c the velocity of light.

For the attractive energy between the nucleons, a pure exchange energy has been assumed. As further energy terms of the statistical nucleus, we have taken into account the kinetic zero-point Fermi energy, the kinetic inhomogeneity correction of Weizsäcker and further the Coulomb repulsive energy of protons as well as the Coulomb exchange interaction energy between protons, arising from the Coulomb interaction of protons[3]. All these energy terms are functions of the neutron density $\rho_n(r)$ and proton density $\rho_p(r)$, where r is the distance from the centre of the nucleus.



Nuclear energy per nucleon, E_{n}/A, as a function of the mass number A.
O, calculated values, ●, empirical values for stable nuclei; ○, empirical values for unstable nuclei

Our task is to determine the density distributions which make the total energy of the nuclei a minimum. The density distributions must fulfil the following conditions: first, the density distributions must be normalized with respect to the given number of neutrons and protons in the nucleus; secondly, at great distances from the nucleus, the density distributions must rapidly decrease to zero; and thirdly, for reasons of symmetry, the slope of the density distributions must vanish in the centre of the nucleus.

The first step of the Ritz method consists in setting up for the density distributions the following functions:

$$\begin{aligned}\rho_n(r) &= \rho_{n0}\exp(-a^2r^2/r_0^2)\\ \rho_p(r) &= \rho_{p0}\exp(-a^2r^2/r_0^2),\end{aligned} \qquad (3)$$

where a denotes a variational parameter and ρ_{n0} and ρ_{p0} are normalizing factors. For these one obtains, from the normalizing conditions, $\rho_{n0} = Na^3/(\pi^{3/2}r_0^3)$ and $\rho_{p0} = Za^3/(\pi^{3/2}r_0^3)$, where N and Z denote the number of neutrons and protons respectively. According to (3), in the first approximation, the density distributions of neutrons and protons have been assumed to be equal, and a difference between the two density functions has been taken into account only inasmuch as the normalizing constants ρ_{n0} and ρ_{p0} are generally different because, except in the case of light stable nuclei, N is not equal to Z. Inserting the density functions in the energy expression, the energy becomes a function of the variational parameter a, which can be determined from minimization of the energy.

In the whole theory the only empirical parameter is the constant γ in (1). It will be shown that, by an adequate choice of this single parameter for the binding energy of nuclei, results can be obtained which are, from the lightest to the heaviest nuclei, in very good agreement with the experimental results. The discrepancies between the calculated values and the empirical ones are, except for very light nuclei, less than 7 per cent; for very light nuclei, the binding energy of which is not a monotonic function of the mass number, the statistical theory can give, of course, only a mean value of the strongly fluctuating empirical value, which is actually achieved by the statistical theory. In the accompanying diagram, for given mass numbers A, the calculated values of the nuclear energies per nucleon, E_{0s}/A, of the nuclei with the deepest energy are represented with the empirical ones[4].

The atomic numbers Z of the nuclei with the highest energy for given mass numbers A are also very satisfactorily obtained by means of the theory, the discrepancy between them and the empirical atomic numbers being throughout smaller than 8 per cent.

That the statistical theory developed here—applicable, according to its character, in the first place to nuclei of large mass number—offers such good results also for light nuclei is to be attributed to the fact that we have introduced two corrections. On one hand, we have eliminated from the statistical expression of the exchange interaction energy of equal nucleons the energy resulting from the self-exchange of the nucleons. On the other hand, a correction has been introduced for the kinetic energy whereby the statistical kinetic energy for the nucleus ^{4}He and for lighter nuclei goes over into the exact wave-mechanical expression. By the use of these corrections, the statistical expression of the total energy of light nuclei is found to approximate closely to the wave-mechanical expression and gives a good mean value for the empirical results.

A detailed account of this work will be given in the *Acta Physica Hungarica*.

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Compare, for example, Heisenberg, W., "Theorie des Atomkerns", 161 (Max-Planck Institut fur Phys., Gottingen, 1951).

Concerning these energies, compare, for example, Gombás, P., "Die statistische Theorie des Atoms und ihre Anwendungen" (Springer, Vienna, 1949).

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Cores of Terrestrial Planets

ONE feature of Prof. H. C. Urey's new theory[1] of the development of the planets is that it leads him to conclude on several grounds that the earth's central core has an iron composition. This conclusion is in conflict with Ramsey's proposal[2] that the density throughout the earth's deep interior, at least below a depth of 1,000 km., is essentially determined by pressure right through to the earth's centre rather than by change of chemical composition. The conclusion as stated is also in conflict, though to a less degree, with my proposals, which differ from Ramsey's through finding a balance of evidence[3] in favour of a separate chemical composition, such as nickel–iron with possibly some denser material, for the earth's *inner* core, but agree with Ramsey's in postulating a modified ultrabasic rock composition for the outer part of the core, that is, between depths of 2,900 km. and 4,980 km.—the region that I have referred to[4] as 'E'; the latter postulate will be referred to as α. On the further hypothesis, β say, that the terrestrial planets have a common primitive composition, Ramsey's theory implies that neither Venus, Mars nor Mercury has an inner core, whereas my work favours the view that all three have inner cores.

The purpose of this communication is to show that evidence can be brought to bear to qualify a number of the arguments by which Urey infers an iron composition for the region E. At the same time, it is interesting that strong new support is found for the suggestion that the inner core is chemically distinct from the rest of the earth. Four main points will be considered, as follow:

(1) Urey appears to accept Elsasser's conclusion[5], based on Bridgman's experimental results and calculations of Feynman, Metropolis and Teller[6], using a Thomas–Fermi–Dirac model, that a silicate composition for the region E "appears to be excluded". I have recently shown, however, that Elsasser's calculations are unsatisfactory in an important particular, a criticism which has been accepted by Elsasser (in a personal communication). My investigation leads me to the view that, on balance, the data of Bridgman and of Feynman, Metropolis and Teller tend slightly to favour a silicate composition for the region E, although they do not provide a crucial test. The details, which are intricate, are being published elsewhere.

(2) Urey considers that the mass and radius of Venus are so similar to those for the earth "that they can be made to fit any theory that accounts for the Earth". Actually, calculations by Jeffreys[7] on Venus show that, on the assumption β, the hypothesis that the region E is chemically distinct from the mantle is untenable; the hypothesis yields 1 : 5·6 for the ratio of the mass of the central core of Venus to the total mass of Venus, as against a ratio of 1 : 4·1 for the earth. This discrepancy is in significant contrast to the measure of agreement obtained with observational data on Venus by Ramsey and myself on the opposite hypothesis α.

(3) In respect of Mars, Urey directs attention to the discrepancy found by Ramsey in fitting this planet to the hypotheses α and β. But I have shown[4,8] that if use is made of the earth model B[8], constructed from the hypothesis[9] that compressibility is a smooth function of pressure through the earth's deep interior, then α and β fit the observed radius, mass and ellipticity of Mars within the standard errors of observation. I am repeating these calculations using revised observational data quoted by Urey, but unless the revision brings to light unexpected changes, Mars must be regarded as giving good support to α and β, the earth model B having been constructed without any *ad hoc* adjustment to fit planetary data.

(4) Observational data on Mercury prior to 1950 were considered to be too imprecise to be used as a test of α and β. Rabe's recent calculations[10], based on the perturbations of Eros, give the mass of Mercury as 0·0543 times that of the earth, an increase of order 20 per cent from the previous estimate. Estimates of the value of Mercury's diameter are still very uncertain, and, taken along with Rabe's value of the mass, lead to estimates of the mean density ranging from 4·6 to 5·2 gm./cm.^{3}. Such values are incompatible with the possibility that Mercury may have the same mean density at zero pressure as other planets, and Urey interprets this as a further test against the presence of a silicate core in the earth.

If Rabe's revision is accepted, it is necessary to accept with fairly high probability that, in relation to the hypothesis β, Mercury is an exceptional planet in some important respect; only a considerable future upward revision of estimates of Mercury's diameter could affect this conclusion. But Mercury may still be exceptional in this respect and yet at the same time compatible with α and β.

An obvious exceptional feature of Mercury is that it is the nearest planet to the sun, and it now turns the same face to the sun. According to radiometric measurements, the present temperature of the subsolar point at perihelion is 685° K., and the molecular weight of escaping molecules at this point would be about 70. This would permit the escape of some of the ingredients of an initial rocky mantle provided they could be volatilized sufficiently readily. Various mechanisms could be suggested for bringing about the temperature necessary for such volatilization; of these perhaps the most likely is that, earlier in the history of the solar system, the orbit of Mercury was much more eccentric than now and that Mercury was once much nearer the sun at perihelion. The suggestion then emerges that Mercury may well have lost not merely a normal atmosphere, but also an appreciable proportion of an initial rocky mantle, by volatilization and subsequent escape, and that Mercury was thus once a considerably larger planet.

On this suggestion, Mercury could still have the same primitive composition as the earth, Venus and Mars, and the region *E* of the earth could still be modified silicate rock. In fact, on this set of assumptions, it should be possible (subject, of course, to a number of uncertainties, including the uncertainty of the value of Mercury's diameter) to estimate the mass of the primitive Mercury; it is hoped to present this estimate in a later paper.

The suggestion here made may possibly bear some relation to the mechanism which Urey proposes, in his theory, for the fractionation of silicate and iron phases in various planets, taken in conjunction with the statement in his main thesis "that the primitive planets consisted of a grossly homogeneous mixture of silicate and iron phases". The statement quoted is consistent with hypothesis β and is consistent with ideas I have favoured. But the possible significance of Mercury's proximity to the sun leads me to question whether the present mean density of Mercury can properly be used for discriminating in favour of a predominance of the iron phase in the region *E* of the earth.

On the other hand, it would seem that the probability is now increased against that part of Ramsey's view which holds that the earth's inner core is essentially a second pressure modification of ultrabasic rock. On Ramsey's view, Mercury has no core, and Urey's criticism cannot be so readily met by assuming a substantial loss of material in the course of Mercury's evolution. A substantial loss would imply the presence of a modified-silicate core in the primitive Mercury, and, in the absence of a chemically distinct inner core, loss of the core would lower the mean density appreciably.

On the question of the difference between the views of Ramsey and myself, it may be stated that all available astronomical evidence now favours a distinct chemical composition for the earth's inner core. The observational data on all four of (*a*) the mass and diameter of Venus, (*b*) the mass and diameter of Mars, (*c*) the figure of Mars, and (*d*) the mass and diameter of Mercury, independently favour the presence of inner cores in these planets.

It has already been suggested by Jeffreys[11] that Urey's stimulating theory, which rests in large part on arguments from physical chemistry, may need some modifications in order to meet arguments from other sources; and it will be of interest to know how far hypothesis α can be fitted into Urey's theory of the origin of the planets without disturbing other important conclusions.

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Radio-Frequency Radiation from Tycho Brahe's Supernova (A.D. 1572)

Since the discovery of localized sources of extra-terrestrial radio-frequency radiation in 1948[1], surveys have been carried out over the whole sky[2,3] and the positions and intensities of about one hundred sources are now known. Although a few of these sources have been identified with extra-galactic nebulæ[3-5], it is generally considered that the majority must lie within the Galaxy with a distribution, and perhaps a density, similar to that of the common visual stars[6]. However, it has not yet been possible to associate the radio sources with any class of visual objects in the Galaxy, and in only one instance has an identification been made, namely, the identification of a source in Taurus with the Crab nebula[7]. As the Crab nebula is believed to be the remnant of the supernova of 1054, it is to be expected that the remnants of other supernovæ are also sources of radio radiation. The other supernovæ known to have occurred in the Galaxy are those of 1572 and 1604 but the published surveys show no radio source in either of these positions.

Recently, a detailed survey[8] has been made of the region of the sky which lies within the field of view of the 218-ft. paraboloid at the Jodrell Bank Experimental Station. The observations have been made at 158·5 Mc./s., and at this frequency the aerial has a beam-width of 2° between half-power points. In this survey a number of localized sources of radiation have been detected, several of which have not been reported previously. The co-ordinates of one of these sources agree closely with those of the supernova of 1572, as shown in Table 1, and in view of this agreement the radio source may be tentatively identified with the remnant of the supernova.

Table 1. Data on Radio Source and Supernova (1572) Epoch 195

	R.A.	Declination	Intensity*
Radio source	00h. 21m. 49s. ±2m.	N. 64° 15′ ±35′	1·7 × 10^{-24} W./sq.m./c/s. ± 25 per cent
Supernova of 1572 (ref. 10)	00h. 22m. 0·2s.	N. 63° 52′ 12″	

* The intensity given is twice that observed in one plane of polarization.

The chief difficulty in observing this source lies in its proximity to the intense source Cassiopeia I (R.A. 23h. 21m. 12s., declination N. 58° 32′, Epoch 1950 [5]), and when it was first observed in 1951 there was some doubt as to whether it was genuine, or represented the reception of the nearby intense source in a side lobe of the aerial beam. This doubt has now been removed by means of a special interferometer which observed the two sources simultaneously, and showed that the radiation received from the source in the position of the supernova is incoherent with that received from Cassiopeia I. The proximity of this source to Cassiopeia I presumably explains why it was not reported in the survey made with an interferometer at 81 Mc./s. by Ryle, Smith and Elsmore[3].

Table 2 shows a comparison between the visual data available for the supernovæ of 1054 and 1572 and the intensities of the associated radio sources.

Table 2. COMPARISON OF THE SUPERNOVÆ OF 1054 AND 1572

Supernova	Apparent visual magnitude at maximum brightness	Apparent integrated photographic magnitude of remnant	Intensity* of associated radio source (watts/sq. m./cps.)
A.D. 1054	−6·5 to −7·0 (ref. 9)	+9 (ref. 10)	19×10^{-24}†
A.D. 1572	~ −4 0	> +15 (ref. 11)	$1{\cdot}7 \times 10^{-24}$

* The intensity is given for 158·5 Mc./s. and is twice that observed in one plane of polarization.

† This intensity is taken from the spectrum of the radio source given by Stanley and Slee (ref. 2).

No visible remnant of the supernova of 1572 has yet been observed, and the integrated photographic magnitude given in Table 2 represents the upper limit to the intensity, as estimated by Baade[11].

There is a difference of about 2·5 magnitudes between the intensities of the two radio sources, and this is equal to the difference between the apparent visual magnitudes reached by the supernovæ at maximum brightness. There is, however, a much greater difference of at least 6 magnitudes between the integrated photographic magnitudes of the remnants of the supernovæ. In view of the present lack of knowledge of the processes involved both in a supernova and in the emission of radio-frequency radiation from a localized source, it is not possible to offer any explanation of this discrepancy.

The discovery of a source in the position of the supernova (1572) supports the conclusion, originally based only on the observation of a source in the position of the Crab nebula[7], that the remnant of a supernova is a source of intense radio-frequency radiation. This phenomenon is of great interest since no satisfactory mechanism for the generation of the radiation has yet been proposed. Further evidence could be gained by a careful search for a radio source in the position of the supernova of 1604, which unfortunately lies outside the field of the 218-ft. paraboloid. The region has already been surveyed by Stanley and Slee[2] at 100 Mc./s., and no source in this position has been reported. However, their survey had a limit of detection of about 10^{-24} W./sq. m./cps., and the present results indicate that a source in the position of the supernova (1604) may have been overlooked.

The work has been carried out at the Jodrell Bank Experimental Station of the University of Manchester. We wish to thank Prof. Z. Kopal for directing our attention to the problem and Prof. A. C. B. Lovell for his interest in the investigation. One of us (R. H. B.) is indebted to Imperial Chemical Industries, Ltd., for a research fellowship, and the other (C. H.) to the Department of Scientific and Industrial Research for a maintenance grant.

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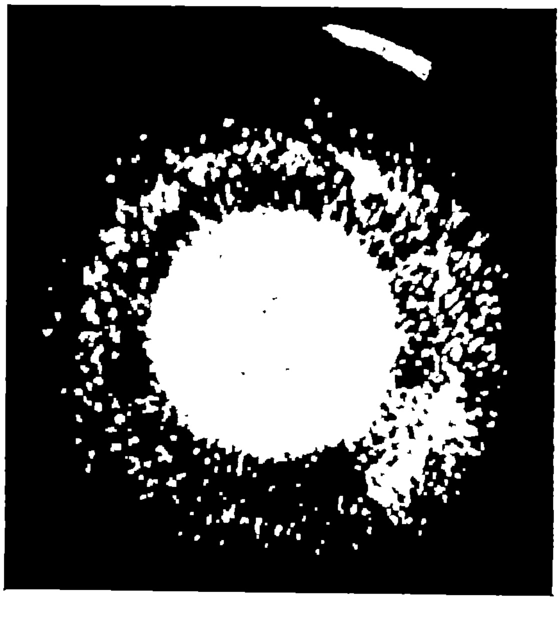
Radio Echoes and Lightning

OBSERVATIONS are being made by 10-cm. radar at Salisbury, Southern Rhodesia, on distant and overhead storms and rain clouds.

On one occasion with a thunderstorm passing overhead, the vertically directed radar beam gave several unusual echoes which occurred simultaneously with lightning flashes. The echoes were recorded by a time-lapse camera used to photograph the P.P.I. screen. A copy of one of these photographs is reproduced herewith. It shows a circularly symmetrical precipitation echo, and a lightning echo appears as a curved streak of unusual brightness. In this particular case the height of the echo base above ground was 26,600 ft., the vertical depth of echo was 1,900 ft. and the echo duration 0 39 sec. The temperature at this level, from the early-morning *radio-sonde* sounding, was − 26½° C. Rotation of the P.P.I. scan was anticlockwise.

In other photographs obtained, but less suitable for reproduction, two echoes occurred concurrently and separated by varying intervals of height.



The echoes are being analysed in terms of the individual strokes comprising a discharge to ground, with special reference to the junction-streamer process described in a recent paper by Malan and Schonland[1]. It is suggested that the echoes originate from ionized portions of the cloud charge. A detailed paper is being prepared for publication.

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[1] Malan and Schonland, *Proc. Roy. Soc.*, A 206 (1951).

Anomalous Properties in Quartz

Attempts to estimate quartz in certain New Zealand clays by the differential thermal method have revealed the occurrence of a variety with abnormal inversion properties.

The phenomenon was first observed[1] in clays occurring in the North Auckland peninsula as residual deposits formed by the weathering of dacite and rhyolite flows. These clays consist of 40–60 per cent of quartz, the balance being halloysite with minor amounts of felspars and accessory minerals. The quartz exists in two forms, one of which shows the normal α ⇌ β inversion at 573° C., while in the other form the inversion is more sluggish than usual and occurs at 555–560° C. The abnormal form is usually concentrated in the sizes below 75 microns.

Since the original observation in 1945, similar phenomena have been observed in decomposed rhyolite at Mount Somers, South Canterbury, and in well-weathered greywacke at Glen Massey, New-castle Survey District. The associated clay mineral in these cases is kaolinite. In the North Auckland occurrences cristobalite and tridymite are frequently present.

When treated by the pyrosulphate fusion technique of Trostel and Wynne[2], the 0–10 micron fraction of clay from Parua Bay, Whangarei, yields pure quartz of the low-temperature (560° C.) inversion type. Measurements on this material show: (1) chemical composition, 99·3 per cent SiO_2; (2) X-ray diffraction pattern indistinguishable from normal quartz; (3) thermal expansion curve of the quartz type, but with a total expansion at 600° C. of 0·85 per cent, as against 1·10 per cent for normal quartz of the same particle-size; (4) the α ⇌ β inversion although more sluggish than normal, and the accompanying heat effect approximately half the normal value; (5) normal conversion to cristobalite above 1,470° C.

The evidence indicates that there exists a modification of quartz in which the mechanism of inversion differs from the normal. The ceramic implications of this observation will be obvious, and in particular the use of the differential thermal method for the quantitative estimation of quartz requires more critical consideration than it has hitherto received.

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Feb. 5.

[1] McDowall, I. C., and Dunn, L. R. L., N.Z. Pottery and Ceramics Research Association Tech. Rep. No. 1 (1947).

Trostel, L. H., and Wynne, D. J., *J. Amer. Ceram. Soc.*, 23, 18 (1940).

Abnormal Thermal Behaviour of α-Quartz from some New Zealand Soils

In 1947, McDowall and Dunn[1] reported the differential thermal curves for free quartz in eigh New Zealand clay deposits. They pointed out tha the peaks of the α–β inversion were broader than those of quartz–alumina mixtures, and that in one case a small sharp peak at 573° C. was associated with a broader one at 555–560° C., resulting in an unusua double peak. The properties of these unusual forms of quartz are further described by McDowall and Vose[2].

In 1948, during an investigation of minerals in New Zealand soils, a number of soils were found to contain a form of quartz which, although shown by X-ray to be normal, well-organized α-quartz failed to give the usual pronounced thermal effec due to α ⇌ β inversion in differential thermal analysis The soils in which this form of quartz occurs include Mangatea silt loam from Katoa, Whirinoki clay loam from Hokianga, and Puhoi clay loam from Waiwera These are weakly or moderately leached yellow-brown earths derived from sandstone or mudstone. They occur in locations some hundreds of miles apart and there is no suggestion at present that their parent material has a common origin. Their mineral colloids contain appreciable amounts of quartz, illite and montmorillonite. Quartz is highest in their silt fractions (between 2 and 20 microns equivalent diameter).

Characteristic behaviour is illustrated by the quartz from the silt fraction of the *B* horizon of the Mangatea silt loam. This silt appeared from X-ray diffraction to contain about 50 per cent of α-quartz, but its thermal pattern, judged by peak height and area corresponded to less than 5 per cent of α-quartz 53 per cent of free silica was separated from the silt by the pyrosulphate fusion method of Trostel and Wynne[3]. The separated material contained more than 99 per cent of SiO_2 and appeared from X-ray diffraction to consist almost entirely of α-quartz but its thermal pattern corresponded to less than 10 per cent of α-quartz.

This form of quartz differs from the form of quartz in clay deposits described by McDowall and Vose[2]. The quartz from clay deposits has broadened peaks in the neighbourhood of 560° C., whereas the form from soils has a characteristic peak at 573° C. much smaller than that expected from the amount of α-quartz present. The thermal expansion of the quartz from clay is abnormal, whereas that of the soil quartz is normal. Cristobalite and tridymite are present in the quartz from some of the clay deposits but none is detected in the soil quartz, although cristobalite has sometimes been reported in soils containing montmorillonite.

Berkelhamer[4] has stated that chalcedony registers a perfect quartz X-ray pattern but gives a reaction at the α ⇌ β inversion point equal in magnitude to that produced by approximately 1–4 per cent of quartz. This result is confirmed with New Zealand samples of chalcedony.

Optical examination of the silica residue of Mangatea silt loam was made by Mr. J. J. Reed Geological Survey, New Zealand Department of Scientific and Industrial Research, who found that the sample contained a small amount of normal quartz, but consisted mainly of glassy isotropic material of refractive index 1·50, which is lower than that of chalcedony (1·537), the latter being ghtly lower than that of quartz (1·5442 and 5532).

It is possible that the small reactions at the inrsion point of both chalcedony and the glassy aterial described are due to the presence of some rmal quartz. It also seems that chalcedony may in some way intermediate between normal quartz d the glassy material.

The evidence of the quartz from clay deposits ows that it is possible for a thermal effect related the α ⇌ β inversion to occur at a lower temperature d more sluggishly than the normal change. Witht further evidence it is not possible to determine the behaviour of the quartz from soil and chalcedony related or a separate phenomenon.

Whatever the mechanisms of the thermal effects, is certain that the occurrence of the form of α-artz described above would cause errors in any antitative estimation of soil quartz based solely the differential thermal method.

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epartment of Scientific and Industrial Research,
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Twin Flames

SINCE Wolfhard's spectroscopic investigations of e reactions in a widened combustion zone at reuced pressures[1], the appearance and disappearance a variety of chemical species in different regions the luminous zone of hydrocarbon Bunsen flames ave been demonstrated[2].

In the course of some studies on the effect of fuel dditives on the laminar flame velocity of hydrorbons burning in air at atmospheric pressure, we ave found that in mixtures of fuels of widely differg reaction velocities (propane and diborane), within rtain air – fuel limits, the reaction zone of a Bunsen ame separates into two distinct luminous regions (Figs. 1*A*, *B*, *C*). In this twin flame, the first luminous zone is believed to be due to the oxidation of diborane, the second to the oxidation of the hydrocarbon. As the air – fuel ratio is decreased, the diborane oxidation continues in a well-defined reaction front, and the hydrocarbon reaction zone disappears gradually and changes into a diffusion flame (Figs. 1*D*, *E*). Careful manipulation of the flow system enables one to quench the hydrocarbon reaction while still retaining the primary zone of the diborane oxidation. A plot of flame velocities (determined by the Smith–Pickering method[3]) with varying oxygen content in the mixture exhibits two maxima, one near the stoichiometric air – fuel ratio based on the total fuel, the other near the stoichiometric air – fuel ratio based on B_2H_6 – air, considering the hydrocarbon as non-reacting diluent (Fig. 2).

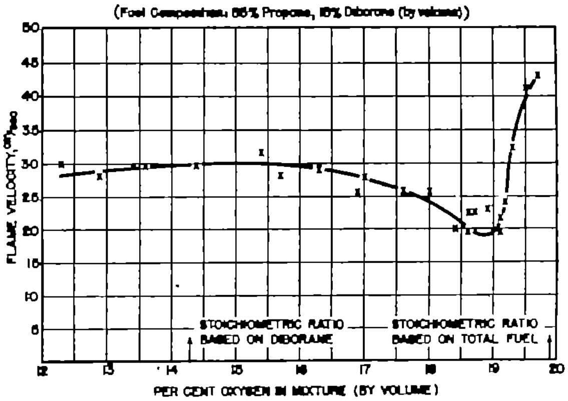

Fig. 2. Flame velocity of propane–diborane mixtures in air

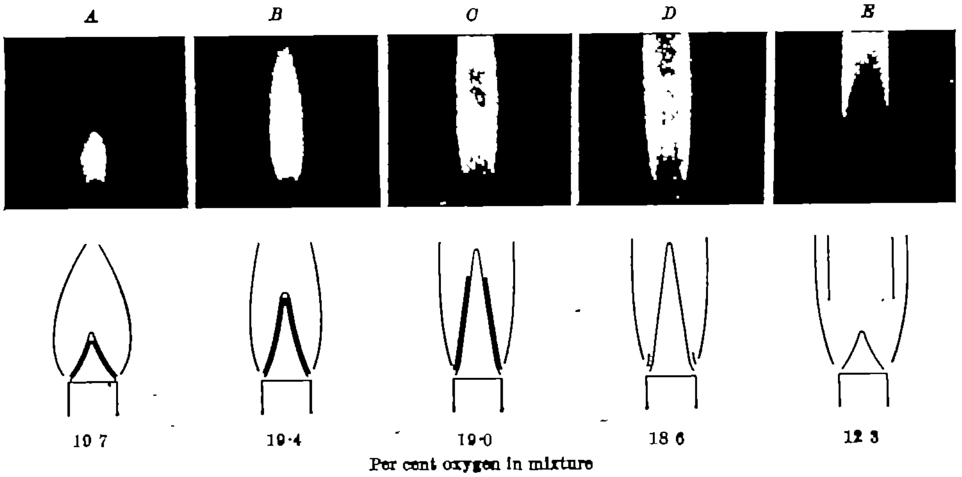

Fig. 1. Variation in twin flame fronts of diborane–propane–air mixtures with decreasing oxygen content

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Sedimentation of Halloysite

IN the North Auckland peninsula of New Zealand there are extensive deposits of halloysitic clays formed by weathering of dacite. Attempts to determine the particle-size distribution of a well-crystallized sample from Matauri Bay, Whakarara Survey District, have revealed anomalous sedimentation behaviour.

A suspension having a concentration of 1 per cent by weight was prepared by tumbling for 16 hr. in 0·003 per cent sodium pyrophosphate solution, and the Andreasen pipette procedure was used to determine the concentration at 10, 5, 2 and 1 microns. The average of four determinations is given in the accompanying table.

PERCENTAGE OF HALLOYSITE REMAINING IN SUSPENSION AFTER SETTLING

Settling time (min.)	Nominal size (microns)	Percentage finer than size
16	10	97·3
62	5	97·7
355	2	97·4
1,760	1	97·5

Fig. 1, which is an electron micrograph of the top of the suspension after three days settling, shows that there are many large particles remaining in suspension and that the size distribution determined by the pipette method has no relation to the true size-range. On prolonged standing, a clear layer develops at the surface and is followed by a zone of rapidly increasing concentration. Fig. 2 is an electron micrograph of the suspension 1 cm. below the surface, and at the top of this cloudy layer after two months standing. Although generally finer than after three days standing, there are numerous particles of one micron and larger.

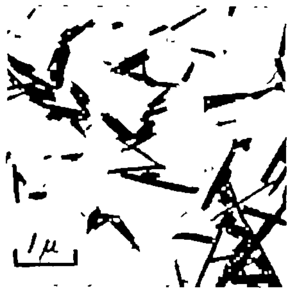

Fig. 1. After standing for three days

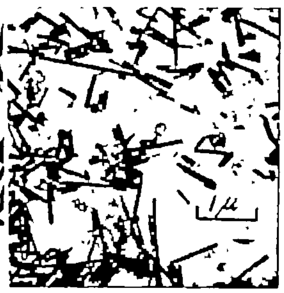

Fig. 2. After standing for two months

It is suggested that the long rod-shaped particles form a loose lattice structure in the suspension and that this impedes the settling of the particles. The slow decay of this lattice on standing leads to the formation of a clear layer at the surface.

The electron micrographs were prepared by Mr. K. I. Williamson, of the Dominion Physical Laboratory, Department of Scientific and Industrial Research, New Zealand, and our thanks are due to the Director of that Laboratory for permission to reproduce them.

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Decomposition of Organic Matter by Recoil Atoms from an Adjacent Phase

DURING experiments involving the irradiation mixed powders of uranium oxide and graphite the Harwell pile, BEPO, we found evidence the decomposition of organic matter present in t graphite caused by fission processes occurring in t adjacent oxide phase.

'Ultra-fine' colloidal graphite powder from Mess Acheson, Ltd., was intimately mixed with an equ weight of uranium dioxide of 5 μ nominal partic size. The mixture was heated in vacuum at 200° for 4 hr. in a silica vessel prior to irradiation. Th vessel was connected by silica tubing to the Toepl pump outside the pile, so that gases evolved durin irradiation could be collected, measured and analyse by the Blacet–Leighton technique[1]. The rate evolution of gas could be determined by operatin the pump at regular intervals and measuring t length of bubble in the calibrated delivery capillar

The rate of evolution of gas showed immedia response to changes in pile power-level in a mann which suggested that thermal effects were not t cause. Moreover, the measured temperature und steady conditions at full power was only 75° C while the rate of gas evolution at 200° C. pri to irradiation was a negligible fraction of th experienced at full power.

Similar experiments with graphite alone, uraniu oxide alone, and with mixtures of zinc oxide an graphite gave very much smaller amounts of gas.

Material	Thermal neutron dose (n cm.$^{-2}$ × 10^{-17})	Gas evolved (mm.^{3}/gm graphite)
ZnO + graphite	16·5	0·5
Graphite	3·8	0·8
UO_2	4·3	81 (per gm. of UO_2)
UO_2 + graphite	3·8	1,332

This makes it clear that most of the gas evolve from the mixture of uranium oxide and graphite dependent on the fission process in the uranium oxid and that the material being decomposed is not in th uranium oxide phase. Fission fragments and th atoms which they displace evidently pass into th adjacent graphite phase and cause decomposition organic matter. The nature of this organic materi is unknown; but thermal tests above 500° C. hav shown the presence of appreciable organic impurit in the samples of graphite used.

It is interesting to note that for the mixtu of uranium oxide and graphite, the whole of th available energy of the fission fragment (mo of which would be lost in the uranium oxid phase) was only about 400 times the energy d posited in the graphite from pile neutron radi tion alone, yet the evolution of gas from th mixture was more than 1,600 times that from th graphite alone. Fission fragments and the ato which they displace are evidently much more efficie in causing the decomposition of organic matter tha the atoms displaced by neutron scattering.

Our thanks are due to the Director, Atom Energy Research Establishment, for permission publish this communication.

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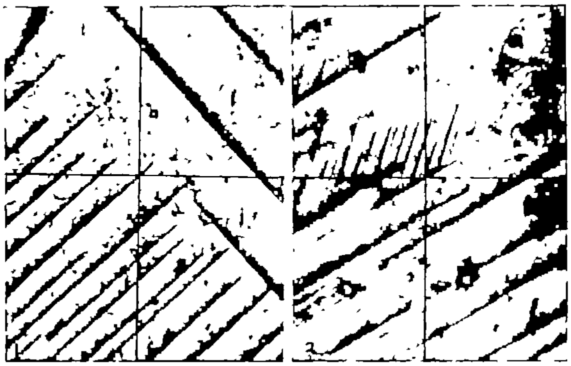
Twinning Structure in Crystals of Tungsten Trioxide

ɩ MICROSCOPIC examination of crystals of tungsten ɔxide (WO_3) has revealed a type of twinning very ıilar to the domain patterns characteristic of the roelectric (tetragonal) phase of barium titanate ıTiO$_3$). This similarity is significant in view of ı reported ferroelectric behaviour of tungsten ɔxide[1].

Ihe crystals, examined under the polarizing croscope, were grown by sublimation of the pours from a molten solution of tungsten trioxide solved in barium chloride, and contained in a ıtinum crucible. Their normal crystal habit was the form of very thin plates which varied in their nensions up to 5 mm. Most of them were almost nsparent and ranged in colour through various ıdes of pale green. Apart from the truly single ɣstals, many of the specimens showed a highly inned structure when viewed in a direction normal the plate surface. In polarized light, a series of rrow, parallel bands, in general, extended diagony across the crystal at an angle of approximately ' to the edges. From the effects of optical extinction th respect to the directions of vibration of the larized light, it was determined that the unit cell es of one domain are perpendicular to those of neighbour. These conclusions agree essentially th the observations of Ueda and Ichinokawa[2]. In dition to the fact that the cell axes, lying in the ıne of the crystal, differ only slightly from each ıer in length, this appears to be a prerequisite for ɘ formation of this domain pattern which is aracteristic of the ferroelectric phase in general. tetragonal barium titanate[3], the *a* and *c* axes of the ıt cell differ by approximately 1 per cent only. In ɘ analogous case of tungsten trioxide, the *a* and ıxes, which lie in the plane of the crystal plates, ıve a difference of less than 3 per cent[4]; the much orter *c*-axis is perpendicular to this plane. The mmetry of tungsten trioxide has been given as clinic[4] because of the slight distortion of the interial angles from 90°. However, for purposes of ıcussion, the crystal may be described in terms of pseudo-orthorhombic symmetry[3] with a twinning ıne {110}.

The boundary between contiguous domains appears tically as a fine dark line. This may be due either distorted unit cells at the junction, or to an actual smatching between the respective lattices. The n-uniform optical extinction which often occurs at ɘ boundaries would seem to indicate that these ɡions are in a highly strained state. This is especially vious in the wedge-shaped domains, or those which ve been formed by the convergence of their boundɣ planes within the crystal (Fig. 1). The banded main pattern presumably results from the relief internal strains developed during the growth of ɘ crystal, the wedge domains merely representing arrested or partial twin development.

On the larger specimens, twinning on a broader ıle was commonly observed, whereby the crystal divided into areas or distinct groups of line patterns iented at right angles to each other. From the companying photographs it can be seen that the ıdge domains exhibit a wide variation in width, d many of them have bifurcated ends. In Fig. 2 ıall branch domains can be seen developing from ɘ larger ones at an approximate angle of 45°, that parallel to the crystal edges. It is significant that this 'feather' structure appears to develop on one side only of the boundary. All these peculiarities may be assumed to be the result of internal strain.



Domain structure of tungsten trioxide crystals. × 200.
(1) Wedge domains showing the dark areas caused by internal strain. (2) Feather-like development of the domains

A more detailed explanation of some of the structural peculiarities of tungsten trioxide will be reported later.

I wish to thank the Director of the British Electrical and Allied Industries Research Association for permission to publish this communication.

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March 25.

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Occurrence of Small-angle X-Ray Diffraction Maxima in some Artificial Cellulose Fibres

DIFFRACTION at small angles in cellulose fibres and rayon has been investigated by several workers[1]. Generally, a diffuse scattering increasing towards the primary beam has been observed on the equator of the fibre diagrams, with no distinct maxima characteristic of long spacings.

In fibres from highly oriented polyamides and from some other synthetic polymers, such as 'Terylene' and polythene, maxima at small angles have been observed on the meridian of the fibre diagram and have been related tentatively to a periodicity in the length and arrangement of the crystalline and non-crystalline regions in the direction of the fibre axis[2]. In well-oriented cellulose fibres no meridional maxima have been reported so far.

In an investigation on the small-angle scattering of various types of artificial cellulose fibres, exposed in the air-dry as well as in the water-swollen condition, we have found that some specimens in the water-wet state do show a distinct, though rather broad, equatorial maximum at small angles.

The exposures were made in a vacuum camera constructed by Backers in the Laboratory of Technical Physics of the Technical University, Delft, under the direction of Prof. H. B. Dorgelo and afterwards improved by Daams. This is essentially a three-slit arrangement with a metal wire for inter-

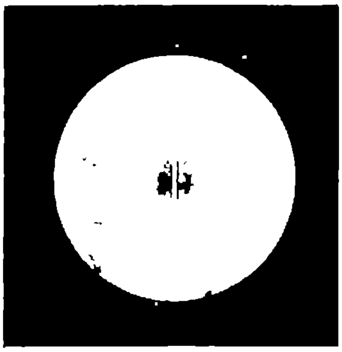

Fig. 1

ception of the primary beam[1]. The specimen-to-film distance is 77·6 mm. and the smallest observable diffraction angle 2 θ amounts to 0·0044 radians for copper radiation (corresponding to a Bragg spacing of more than 300 A.). In blank exposures no radiation whatever is detected on the film.

The fibres were exposed mounted parallel on a small rectangular wire frame, either in the air-dry condition or in the water-swollen state. In the latter case, the wire frame was enclosed in a small vessel provided with parallel windows made from very thin polymethylmethacrylate film and entirely filled with water. It was found to be essential to use radiation strictly monochromatized by reflexion from a crystal face.

Under these conditions, the photometer curves of the fibres exposed either dry or in the vessel filled with water are free from 'background' (that is, the blackening drops off to a zero value at some distance from the primary beam), and a blank exposure of the vessel with water does not produce any detectable blackening of the film in the small-angle region. (Exposure times were about 8 hr., using a powerful rotating-anode tube.) If nickel-filtered copper rad tion is used, there is always a considerable bac ground and, moreover, the small-angle maxima, present, can scarcely be detected. This reveals t occurrence of rather large amounts of parasi 'white' radiation of uncontrollable intensity even ve near the primary beam. Under these conditio blank exposures of the vessel also give rise to blacke ing of the film.

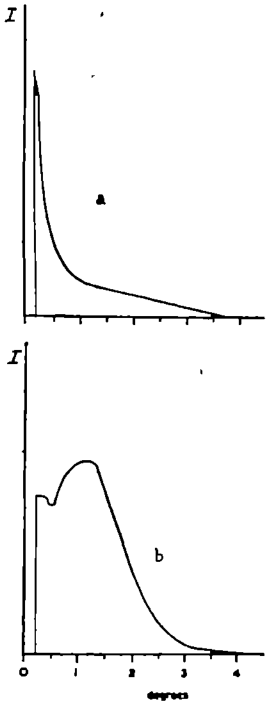

Fig. 2. Fibre *G*: (*a*) dry; (*b*) wet

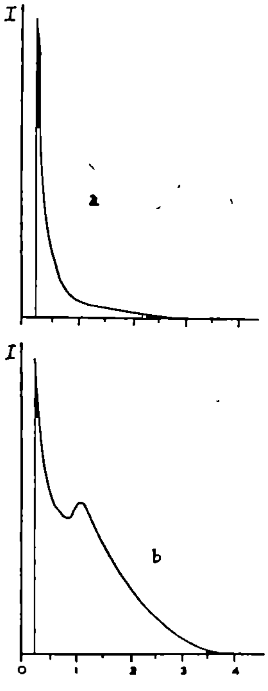

Fig. 3. 'Fortisan': (*a*) dry; (*b*) wet

Fig. 1 is the monochromatic exposure of Fibre in the wet state. In Figs. 2 and 3 are reproduced t photometer curves of monochromatic exposures Fibre *G* (sample by courtesy of Du Pont de Nemou Wilmington, Del.) and of 'Fortisan' (Celanese Cor in the air-dry state (*a*) and in the water-swoll state (*b*).

The positions of the maxima for the wet e posures correspond to Bragg spacings of 77 A. a 84 A., respectively. In the case of 'Fortisan' (Fig. there is clearly an additional continuous small-an scattering, increasing steeply towards the prima beam. In Fibre *G* (Fig. 2) there is no indication o similar continuous scattering.

We wish to leave open for future discussion t interpretation of these maxima. At all events th indicate some rather pronounced lateral periodic in the structure which is quite unexpected in artific fibres.

No maxima have shown up in other rayons so f investigated; but work is in progress to extend t range of specimens.

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April 25.

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Reaction of Vitamin A Aldehyde with Plasma Albumin

Cohn[1] has shown that carotene and vitamin A a concentrated in fraction III-O of plasma, which a lipoprotein. It has been known for some time[2] th vitamin A can occur in water-soluble form in t urine of human beings in certain pathological co ditions. In such cases protein is invariably prese in the urine. It does not follow, however, that uri which contains protein can take up vitamin A wh added to it. Adequate explanation of this phenomen has not been forthcoming. The function of vitamin in the visual cycle has been very elegantly demo strated by Wald[3]. Recently, Morton[4] has shown th retinene, which is an important factor in the visu cycle, is vitamin A aldehyde, and he has also show how it can be prepared in the laboratory. It w therefore considered that attempts should be ma to prepare a water-soluble compound of vitamin with plasma protein and study its properties. T present preliminary communication summarizes t results obtained in this Institute.

Plasma albumin solution. This was prepared following Cohn's method[6], as follows. Bovine plasma was diluted with acetate buffer and brought to *p*H 5·9 at a temperature of – 3° to – 5° C. in a 'Thermos' flask, using a freezing mixture. To this was added, very slowly, a well-cooled solution of ethyl alcohol and acetate buffer (95 : 5) until the alcohol concentration of the mixture reached 40 per cent. Half an hour later, the mixture was filtered at a low temperature through Whatman filter paper No. 42. The clear filtrate, the protein content of which is entirely albumin[7], was diluted with phosphate buffer, *p*H 7·5, and an aliquot was dialysed in a rotary dialyser in a current of phosphate buffer (*p*H 7·5) in a cold room. Samples were taken at intervals and tested for the presence of ethyl alcohol by conversion to acetaldehyde, which was detected[8] by Schiff's reagent (max. absorption at 485 mμ). After dialysing for 36 hr., the albumin solution was found to be free from ethyl alcohol. After filtration and dilution, the absorption spectra of the albumin solution was taken (Fig. 1). It will be seen from the graph that the protein has an absorption peak at 280 mμ, which agrees with the value quoted in the literature[9].

Vitamin A aldehyde. Vitamin A acetate (1 million I.U./gm. in oil) was saponified with alcoholic potash, and vitamin A alcohol extracted with petroleum ether (40–60°). It was purified by chromatography, and vitamin A aldehyde prepared by Morton's method[5]. The absorption spectrum of the aldehyde was checked and found to have a peak at 369 mμ in petroleum ether. The solvent from an aliquot was removed *in vacuo.*

The residue was dissolved in ethyl alcohol and added to an aliquot of albumin solution. The mixture was shaken gently for about half an hour, and then dialysed in a rotary dialyser against phosphate buffer at *p*H 7·5, in the cold room. Tests for the presence of ethyl alcohol were carried out at intervals. After dialysing for 36 hr., the solution was found to be free from ethyl alcohol. It was then filtered and the absorption spectrum was taken after the necessary dilution. Two well-defined peaks, one at 280 mμ, characteristic of the protein used, and the other at 378 mμ due to the new chromophore, were found (Fig. 2).

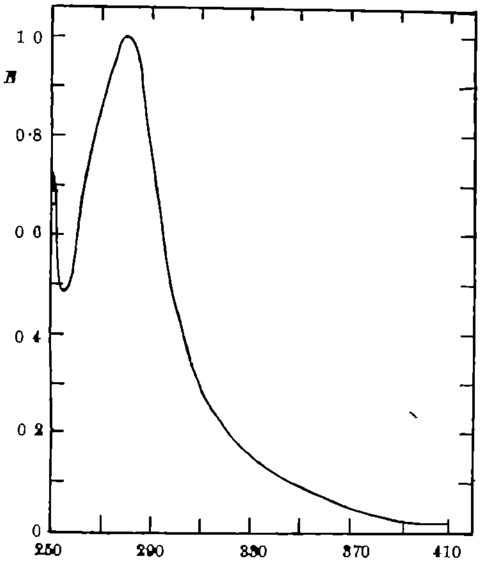

Fig. 1. Absorption spectra of plasma albumin in phosphate buffer (*p*H 7·5)

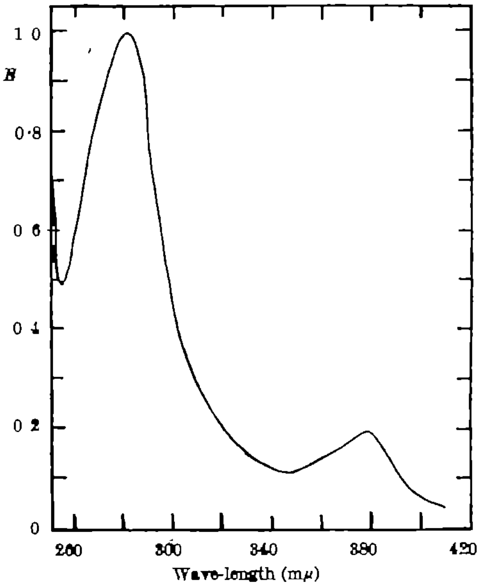

Fig 2. Absorption spectra of condensation product of plasma albumin and vitamin A aldehyde in phosphate buffer

The solution of the albumin–vitamin A aldehyde complex, suitably diluted for spectrophotometric study, gave the following analysis for albumin (micro-Kjeldahl method) and aldehyde : (i) protein content, 0·968 gm./100 c.c. of solution ; (ii) vitamin A aldehyde, 2·985 × 10^{-5} gm./100 c.c. of solution ; aldehyde content as percentage of protein content, 0·003.

In normal human plasma[10], 120–200 I.U. of vitamin A is associated with 6–8 gm. of protein ; that is, 1 gm. of protein is associated with approximately 6 μgm. of vitamin A. In the condensation product of protein and vitamin A aldehyde, 100 gm. of protein is associated with 3,000 μgm. of vitamin A aldehyde, which is roughly equivalent to five times the concentration of vitamin A alcohol present in normal blood.

The sample of vitamin A acetate used was kindly supplied by Messrs. Hoffmann LaRoche and Co., Basle. We thank the Indian Council of Medical Research for financial support, and also Col. C. K. Lakshmanan, director of this Institute, for encouragement in the work.

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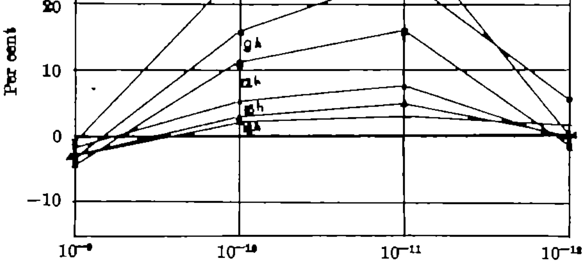
Sensitivity of Cress Roots to Indole-Acetic Acid

In 1939, Thimann[1] recorded in a discussion on the growth of roots: "The amount of auxin normally in these roots is not far from the optimum for their growth, so that further addition could be expected to accelerate growth only slightly". A marked increase in the root growth induced by indole-acetic acid should be obtained only if the supply of the acid in the root is less than the optimum; thus distinct increases have been produced with de-capitated roots depleted of their own source of indole-acetic acid[2]. However, experiments with *Lepidium sativum*[3], *Linum usitatissimum*[4] and *Artemisia absinthium*[5] have shown that it is possible to accelerate the root-growth of germinating seeds.

We found that the roots of germinating cress seeds have no constant growth-rate in spite of constant conditions. The measurements began 24 hr. after sowing. At intervals of 3 hr. the lengths of the roots were measured. At first the growth-rate increases to a maximum, then it decreases. The root of a cress seedling passes through three phases of growth: (1) at the beginning of germination a phase with a low growth-rate; (2) a phase of maximum growth-rate; (3) a phase of decreasing growth-rate. We were able to demonstrate by the determination of the indole-acetic acid content in roots of the second phase (5–6 mm. long) and of the third phase (20–25 mm. long) that the concentration of the acid in the short roots is about double that of the long roots. The amount of indole-acetic acid available to the roots determines the growth-rate. An acceleration of the growth-rate (about 15–20 per cent) was obtained with cress seedlings of the harvest 1944 and 1947, if the measurements were carried out in the third phase. The cress roots are sensitive to indole-acetic acid if their growth-rate is less than optimal.

The difference in duration of the first and second phases is evidently connected with the amount of indole-acetic acid in the seeds. We showed[6] that the amount of the acid contained in cress seeds of different years of harvest and of the same seedsman (H. Hild, Marbach, Germany) may be different: seeds of the year 1950 contain about ten times as much indole-acetic acid as seeds of the year 1947. The third phase is reached early with seeds of 1944 and 1947, late with seeds of 1949 and 1950.

The accompanying diagram shows the result of an experiment carried out with cress harvested in 1949, in which the effect of immersing the roots in indole-acetic acid for different lengths of time was determined[7]. The greatest increase occurred after a short treatment. As the roots approach their phase of maximum growth-rate, their sensitivity to the acid decreases progressively. If the acid is added to roots in the maximum growth-phase there is no response.



Lepidium sativum (harvest, 1949). Percentage increase (+) and inhibition (−) of the growth of roots in comparison with control (o–o– line) at various concentrations of indole-acetic acid and various treatment times

The roots of the cress seedlings which are susceptible to indole-acetic acid must be used either during the first or the third phases, but not during the period of maximum growth-rate (second phase). Even then the concentration of indole-acetic acid must be low, 10^{-10} gm./c.c. or less. Thus before the test is applied, it is necessary to determine the growth-curve of the available seeds.

It is believed that the causes of the low growth-rates in the first and third phases are different. In the first phase, the supply of indole-acetic acid is insufficient, because there is a delay while the reserves in the seeds gradually become available. These processes of activation are very uncertain, and it is rather difficult to bring them under control. Therefore, the results show great variability. In addition, the errors involved in measuring small increments (1–3 mm.) are greater. A real deficiency of indole-acetic acid occurs during the third phase because the reserves in the seeds run low. The seedlings are in the dark, and the normal supply is not established. The response to indole-acetic acid is very uniform, and the measurement of the larger increases (17–22 mm.) can be done more exactly.

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Isolation of a Carbamido Acid from Autolysed Yeast

Samples of baker's yeast that have undergone autolysis in presence of toluene or chloroform give an intense red colour reaction when boiled with diacetyl in hydrochloric acid, which is characteristic of compounds of the type[1] $—CH_2—NH—CO—NH_2$. Of the natural urea derivatives at present known, citrulline is the only one that gives a red carbamido diacetyl reaction; urea, itself, gives a yellow colour; allantoin and allantoic acid give varying shades of orange-pink, probably due to urea liberated under the conditions of the test; cyclic ureides do not react chromatically. Hence, it was assumed at first that the yeast reaction was due to citrulline, originally present as a unit, or arising from arginine by desimidation.

With the object of identifying the chromogen, the autolysate obtained from 6 lb. of baker's yeast was filtered, diluted and subjected to displacement chromatography on 'Zeo-Karb 215'. The progress of the operation was followed by means of the diacetyl reaction, and the carbamido-rich portion of e effluent was collected and treated with copper rbonate. After recrystallization, a series of copper omplexes was obtained, from which the most bundant fraction was selected for investigation. It iffered completely in solubility and appearance from e known citrulline copper compounds. After reoval of the copper, the carbamido derivative was olated by recrystallization from water, and was btained as an ash-free, almost colourless microrystalline powder, the melting point of which reained constant at 238–239° decomp., after three ecrystallizations. The yield was approximately 00 mgm., from 6 lb. of yeast. Analysis: C, 44·1; I, 7·8; N, 15·0 per cent, corresponding to the ormula $C_7H_{14}O_4N_2$, which requires: C, 44·2; I, 7·4; N, 14·7 per cent.

Properties. The compound is very soluble in cold ater, forming an acid solution. It is almost insoluble n absolute ethanol and other neutral organic solvents. ormaldehyde titration gives a value corresponding o one active $—NH_2$ group per C_7 unit.

Function tests. (1) Carbamido diacetyl reaction, eep red; (2) *para*-dimethylaminobenzaldehyde in /1 sulphuric acid, bright yellow; (3) ninhydrin in ot, saturated boric acid, slow grey-violet (α-aminocids react much more rapidly and vividly under the ame conditions); (4) nitro-chromic test for primary nd secondary alcohol groups[2], slow; (5) lactose est for short-chain primary amines and ethanolmine[3], negative; (6) Millon reaction for phenols, egative; (7) aldehyde tests for indoles, negative; 8) pentacyanoferrate test for amidines and guanidxines[4], negative; (9) Sakaguchi reaction for subtituted guanidines, negative.

The investigation was supported by a grant to one f us (W. A. B.) from the Medical Research Council f Ireland, and is being continued.

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Role of Progesterone in the Mating Behaviour of the Ewe

IT has been postulated[1–3] that a waning corpus uteum in the presence of a developing follicle is ecessary to produce œstrus in the ewe. One attempt o test this hypothesis by treating the anœstrous we with 2–5 mgm. progesterone before gonadotrophin njection yielded negative results[1]. Pretreatment vith 40–100 mgm. testosterone propionate has esulted in some 75 per cent incidence of œstrus ollowing pregnant mare serum injection[4]; but rates f conception are low. This low conception is due o either suppression of ovulation or to faulty ynchronization between ovulation and œstrus[3].

During December 1951, at which month ewes of British breed are in deep anœstrus in Australia, experinents were carried out on the Werribee State Research Farm near Melbourne, with the object of determning the role of progesterone in inducing mating ehaviour. In the first trial, four groups, each of seven mature Suffolk ewes, were treated with 1,000 I.U. pregnant mare serum subcutaneously in saline, alone or in combination with 35 mgm. progesterone subcutaneously in oil. They were sacrificed at appropriate intervals after treatment and, in those ewes served, the Fallopian tubes were washed out in the search for ova. Treatments were as follows: (1) 1,000 I.U. pregnant mare serum alone; (2) 1,000 I.U. pregnant mare serum + 35 mgm. progesterone simultaneously; (3) 1,000 I.U. pregnant mare serum 24 hr. after 35 mgm. progesterone; (4) 1,000 I.U. pregnant mare serum 48 hr. after 35 mgm. progesterone. Results are shown in the accompanying table.

Treatment No.	No. of ewes	No. of ewes ovulating	No. of ewes in œstrus	No. of ewes yielding fertile ova
1	7	4	–	–
2	7	7	–	–
3	7	7	–	–
4	7	7	3	2

No significance is attached to three ewes failing to ovulate in group 1. All three had extremely small ovaries containing only rudimentary follicles. It is considered significant, particularly in view of subsequent work, that œstrus was observed in three ewes of group 4, but not in any other group. Œstrus and ovulation occurred 2, 3 and 5 days after injection of pregnant mare serum. It is also significant that fertile ova were recovered from two of the three ewes coming into œstrus. No ovum was recovered from the third ewe. None showed any evidence of a spontaneous corpus luteum which could have reacted with the injected gonadotrophin, so heat and ovulation are attributed to a progesterone–gonadotrophin synergism. The response obtained has approached physiological normality more closely than the previously reported testosterone–gonadotrophin synergism, and has yielded fertilized ova after a single injection of pregnant mare serum.

Two subsequent trials, in which progesterone was administered in 50 per cent ethanol both subcutaneously and intravenously up to 48 hr. before the injection of pregnant mare serum, yielded negative results, the ewes ovulating without œstrus. This indicates that pretreatment some time before an injection of pregnant mare serum, and slow absorption of the progesterone, are necessary for induction of œstrus; treatment earlier than 48 hr. before injection is indicated.

It is suggested that the action of progesterone is to develop receptors in organs such as the uterus, for example, these receptors responding to subsequent œstrogen stimulation resulting in œstrous behaviour. This view receives some support from the observation that tonic uterine contractions, normally present at œstrus, are absent at ovulations induced by gonadotrophin which are unaccompanied by œstrus[5]. Since œstrus with ovulation was observed as early as 48 hr. after administration of pregnant mare serum, and since progesterone did not appear to act like testosterone and inhibit or markedly delay ovulation, this would appear to preclude the suggestion[3] that progesterone acts simply by delaying ovulation.

Further work is planned for the next anœstrous season. Grateful acknowledgment is made to the staff of the Werribee State Research Farm, and in particular to Mr. Bruce McGregor, for their cooperation. Progesterone was kindly given by the

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Synthesis of Diphosphopyridine Nucleotide by Cell Nuclei isolated in Aqueous Media

IT has recently been demonstrated that reasonably homogeneous preparations of cell nuclei can be isolated in good yield from rat or mouse liver[1]. By means of centrifugal fractionation of liver homogenates prepared in an aqueous medium (0·25 *M* sucrose – 0·0018 *M* calcium chloride), it has been possible to obtain 70–90 per cent of the nuclei with a minimum of cytological alteration in preparations containing by direct count less than 1 per cent of the intact cells of the tissue and less than 0·5 per cent of the free mitochondria of the homogenates.

The value of this method in cytochemical studies obviously depends on the permeability of the nuclear membrane. In this respect, Allfrey *et al.*[2,3] have contended that cell nuclei isolated in aqueous media are ill-adapted for studies of enzyme localization, primarily because extraction of water-soluble proteins is said to occur. These investigators have described a tedious method for the isolation of nuclei in organic solvents, utilizing desiccated tissue as the starting material. We are of opinion that it is unnecessary to resort to non-aqueous media.

Evidence for the integrity of nuclei isolated in aqueous media (other than their relatively high protein content[1]) has arisen from a study of the distribution in mouse liver homogenates of the enzyme catalysing the synthesis of diphosphopyridine nucleotide from nicotinamide mononucleotide and adenosine triphosphate. In a number of experiments, 69–101 per cent of the diphosphopyridine nucleotide-synthesizing activity of the homogenates was recovered in the nuclear fraction. Approximately 3 per cent of the original activity was found in the mitochondrial fraction, and the remainder was present in a fraction containing submicroscopic particles and the soluble material of the cytoplasm. The specific activity of the isolated nuclei (2·0–2·4 micromoles of diphosphopyridine nucleotide formed per hour per milligram of total nitrogen at 38°) was greater than that of the homogenates by a factor of 5–6. The higher recoveries of enzyme in the nuclear fraction (an average of 92 per cent in four consecutive experiments) were obtained when a step known to cause nuclear damage was eliminated from the fractionation procedure, and it seems entirely possible that the small amount of activity found under these conditions in the cytoplasmic fractions may have been the result of nuclear damage during the initial homogenization of the liver. When the isolated nuclei were disrupted by exposure to sonic oscillations[4] for 10 min. at 2°, approximately 85 per cent of the activity remained unsedimented after centrifugation for 30 min. at 130,000 times gravity.

The synthesis of diphosphopyridine nucleotide by liver cell nuclei is of interest for several reasons. Th enzyme involved is a water-soluble protein that ha been purified to a considerable extent[5]. Thus, a least in this one instance, the claim of Allfrey *et a* with respect to the extraction of proteins from nucle by aqueous media is not supported. Furthermore, s far as we are aware, the present finding comprise the first example of the clear-cut localization of a enzyme in isolated nuclei. Finally, since a number o diphosphopyridine nucleotide-linked dehydrogenase have been recovered largely in the cytoplasmi fractions[6], the synthesis of the coenzyme by isolated nuclei represents an example of an apparent biochemical interaction between nucleus and cytoplasm

A more detailed description of the present work will be published elsewhere.

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Behaviour of Fertilized Rabbit Eggs exposed to Glycerol and to Low Temperatures

MAMMALIAN spermatozoa, red blood-cells and ovarian tissue suspended in glycerol-containing media have been cooled to, and maintained for long periods at – 79° C. or – 190° C., and have resumed functional activity when thawed and inseminated transfused or grafted[1–4]. The present study of the reaction of fertilized rabbit eggs to glycerol and to low temperatures was undertaken to extend these researches to a different and more active type of cell and one which has not hitherto been found to survive exposure to low temperatures[5,6].

Fertilized eggs were recovered from the Fallopian tubes of rabbits 18–25 hr. after injection of chorionic gonadotrophin and artificial insemination. In preliminary experiments they were transferred to homologous serum containing 15 per cent glycerol at + 20° C. Under these conditions the eggs shrank down within the zona pellucida, presumably because of the hypertonicity of the medium. At + 5° C. the shrinkage was greater. When transferred successively to 2·5, 3·75, 5 and 7·5 per cent glycerol in serum at + 20° C., they contracted and re-expanded during one hour at each stage, suggesting that glycerol was penetrating into the eggs. In the course of treatment with 10 and 15 per cent glycerol, however, they shrank irreversibly, and when incubated in 15 per cent glycerol for 18 hr. or cultivated in serum after removal of glycerol by gradual stages or by washing, they degenerated. By contrast, fertilized rabbit eggs treated in successive 10-min. stages with 2·5 3·75, 5, 7·5, 10 and 15 per cent glycerol in serum at + 37° C. contracted only slightly and quickly re-expanded, suggesting that the ova were more permeable to glycerol at + 37° C. than at + 20° C. The glycerol was then removed at + 37° C. by eversing these stages, and some of the eggs began o divide in 3·75 and 2·5 per cent glycerol and the emainder soon after transfer to serum. The majority continued development *in vitro* for a further 24–48 hr. and became morulæ, showing that brief exposure to glycerol at body temperature has not, apparently, any adverse effect on the egg. The necessity for reatment with warm glycerol is of particular interest, ince most cells and tissues so far tested have tolerated glycerol well at room temperature, whereas the best results with bull spermatozoa were obtained[1] by prolonged soaking in glycerol at + 5° C.

Eggs treated with glycerol at + 37° C. were then ooled to, and kept at, different temperatures. The glycerol was removed after rewarming to + 37° C. and before cultivation. Of different batches superooled in various ways to – 15° C., 75 per cent were viable after one hour, 67 per cent after one day, 40 per cent after two days and 69 per cent after hree days at that temperature. By contrast, only 0–30 per cent of eggs were viable after an exposure of an hour to – 17° or – 20° C., or after four to even days at – 15° C., when the medium had olidified. It seemed, therefore, that 15 per cent glycerol in serum at – 15° C. gave results little different from plain serum[7] at + 10° C. and was unpromising for long-term study of fertilized rabbit eggs.

Other batches of eggs in 10, 15 or 20 per cent glycerol in serum were cooled at different rates to – 79°, – 160° and – 190° C., and left for periods varying from 10 min. to two days before thawing at + 40° C. Immediately after thawing, all the eggs rozen rapidly by the method of Luyet[8,9] were uptured, misshapen or degenerate. By contrast, a high proportion of eggs cooled relatively slowly by the methods used for sperm and ovarian tissue[1,4] were, on thawing, normal in appearance. After emoval of glycerol, however, the majority degenerated. So far, out of a total of 556 eggs slowly cooled either to – 79° or to – 190° C., only six unicellular eggs, each from a different treatment group, have divided normally in culture. Three of them divided nto two blastomeres, two reached the 4-celled stage, and one became 6-celled. Phase-contrast microscopy revealed no abnormalities of cleavage or n their structure.

This result is sufficient to show that exposure to ow temperatures is not necessarily lethal to mammalan ova, even during the highly active and unstable phase between syngamy and segmentation. Further experimentation, especially on the rate of freezing and thawing and on the use of glycerol, should make t possible to increase greatly the rate of survival and elucidate further the processes involved in the reezing and thawing of living cells.

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Origins of the Volatile Fatty Acids in the Rumen

MEMBERS of the saturated fatty acid series C_1–C_7 are formed during the fermentation of wheaten hay or lucerne hay in the rumen of the sheep[1,2], and these acids, together with the methane and carbon dioxide also produced, account for a large part of the carbon of the digestible fraction of the fodder. Cellulose and hemicellulose form the bulk of this digestible material, and protein contributes to it to a lesser degree; it is therefore important to determine the nature of the products formed from each of these main components of the substrate. The fermentation of any particular compound may depend on the activities of a number of different organisms, and the detailed course of the degradation will present a difficult problem, involving, finally, a study of these organisms in pure culture. Its elucidation will, however, best be pursued in the light of knowledge of the products formed from the substance by the mixed culture of rumen organisms.

By means of the methods and techniques previously developed for the study of the fermentation of the natural fodders[3], we have examined the fatty acids produced *in vitro* from cellulose and hemicellulose when fermented alone, or together, or in the presence of wheaten hay. The products were compared with those formed from wheaten hay alone. We have also compared the products formed from a mixture of cellulose and hemicellulose with those produced from the same mixture in the presence of a small quantity of protein prepared from wheaten hay; and finally, we have fermented cellulose in the presence of various amounts of casein. The results of some of these experiments are presented in Tables 1 and 2.

It is clear that the fermentation of both cellulose and hemicellulose gave rise to approximately equal parts of acetic and propionic acids, together with a very small proportion of butyric acid, and that the presence of protein led to the formation of greater proportions of the latter acid. The formation of acetic and propionic acids from cellulose has already been described by Elsden[6] and by Marston[7]; but the production of these acids in approximately the

Table 1. FERMENTATION OF WHEATEN HAY AND SOME OF ITS SEPARATE CONSTITUENTS

Substrate	Composition of acid produced		
	% Acetic	% Propionic	% Butyric (*e*)
Wheaten hay (*a*)	54	26	20
Cellulose (*b*)	48	46	6
Hemicellulose (*c*)	46	45	9
Cellulose, hemicellulose	46	46	8
Cellulose, hemicellulose protein (4%) (*d*)	52	35	13

(*a*) Different samples of wheaten hay may show marked differences in the proportions of acids formed from them. (*b*) Cellulose prepared from wheaten hay by the method of Norman and Jenkins (ref. 4). (*c*) Hemicellulose prepared from wheaten hay by the method of McIlroy, Holmes and Mauger (ref. 5). (*d*) Protein prepared from wheaten hay. (*e*) Butyric acid includes any higher acids of the series which may have been present.

Table 2. INFLUENCE OF CASEIN ON CELLULOSE FERMENTATION

Substrate	Composition of acid produced		
	% Acetic	% Propionic	% Butyric
Cellulose (*a*)	51	42	7
Cellulose, casein (5%)	47	31	22
Cellulose, casein (10%)	44	31	27
Cellulose, casein (20%)	45	25	30

(*a*) Finely ground filter paper.

same proportions from the two constitutionally different substrates, cellulose and hemicellulose, was unexpected, and is particularly interesting from the point of view of the intermediate products involved in each case. Confirmation of these findings with other samples of hemicellulose or with pure pentosans is needed.

Whether or not the degradation of separated cellulose or hemicellulose follows the same pathways as the degradation of the substances within the whole plant structure cannot finally be decided. It is possible that the course of fermentation of a particular substance may be altered by any considerable change in the nature of the substrate as a whole. It is therefore true that some doubt must always remain in the interpretation of these results. In this regard it may be mentioned that the acid formed from a mixture of cellulose (or hemicellulose) with wheaten hay was intermediate in composition between that formed from cellulose (or hemicellulose) on one hand, and that from wheaten hay on the other.

Since only a small proportion of butyric acid is produced from either cellulose or hemicellulose, some other origin for this acid in the fermentation of wheaten hay is implied. It has already been shown that part of the butyric acid in the rumen is synthesized from acetic acid[1], and it is possible that this accounts for the small quantities formed in the cellulose and hemicellulose fermentations. The present experiments suggest that another part of the butyric acid may be derived from the protein fraction of the fodder.

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Stimulating Effect of Amino-Acids on the Survival at 37° C. of *Trypanosoma rhodesiense* in a Serum-free Synthetic Medium

Blood (whole, or as plasma, serum, erythrocytes or laked erythrocyte solution) is an essential component of culture media for many pathogenic Protozoa. The essential nutritive components in rabbit, ox, sheep, horse or pig serum required to maintain pathogenic African trypanosomes in culture at 37° C. in the trypanosoma form have not been investigated extensively since the discovery by Yorke, Adams and Murgatroyd[1] that *T. equiperdum*, *T. rhodesiense* and *T. gambiense* could be maintained under these conditions in an actively motile state and in undiminished numbers for 24 hr.

Suspensions of *T. rhodesiense* were prepared from infected mice and set up according to Yorke's basic technique. Marked variability in culture survival was traced to the serum content of the parasite inoculum. The importance of this factor is shown i experiments using washed parasites (Table 1).

Table 1

Medium*	Serum concentration (v/v)	Survival time (hr.)
BR	6·3 per cent	>6 <23
BR	1·6 ,,	<1
BRG	0·1 ,,	4

* For compositions of media, see later.
† Survival times refer to period during which parasites are active motile and in undiminished numbers.

The more marked effect in the presence of glucos suggests coenzyme activity, and glucose dehydr genase activity at 25° C. of washed *T. rhodesiens* suspensions (M/60,000 methylene blue, M/100 glucos in isotonic phosphate buffered Ringer solution pH 7·4 reaction in Thunberg tubes followed photometricall is, in fact, stimulated by serum even in concentration as low as 0·0004 per cent. Suspensions washed twic in *BR* gave reproducible survival times under standar conditions and were used throughout.

Effect of glucose, trace metal salts and ten 'biologicall essential' amino-acids on T. rhodesiense *survival i sterile isotonic phosphate-Ringer* (*BR*) pH 7·4. Th composition of these solutions was as follows: ('Pyrex distilled water and A.R. grade salts throughout; fin concentrations in μgm./ml.).

BR: NaCl, 4,000; KCl, 100; $CaCl_2$, 100; $MgCl_2.6H_2O$, 25
$NaHCO_3$, 1,000; KH_2PO_4, 1,800; Na_2HPO_4 (anhydr.), 7,57
G: Glucose, 2,000.
M: $FeCl_3.6H_2O$, 0·15, $CuSO_4.5H_2O$, 0·12; $MnSO_4.4H_2O$, 0·01
$NiSO_4$, 0·013; $CoSO_4.7H_2O$, 0·024; $ZnSO_4.7H_2O$, 22.
A: DL-Threonine, 126; L-valine, 63; L-leucine, 158; L-iso-leucin 53; L-arginine HCl, 79; L-lysine HCl, 79; DL-methionin 126, L-phenylalanine, 26; L-histidine, 26; L-tryptophan 21; (total amino-acid concentration, 757 μgm./ml.).

All solutions throughout were sterile and the usu precautions were taken with heat-labile component Effects of these blocks of constituents on surviv are shown in Table 2.

Table 2

Medium block	No. of separate suspensions	No. of individual cultures	Survival time in undiminished numbers (hr.)*
BR	2	6	0·5
BRG	9	11	1
BRGM	48	91	1
BRGMA	38	58	4·5

* Survival times refer to period during which parasites are active motile and in undiminished numbers.

Of the 91 cultures with *BRGM*, 83 survived 1 h and 8 survived 1·5 hr., and of the 58 cultures wit *BRGMA*, 19 survived 4·5 hr.; 9, 5 hr.; 9, 3·5 hr. 7, 4 hr.; 7, 6 hr.; 4, 3 hr.; 2, 5·5 hr. and 1, 7 hr.

An effect quantitatively similar to that of th amino-acid mixture was produced by a vitamin-fre casein hydrolysate (Ashe) at a level of 500 μgm./m Survival was found to be proportional to amino-ac concentration at levels down to 48 μgm./ml., and t casein hydrolysate concentration at levels down t 15 μgm./ml.

Substances without effect on survival on addition *BRGMA*. *Added individually:* DL-cysteine, glut thione, L-cystine, L-tyrosine, L-serine, glycine, D aspartic acid, L-glutamic acid, creatine; ammoniu chloride, urea; citrate, fumarate, malate, succinate xanthine, hypoxanthine, uracil, thymine, guanine an guanidine.

Added together or in a variety of combinations ascorbic acid, aneurin, riboflavin, biotin, pant thenate, pyridoxine, nicotinic acid, nicotinamid inositol, choline, folic acid, p-aminobenzoic acid.

Substances with significant effect (1–2 *hr. prolonga-on*) *on survival on addition to BRGMA*. Adenine, denosine, yeast nucleic acid (commercial), thymus ucleic acid (commercial), adenine and ribose and icotinamide, adenosine and nicotinamide, adenosine nd nicotinic acid.

Rabbit serum ultrafiltered through transparent ellulose (British Sidac, Ltd.; pore size 7–30 A.) and resumably protein-free (biuret negative) has a more arked but, compared with an equal volume of erum, incomplete ability to promote parasite survival 5 hr. with *BR*, *BRG*, *BRGM*, and about 8 hr. with *RGMA*). A comparable effect is produced by 0·2 per ent 'Difco' bacto-peptone.

Effect of gaseous environment. All the above xperiments were carried out in air. Carbon dioxide-ree air, 100 per cent oxygen and 100 per cent itrogen were found to be toxic for cultures in *RGMA* containing water-soluble vitamins, adenine nd ribose. Survival in this medium was enhanced y incorporation of 5 per cent carbon dioxide, and arkedly enhanced by the mixture 5·6 per cent arbon dioxide, 7·8 per cent oxygen, 86·6 per cent itrogen.

This work was carried out in the Department of hemotherapy, Liverpool School of Tropical Medicine, uring the tenure of a May and Baker Research ellowship by one of us (J. W.) and of a Medical esearch Council grant by the other (I. M. R.).

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March 24.

Yorke, W., Adams, A. R. D., and Murgatroyd, F., *Ann. Trop. Med. Parasit.*, **23**, 501 (1929).

Chemical Composition of Mammalian Sperm

Mammalian sperm have been reported by various orkers to contain no nucleoprotamine or nucleo-istone extractable by the usual means (with water r neutral salt solutions)[1]. This has been confirmed n the case of the bull, man, dog, boar and ram, ut basic protein and nucleic acid, having solubility roperties quite different from the usual, have been xtracted from the isolated heads of these cells.

A lipoprotein has also been extracted from the solated heads of the above-mentioned sperm. In the ase of bull sperm, this complex contains slightly ore than 25 per cent lipid, which includes phospho-ipid and cholesterol. The lipoprotein of human perm was found to contain only one component lectrophoretically at pH 8·2.

The sperm heads can be fractionated, by a simple rocedure, into three parts which make up almost all he total substance of the heads. The lipoprotein is btained by extracting with a 0·14 M sodium chlor-de solution adjusted to pH 9 with sodium hydroxide, nd the basic protein and nucleic acid by extracting ith more strongly alkaline solutions. The lipoprotein is precipitated from solution at about pH 5·6, the basic protein in the region of pH 11 and the nucleic acid at about pH 2.

Details of this work will be published elsewhere.

This investigation was supported in part by a research grant, C-1327, from the National Cancer Institute, of the National Institutes of Health, U.S. Public Health Service.

R. Duncan Dallam
Lloyd E. Thomas
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March 24.

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[1] Miescher, F., "Die Histochemischen und Physiologischen Arbeiten von F. Miescher", 82 (Leipzig, 1897). Mathews, A., *Z. physiol. Chem.*, **23**, 399 (1897). Boshijan, G. M., *Trudy Lab Izucheniyu Belka, Akad. Nauk. S.S.S.R., Otdelenie Himicheskih Nauk*, No. 1, 49 (1940). Mirsky, A. E., and Pollister, A. W., *J. Gen. Physiol.*, **30**, 101 (1946). Thomas, L. E., and Mayer, D. T., *Science*, 110, 393 (1949).

Totem Poles and Blood Groups

In reviewing a book on totem poles in the Pacific coast region of British Columbia, Dr. G. H. S. Bushnell[1] accepts the suggestion that "the north-west coastal tribes may themselves have come over from Siberia within the preceding few centuries". This conclusion, which was formerly held, is negatived not only by the fact that the Eskimos have long occupied the whole of the Alaskan coast, but also by the blood groups of the Indians in question.

To test this very question, three hundred of the coastal Indians were blood-grouped many years ago[2]. Although much mixed with Europeans, they showed only 12·7 per cent A, and two B individuals, one of whom was Negroid. If they were a late wave from Siberia, they should have had a high frequency of B, like all the Mongoloid peoples of Asia. Ride and Furuhata afterwards tested 203 more Indians from the same areas with similar results. The high percentage of the O blood group (75–86 per cent) is thus quite incompatible with a late Mongoloid origin of the British Columbia Indian tribes. They must apparently be derived from an earlier stratum of Asiatic population, which is represented, at least in part, by some Tibetans and by certain remnant tribes on Formosa. This subject has also been discussed elsewhere[3].

R. Ruggles Gates
The Athenæum,
London, S.W.1.

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[1] *Nature*, **169**, 725 (1952).

[2] Gates, R. R., and Darby, G. E., *J. Roy. Anthrop. Inst.*, **64**, 23 (1934).

[3] Gates, R. R., "Human Ancestry" (Harvard Press, 1948).

In quoting the suggestion to which Prof. Ruggles Gates takes exception, I did not mean to give the impression that I either accepted or denied it, since I did not feel competent to express an opinion about it.

The first objection, based on the distribution of the Eskimos, does not seem to me to exclude the possibility of a migration by sea. On the other hand, speaking as a layman in matters of genetics, I can only say that the evidence of blood groups seems conclusive, and I am grateful to Prof. Ruggles Gates for directing attention to it.

G. H. S. Bushnell

FORTHCOMING EVENT

Wednesday, September 3—Wednesday, September 10

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Queen's University, Belfast)—Annual Meeting

Wednesday, September 3

At 8 30 p.m.—Prof A. V Hill, F.R.S . "The Ethical Dilemma of Science" (Presidential Address).

Thursday, September 4

At 10 a.m —Prof. A. M Tyndall, F.R.S. · "Contributions to Experimental Physics from Britain" (Presidential Address, Section A)

At 10 a m —Prof. W. Wardlaw . "The Advancing Front of Chemistry" (Presidential Address, Section B)

At 10 a m —Prof. A D. Peacock · "Some Problems of Parthenogenesis" (Presidential Address, Section D).

At 10 a m —Prof. Meirion Thomas, F R S. · "The Anatomy of Metabolism in Higher Plants; Metabolic Processes and Partial Reactions" (Presidential Address, Section K).

At 12 noon.—Prof. P. E Vernon : "The Assessment of Personality" (Presidential Address, Section J).

At 12 noon.—Mr. J Pimlott · "The History of Afforestation in Northern Ireland" (Chairman's Address, Section K*).

At 2 p.m.—Mr. J. A. S. Standall . "Problems and Responsibilities" (Presidential Address, Conference of Delegates).

At 5 30 p m.—Dr. D. W. Bronk, F.R.S. . British-American Association Lecture

Friday, September 5

At 10 a m.—Prof. D T. Jack : "Full Employment in Retrospect" (Presidential Address Section F)

At 10 a.m.—Sir Ben Lockspeiser, F.R.S. . "Progress in Aeronautical Science and Engineering" (Presidential Address, Section G)

At 10 a.m.—Rev. Prof. E. O. James · "Archæology, Folk-lore and Sacred Tradition" (Presidential Address, Section H).

At 10 a m.—Mr A. L. Binns "Education of Africans in East and Central Africa" (Presidential Address, Section L).

At 10 a.m —Dr. N. C. Wright . "Britain's Food Supplies" (Presidential Address, Section M).

At 8 p.m.—Mr. A. C. Hartley · "Oil in Peace and War".

Sunday, September 7

At 8 p.m —Prof. A. Macbeath · "A Plea for Heretics".

Monday, September 8

At 10 a.m —Dr J. E Richey, F R.S.: "Some Aspects of Geological Research and their Practical Application" (Presidential Address, Section C).

At 10 a m.—Prof R. O. Buchanan "Aspects of Settlement in the Overseas Dominions" (Presidential Address, Section E.)

At 10 a.m.—Prof R. C. Garry : "Nervous Control of the Movements of the Alimentary Canal" (Presidential Address, Section I).

At 8 p.m —Sir William Slater · "Science and an Expanding Agriculture".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned ·

AREA CHIEF CHEMIST at the Central and Research Laboratories, Nechells, Birmingham—The Industrial Relations Officer, West Midlands Gas Board, 6 Augustus Road, Birmingham 15 (September 0).

LECTURER IN ELECTRICAL ENGINEERING at the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (September 0).

PHYSIOLOGIST (with a good honours degree in physiology and research experience, preferably involving the perfusion of isolated organs) for research on the bovine udder—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref 52/11 (September 6).

SENIOR LECTURER or LECTURER IN CROP PRODUCTION at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C 1 (September 6).

ENGINEER-IN-CHARGE OF GENERAL AND CO-ORDINATION SECTION (with an honours degree in engineering or equivalent, and wide experience of large power station plant practice) (Ref. AE/279), and an ENGINEER-IN-CHARGE OF BOILER SECTION (with qualifications not below A.M I.Mech E. standard, and a wide knowledge of boiler plant design for large power stations) (Ref AE/280) . in the Generation (Plant Design) Sub-branch at Operational Headquarters in London—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting the appropriate Ref. No. (September 8).

SENIOR LECTURER IN METALLURGICAL ANALYSIS, to Honours B Sc. (Metallurgy) standard, and a LECTURER IN CHEMISTRY—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (September 8)

ASSISTANT LECTURER IN THE DEPARTMENT OF AGRICULTURE (Crop Husbandry)—The Registrar, University College of Wales, Aberystwyth (September 13).

ASSISTANT LECTURER or LECTURER IN CHEMISTRY (with special qualifications in inorganic or analytical chemistry)—The Registrar, The University, Sheffield (September 13).

VICE-PRINCIPAL AND HEAD OF THE UNIVERSITY DEPARTMENT, Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (September 13).

FISHERIES SUPERINTENDENT AND OFFICER FOR THE PREVENTION OF POLLUTION—The Acting Clerk to the Wye River Board, 20 East Street, Hereford (September 15).

RESEARCH ASSISTANT (with a good honours degree and some research experience) IN THE LUMINESCENCE LABORATORY of the Department of Physics—The Registrar, The University, Edgbaston, Birmingham 15 (September 15).

DEMONSTRATOR IN GEOGRAPHY—The Secretary, The University 38 North Bailey, Durham (September 20).

SENIOR RESEARCH OFFICER (Plant Pathologist) IN THE MICROBIOLOGY SECTION, Division of Plant Industry, Canberra, to undertak plant disease investigations and in particular to study fundamenta aspects of host pathogen relationships and the mechanism of resistanc to disease—The Chief Scientific Liaison Officer, Australian Scientifi Liaison Office, Africa House, Kingsway, London, W.C.2, quotin No 3948 (September 27)

ASSISTANT LECTURER IN THE PUBLIC HEALTH ENGINEERING DIVISIO of the Department of Civil Engineering—The Head of the Departmen of Civil Engineering, Imperial College of Science and Technology South Kensington, London, S.W.7 (September 29).

PHYSICAL CHEMIST or PHYSICIST for a research post under th Professor of Chemistry, to investigate the chemical composition o the stratosphere—The Secretary, The University, 38 North Bailey Durham (September 30)

STATISTICIAN (a qualification in statistics, not necessarily medica or in mathematics with experience of statistical work, is essential to work on the problems of human reproductive performance in Aberdeen—Prof. Dugald Baird, Department of Midwifery, University o Aberdeen, Forresterhill, Aberdeen (October 1)

ASSISTANT or ASSOCIATE PROFESSOR OF ANATOMY (preferably wit experience in gross anatomy or neuro-anatomy)—The Dean, Facult of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada.

ASSISTANT LECTURER IN CHEMISTRY, and a RESEARCH ASSISTAN IN METALLURGY—The Secretary, Northampton Polytechnic, St. Joh Street, London, E C.1.

CHEMISTS AND PHYSICISTS (Senior Scientific Officer or Scientifi Officer grade) for work on combustion processes in flames, at th Royal Aircraft Establishment, Farnborough—The Ministry of Labou and National Service, Technical and Scientific Register (K), Almac House, 26 King Street, London, S.W 1, quoting F.557/52A.

DESIGN ENGINEERS at the Atomic Energy Research Establishment Harwell, for work on design of nuclear reactors and their components to take part in design work either as individual designers or in charg of small teams engaged in development of nuclear power systems—The Ministry of Labour and National Service, Technical and Scientifi Register (K), Almack House, 26 King Street, London, S W.1, quotin C.513/52A.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICE (with chemical or biochemical experience) for enzyme research, and SENIOR ASSISTANT (Scientific) with experience in chemistry or biochemistry—The Secretary, Rowett Research Institute, Bucksburn Aberdeenshire

GRADUATE to assist in work on nutritional and toxicological problems—Prof. A. C. Frazer, Department of Pharmacology, The University, Birmingham.

GRADUATE RESEARCH ASSISTANTS (3) IN THE DEPARTMENT O CLINICAL CHEMISTRY, University of Edinburgh · for one post candidates should have a sound knowledge of zoology or comparative physiology and should be trained in histological techniques · for th other two posts training in biochemistry is required—Dr. C. P Stewart, Clinical Laboratory, Royal Infirmary, Edinburgh.

HEAD OF THE ENGINEERING GEOLOGY BRANCH (Executive Engineer Grade II) in the Scientific Services Division of the Snowy Mountain Hydro-Electric Authority Australia—The Engineer-in-Charge, Snowy Mountains Hydro-Electric Authority, 18 George Street, London, W.1

LECTURER, and RESEARCH ASSISTANTS (2), IN BIOLOGY (botan and zoology)—The Secretary, Royal Technical College, Glasgow.

PHYSICAL CHEMIST (with knowledge of the technique of electronics to assist in the development of an installation for the dating of organi remains by the use of radioactive carbon—Dr. H. Godwin, School o Botany, or Dr. A. G. Maddock, Department of Chemistry, The University, Cambridge.

PHYSICAL CHEMIST (Principal Scientific Officer grade) at th Ministry of Supply London headquarters, for the initiation and progressing of research and development work on rubbers for Servic purposes and advice to Service Departments on technical applicatio of rubber—The Ministry of Labour and National Service, Technica and Scientific Register (K), Almack House, 26 King Street, London S.W.1, quoting F.502/52A.

PHYSICISTS and PHYSICAL CHEMISTS (Experimental Officer grade at a Ministry of Supply establishment at Aldermaston—PHYSICA CHEMIST or PHYSICIST with interest, and preferably experience, i work on ceramic materials (Ref F.560/52A), and a PHYSICIST wit experience of X-ray diffraction (Ref A. 219/52A)—The Ministry o Labour and National Service, Technical and Scientific Register (K Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

RESEARCH WORKER with experience in X-ray crystallography, t assist with work concerned with the structures of nucleosides an nucleotides—Dr. W. Cochran, Cavendish Laboratory, Free Schoo Lane, Cambridge

SENIOR BIOCHEMIST (with an appropriate university science degre or the A R I.C., or an equivalent qualification, and wide experience o biochemical work, preferably in hospital laboratories)—The Secretar Derby No. 1 Hospital Management Committee, Babington Building Babington Lane, Derby.

SENIOR EXPERIMENTAL OFFICER at Ministry of Supply Londo headquarters, for duties concerned with research and development o aircraft textile materials in all forms (fabrics, cordages, ropes, etc and involving technical consultations with industry and researc organizations, placing and progressing of contracts and preparatio of specifications—The Ministry of Labour and National Servic Technical and Scientific Register (K), Almack House, 26 King Stree London, S.W.1, quoting F.561/52A

SENIOR PRINCIPAL SCIENTIFIC OFFICER at the Atomic Ener Research Establishment, Harwell, to take charge of mechanic engineering design work in nuclear reactor projects of considerabl magnitude—The Ministry of Labour and National Service, Technic and Scientific Register (K), Almack House, 26 King Street, Londo S.W.1, quoting C.498/52A.

UNIVERSITY GRADUATES IN ELECTRICAL ENGINEERING or in SCIENC Subjects (which must include experimental physics) as ASSISTAN ENGINEERS (temporary) in the Department of Posts and Telegraph Ireland—The Engineer-in-Chief, Leitrim House, Dublin.

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THE INTEGRITY OF SCIENCE

PROF. A. V. HILL'S presidential address to the British Association (see p. 388) takes up as a challenge the concluding paragraph of his predecessor's address at Edinburgh. "It is clearly our duty as citizens to see that science is used for the benefit of mankind. For, of what use is science if man does not survive?" With those words as a text, Prof. Hill proceeds to discuss how far science has already contributed to human betterment, how far it has provided fresh problems, dangers and difficulties, and to suggest ways in which all who are concerned with science can help, as citizens, to make sure that its results, in fact, are beneficial.

Prof. Hill promptly disclaimed for scientists as such any title to superior wisdom or virtue, but proclaimed uncompromisingly that the fundamental principle of scientific work is unbending integrity of thought, following the evidence of fact wherever it may lead, within the limits of experimental error and honest mistake; and since science is a universal interest of mankind, recognizing no barriers of race, class, religion or honest opinion, a necessary condition of scientific advance is goodwill, friendliness and frankness. There is more to science than integrity and goodwill, but these are the qualities chiefly required to utilize the opportunities, and to resolve the problems and difficulties which science has provided for society to-day.

Prof. Hill's address amply illustrates the truth of his own words. Denunciation is unlikely to follow his exercise of the right he claims to discuss not only scientific facts themselves but also their consequences in human affairs; but his address may well provoke controversy, though scarcely comparable with that provoked by Tyndall's presidential address to the Association in Belfast seventy-eight years ago. When new knowledge and traditional beliefs are in conflict men are apt to forget Lord Kelvin's words: "Science is bound by the everlasting law of honour to face fearlessly every problem that can fairly be presented to it".

In reading Tyndall's address to-day, one is impressed, as Prof. Hill remarked, by its reasonableness as well as by its courage. Even when the Association next met in Belfast, in 1902, Tyndall's claim that science would wrest from theology the entire domain of cosmological theory had been practically conceded. Tyndall's words were then seen in their proper context and he was recognized, as Dewar pointed out in his presidential address that year, as no mere materialist, but one who recognized the immovable basis of the religious sentiment in human nature, bringing completeness and dignity to man. Tyndall had admitted that the whole process of evolution is the manifestation of a power absolutely inscrutable to the intellect of man, and acceptance of the necessary limits of scientific inquiry was then perhaps more common than it sometimes is to-day, while his dictum that "every system must be plastic to the extent that the growth of knowledge demands" might equally have formed the text for Prof. Hill's address.

In fact, where we encounter what Prof. Hill calls the ethical problems presented by the advance of science there has been little change in the degree of objectivity with which questions are discussed. It will be noted that, while Prof. Hill starts from the concluding words of the Duke of Edinburgh's address, he promptly applies a corrective to any careless thinking that the Duke's earlier words as to the dependence of progress in almost every form of human activity upon the continued efforts of scientists might engender. "The improvement of man's estate by the application of human knowledge," said Prof. Hill, "is one of the loftiest of adventures: but a belief that it can be achieved by scientific methods alone, without a moral basis to society, is a perilous illusion." Prof. Hill then pointed out, frankly and fearlessly, some of the implications and consequences of advances in public health and sanitation and the control of disease which are often ignored by those framing plans for the development of backward and other areas, such as the Colombo Plan.

Not only is the population increasing but in many places the rate of increase is still rising. In India, a Government Planning Commission in a report of July 1951, "The First Five-Year Plan", dared to point out that, with all the effort that this Plan represented, it would be barely possible to restore by 1955–56 the pre-war standards in regard to food and clothing. Increasing pressure of population on natural resources in retarding economic progress and limiting seriously the rate of extension of social services so essential to civilized existence. Meanwhile there is more than danger that the emergency will result in an over-use of natural resources, leading by land erosion, deforestation and other factors to permanent and irretrievable loss.

This has already happened and is visibly happening now in many parts of the world. With a frankness to which Prof. Hill paid tribute, the Indian Report suggests the education of public opinion on the need for limitation, but it recognizes also that an alteration in population trends takes at least a few generations to materialize. Meanwhile the combating of malaria with insecticides and anti-malarial drugs, of tuberculosis and cholera and other diseases, and the improvement of rural and industrial health, must be recognized as involving a further addition to the population of a million people per annum. Biological, medical, chemical and engineering science, applied for motives of humanity, with no objectionable secrecy, has thus led to a problem of the utmost gravity, demanding for its solution all the resources of science, humanity and statesmanship.

Prof. Hill's address should dispose of the comfortable illusion that it is merely a matter of food supply. The demands which a higher standard of living and an increasing population make on all natural resources are equally disturbing. Prof. Hill has the courage to face the unpleasant but inescapable questions of what reasonable limits are to be placed on human rights, and whether such rights extend to unlimited reproduction while those concerned are screened from its consequences by the discipline and care of others. Such questions have to be fac with courage and honesty and without prejudic They will not be solved by words or by tempo ization.

By taking as example one in which the motives those who made the original discoveries or t humanity of their applications can scarcely be call in question, Prof. Hill made clearer the ethic dilemma implied in such questions as the limits, any, which should be placed on scientific resear and the authority which should determine any su limits, and the wisdom of insisting that all scientif knowledge should be fully and openly disclos without secrecy or reservation of any kind, milita or industrial. The somewhat arid discussions regardin secrecy in nuclear physics are set by him in the wid context of the standards and principles without whic civilization would be permanently and indefinite poorer. If ethical principles deny our right to do ev in order that good may come, are we justified, h asks, in doing good when the foreseeable consequen is evil? Suppose it is certain now that the pressu of increasing population, uncontrolled by disease, w lead not only to widespread exhaustion of the s and of other capital resources, but also to continuin and increasing international tension and disorde making it hard for civilization itself to survive, wh then should be our policy?

Books like "Four Thousand Million Mouths", "Th Geography of Hunger" and "Soil and Civilization", well as some discussions on the development of bac ward areas, have made many in recent months awa of the danger. The ethical dilemma could scarcely b more frankly or better stated than in Prof. Hill address. Moreover, not the least of its merits is tha following the pattern of the Duke of Edinburgh address last year, it helps further to dispel th idea that science and technology are magical mysterious activities, apart from the ordinar occupations of men and women and beyond the comprehension.

That Prof. Hill's address thus contributes to clearer understanding by the ordinary citizen of th nature of scientific work, and especially of the exten and limits of the scientist's responsibility, is the mor important because the address is first and foremo a summons to frank and free discussion. Such di cussion should be the freer from prejudice on th account, and it is to be hoped that it will be marke by both the courage and the integrity for which Pro Hill appeals, to the layman no less than to th scientist. The dilemma is, as he shows, not on peculiar to the scientist: it is one which the scienti shares with his fellow citizens, and besides makin plain to the general public the position of the scientis Prof. Hill insists that to help to guide the use scientific discovery aright is the honourable an compelling duty of a good citizen, whether or not h be also a scientist.

The first need is full and free discussion; but ca should be taken to see that this is not provoked ways that hinder the co-operation between scienc and religion, between the scientist and his fello citizens upon which, like Tyndall, Prof. Hill insist ich co-operation is only possible on the basis of ourage and integrity, and his address is full of plications both for the conduct of political life as ell as for the scientist. Moreover, remarks that read lmost as asides to the scientist in the address are lated closely to this question of co-operation. The arning that the use of the general prestige of science s a bait to attract attention to pronouncements on ther topics is a disservice both to science and to the ublic has its implications for the layman as well as e scientist, but bears very closely on the question f mutual confidence on which co-operation largely epends.

From this point of view Prof. Hill's remarks on the roblem of secrecy in such matters as nuclear research [illegible] practical suggestions to scientists should be oted. They are entirely relevant to his main theme. y considering the ethical basis of their work and ankly discussing the moral considerations which nter in, scientists will go far to establish a confidence n their responsibility and integrity which some ecent episodes have shaken, but which is the nly possible basis for the co-operation and understanding which can reduce these grave problems to anageable dimensions.

Controversial though some of the issues this address aises may be, it is marked by the same reasonableness nd courage that characterized Tyndall's earlier ddress, and its humane outlook and keen sense of oral and ethical values, no less than the modesty nd integrity of its thought, should at least prevent ontroversy from being embittered. Prof. Hill has hown the right way to approach these acute and angerous problems of population and world order nd the utilization of world resources. He indicates learly the limits of the scientist's responsibility, as oo, he impresses on the scientist the need for clear hinking about the ethical basis of his work.

His appeal for responsible discussion is addressed o scientist and layman alike. How far the co-operation he urges will prove effective it is impossible o say. There are too many examples of the way in which religious or national prejudices can override the rational discussion of problems of welfare nd development, even to their own immediate material disadvantage, to be over-optimistic, even without regard to the immense cost and effort required for an education campaign which would quip the backward peoples of the world to meet some of the demands for self-discipline which the situation requires. Nor is education alone adequate o supply the moral qualities which such self-discipline mplies, as we can plainly see in our own and other Western nations.

But without such co-operation there can be no approach made to the solution to the grave problems Prof. Hill passed in review. Co-operation between layman and scientist, as good citizens in the discharge of a common responsibility and in the formation of those judgments of value which in the end determine the use we make of science, is the first step. Ultimately the problem we have to solve, whether as scientist or as layman, is one in the responsible exercise of power, and its solution depends on whether man, having learned to command Nature, can now learn to command himself before he destroys civilization.

To do this is, in Tyndall's phrase, to gain "completeness and dignity", and success depends, as Prof. Hill clearly indicates, not on our resolution of some special ethical dilemma, peculiar to scientific men, but rather on the resolution of the so-called conflict between religion and science. It calls for the use of science to express and apply the principles of ethics, and the use of those principles to guide the conduct of scientific men. In the appreciation of what is good and beautiful, Prof. Hill finds for layman and scientist the vision that can encourage both in the task to which his address summons them.

REPORTING SCIENCE

THE scientific thought of the Western civilization is as much a part of our culture as the developments in the humanities which originated in the Greek and Jewish writings and were nurtured and grew in the centuries of the Christian era. But science, if only in some of its technological manifestations, touches and even moulds the lives and destinies of those who are not interested in culture in its narrow sense. Each year the problem of reporting the results and implications of scientific discovery becomes at once more important and more difficult, but only by communication can we have a true community. It is more important because more of our fabric of living, individually and socially, is dependent on the application of science, and more difficult because, with the increase in the techniques employed by men of science, there has been an increase in the number and complexities of scientific modes of expression. Not only new words and phrases, but also new symbolisms and mathematical calculi are part of the current linguistics of science. Even some of the simplest of processes and expressions used in the calculus of statistics, so valuable in the biological sciences with their applications to human needs, involve great logical difficulties, both mathematical and verbal, for all but comparatively few people.

Because of the present shortage of well-qualified science teachers, even many children who are prepared to take science for the General Certificate of Education (and this is not a large proportion in view of the needs) are not in their adolescent and adult life prepared to understand the significance of the new discoveries of science. In the whole field of adult education in Britain, classes in the sciences account for only 7 per cent of the whole number. Although it is difficult to find suitable tutors, sufficiently well-read in the sciences, and skilful enough as teachers and leaders in adult classes, there still remains the fact that science is not popular, in the true sense of the word, with adults.

The task of explaining science to those whose work lies in some other field is not a new one. In 1633, Phineas Fletcher wrote "The Purple Island" in which he versified physiology. Erasmus Darwin, always optimistic concerning the scientific education of the "ordinary" man, produced "The Botanic Garden" (1789) in rhyme. Fortunately such poetical attempts have not often been followed up, though writers such as Auden have attempted to illuminate the picture of the scientific environment with poetic insight. More than in any other country, British men of science have been able to write clearly and elegantly in their mother tongue. Many have produced work which, quite apart from any scientific significance, has also literary merit. The nineteenth-century writings of Tyndall, Lyell and Charles Darwin still stand as literature. Those of Francis Bacon, Robert Boyle, T. H. Huxley and Gilbert White, to mention a few at random, can be read with pleasure and sometimes with ease. Coming nearer to our times the books in Britain of James Jeans, A. N. Whitehead and J. W. N. Sullivan, whose early death was a great loss to scientific literature, and in the United States the works of Beebe, Sears and, very recently, Rachel Carson, are examples of a good type of vulgarization of science. Nearly all of these writers were men of science.

But what of the reporter who is not a scientific worker, but whose task it is to present news which has to compete in popularity with other forms of news designed to attract public interest and to hold it at any rate until something at least as interesting appears? It would be trite to say that his contribution both in content and emphasis must vary with the type of reader for which his paper caters. It is significant that the only reference in several of our national papers to some dozens of important discourses given during one of the days of the meeting of the British Association for the Advancement of Science in Edinburgh last year was the fact that an important paper on coal supplies had been interrupted with asperity by a "local resident". No doubt this unseemly incident was much better news to those who love sensationalism than a carefully conceived account of the tremendously important fuel and power problem as it will confront our children. It is impossible to blame the reporter or his paper. The matter always returns to the fundamentals of popular education, its contents and its aims.

In the United States, where there is a much greater demand for books and articles on science, and probably also a larger percentage of people who are interested in science, or at least in technology, the reporting of science has had more consideration as to its aims and nature and more organization than it has in Britain. Most of the American writers who report science for newspapers and magazines belong to the National Association of Science Writers which was founded in 1934 for the express purpose of promoting accurate and responsible science reporting. The membership at the present time is upwards of 150. The National Association of Science Writers is affiliated with the American Association for the Advancement of Science.

American publishers and editors say that they have found that it is better to train experienced reporters in science rather than to hope to find sufficient men of science who are able or free to undertake tl type of work. Incidentally, the proper reporting such incidents as a fire, where there is a sequen of observable events, is said to be part of a suitab training of such a reporter; for not only is it necessa to take cognizance of a developing phenomenon, observe true chronology in a chain of events, bu the reporter must also bring to his work an arresti and lively style of writing which will make b 'contribution' compete with that of other news.

Whether he likes it or not, the man of science making history and his work should be explained such.

A number of our American contemporary *Scien* (April 18, 1952) says "good science reporting cou help science itself by explaining research proj[illegible] a public that ultimately pays many of the bi Thanks to accurate reporting of medical and publ health news in newspapers and magazines during tl past few decades, the general public should be fairl well informed on such matters. . .".

Yet with less organization and less advertisemen the quality of writing on science is probably bett in Britain than in any other country. There ca be no doubt that the American Rachel Carson's "Th Sea Around Us" is a good work; but it is, to say th least, no better than the excellent British work "The Ocean", by F. D. Ommaney, and "The Seas' by F. S. Russell and C. M. Yonge, which i splendidly illustrated in colour. Why is the first best-seller, and why did the last have to wait eigh years before a second edition appeared? The answe is probably to be found in advertisement, a matte which is anathema to most men of science.

In the end, charm they never so wisely, the wor of the best science writers will be ineffective unle it is prepared for by a more general and lively teacl ing of science in all types of secondary school, and i this connexion here is No. 1 priority.

BIRD PARASITES

Fleas, Flukes and Cuckoos

A Study of Bird Parasites. By Miriam Rothschil and Theresa Clay. (New Naturalist Series.) Pp xiv+304+40 plates. (London and Glasgow: Wm Collins, Sons and Co., Ltd., 1952.) 21*s*. net.

THE avowed aim of the New Naturalist Series i to interest the general reader in the wild-life o Britain, and the present volume is an outstandin example of the way in which a somewhat specialize branch of natural history—often regarded as 'no quite nice'—can be made of absorbing interest no only to the professional zoologist and amateu naturalist but also to the general reader. Th authors, both distinguished for their work in differen fields of parasitology, have selected the most intensively studied animals of the world—birds—as th starting point for the development of a picture of th vast network of organisms which they harbour bot inside and outside their bodies. This community o parasites comprises animals, plants, bacteria an filterable viruses, whose relationships, life-historie and general biology are very little known.

It is rather surprising that parasitology, a subject resenting so many fields for investigation, should ot have received more attention—at least in Great ritain—for parasites comprise a far greater number f both species and individuals than their hosts. The axonomist will find in them a very wide range of nterest, for to take only one example, the 500-odd ritish birds support very many thousand different arasites, including at least 1,500 species of Mallohaga, few of which have valid scientific names. ertain groups of parasites have been used for trying o demonstrate the true systematic relationships of heir hosts. The Mallophaga, for example, are ighly host-specific, each species being confined to ome particular host, and their evolution has resulted n related birds for the most part harbouring related allophaga. Similarly each order of birds has its wn particular cestode fauna, and the fact that rebes and divers harbour quite distinct tapeworms uggests that these two groups of birds should ot be placed together in any natural scheme of lassification.

The life-cycles of such parasites as trematodes, estodes and nematodes are strange and wonderful, enerally involving perilous journeys through different osts, with a survival-rate from egg to adult of much ss than one in a million. Yet, as pointed out by the ditors of this series, there is not even one worker in ritain wholly occupied with the trematodes or flukes.

The physiology of most parasites is completely nknown; but the little information which is available suggests the existence of highly specialized etabolisms well worth the study of biochemists.

The authors include a general introduction in which arasitism, commensalism, symbiosis, the effect of arasites on their hosts and parasitism on parasites, nd related problems are discussed. After dealing ith the various groups of parasites, ranging from icro-organisms to the arthropods, including a hapter on the fauna of birds' nests, there is an ccount of the brood parasitism in the European uckoo.

The authors are to be congratulated on the production of a book combining so pleasingly both wit nd erudition; it should certainly find a place in very naturalist's library.

E. HINDLE

GENETICAL STUDY OF EVOLUTIONARY PROCESSES

enetics and the Origin of Species

y Prof. Theodosius Dobzhansky. (Columbia Biogical Series, No. 11.) Third edition, revised. Pp. +364. (New York: Columbia University Press; ondon: Oxford University Press, 1951.) 32*s*. 6*d*. et.

T is good to see a new edition of Prof. Dobzhansky's "Genetics and the Origin of Species". The revious edition appeared in 1941, and in ten years great deal can occur in so active a science as the enetical study of evolutionary processes. The many ho valued Dobzhansky's earlier editions will look the new one for an equally informative account of e position as we see it to-day.

The basic principles of the genetical theory of olution are, of course, unchanged. This theory sts on the postulates that heritable variation occurs populations of living things and that, as a consequence, the populations may undergo permanent changes. So in seeking to understand how adaptation and evolution come about, we must inquire into the nature, occurrence and origin of variation in natural populations; into the ways in which heritable variants bring about changes in the structures and properties of these populations; and into the means by which they come to be fixed, both uniformly within populations and differentially between them. In that it is explicitly built round these principles, Dobzhansky's third edition is like its predecessors; but in seeking to take into account the developments of the past decade it has had to be almost completely rewritten.

Ten years ago the discussion of variation centred on mutation and especially on the occurrence of changes which were either visible in the chromosomes themselves or, if genic in nature, produced drastic effects on the phenotype. The growing realization of the importance of continuous variation has moved the emphasis towards the storage of variability, the properties of balance, and the relations they bear to recombination. Dobzhansky's own experimental work has made a major contribution to this development and indeed his studies of variation and balance in wild *Drosophila*, summarized in the new edition, have an elegance and finality which few can fail to admire. All this is reflected in the book, the old being condensed and the new brought out, with perhaps that trace of conservatism understandable in a work which is likely to be so widely quoted.

In discussing selection, Dobzhansky is now able to draw on a much greater wealth of experimental evidence, including, as in the case of mutation, information from micro-organisms. As a consequence, drift, though by no means forgotten, looms less heavily in the consideration of agencies affecting the fate of variants in wild populations. Indeed the part played by drift is necessarily seen in a different perspective when considering the properties of systems of genes than when discussing the fate of single major variants.

Isolating mechanisms, by which genetical diversity is preserved, are again given just prominence. The distinction is drawn between bars to crossing, which can arise by selective action, and hybrid incapacity, which cannot be ascribed to direct selection, and their inter-relations discussed. Hybrid breakdown receives, however, a fuller treatment than do bars to crossing, doubtless because of the greater wealth of experimental evidence about it, especially in animals. This is a matter of emphasis which time can be expected to change. The study of plants has much to offer here, as it has had in laying before us the variety of ways in which a species governs its own breeding structure and genetical composition—a matter on which a geneticist more directly concerned with plants would perhaps have laid rather greater stress.

Argument about emphasis must not, however, be allowed to obscure the value of Dobzhansky's book. The new edition will be as widely appreciated for the picture it sets before us of things as they are to be seen now, as its predecessor was for giving us the picture of 1941. "Genetics and the Origin of Species" has the rare merit of moving with the times—times which Prof. Dobzhansky has himself done so much to move; and it has the even rarer merit of changing not merely by accretion of the new but also by judicious shedding and condensation of the old; for, most remarkable of all, the third edition is in fact shorter than the second.

K. MATHER

HETEROCYCLIC COMPOUNDS

Six-Membered Heterocyclic Nitrogen Compounds with Four Condensed Rings

By C. F. H. Allen, in collaboration with D. M. Burness, Jean V. Crawford, F. W. Spangler, Eleanor R. Webster and C. V. Wilson. (The Chemistry of Heterocyclic Compounds, Vol. 2.) Pp. xiii+345. (New York and London: Interscience Publishers, Inc., 1951.) 10 dollars.

Thiophene and its Derivatives

By Howard D. Hartough; with Special Chapters by F. P. Hochgesang and F. F. Blicke. (The Chemistry of Heterocyclic Compounds, Vol. 3.) Pp. xvii+533. (New York and London: Interscience Publishers, Inc., 1952.) 16.50 dollars.

THESE two volumes are the second and third, respectively, of a series of monographs which are designed ultimately to cover the entire field of heterocyclic chemistry.

The contents of the second monograph of this series, "Six-Membered Heterocyclic Nitrogen Compounds with Four Condensed Rings", call for rather careful description. Regarding pyridine as aza-benzene, it will be appreciated that several poly-aza-benzenes are conceivable and, since the fusion of four benzene rings gives rise to seven distinct aromatic structures, the possible aza-analogues of these and of their hydroaromatic derivatives must be very numerous indeed. Relatively few are known, however, and in the present volume the number is further reduced by exclusion of benzacridine and benzophenazine types and of all compounds in which nitrogen as hetero-atom is shared between rings. Subject to these restrictions the compounds are classified and treated in the following order: aza- and poly-aza- derivatives of naphthacene, benz[*a*]-anthracene, benzo[*c*]phenanthrene, chrysene, triphenylene, benzanthrene and pyrene. Further subdivision is based on the number and position of the nitrogen atoms in the molecule, and sectional discussions are followed by descriptive lists of individual compounds, complete with references to the end of 1950. Nomenclature is treated in a rational manner, and, as is explained in the preface, an attempt is made through a comprehensive index to anticipate and cope with the difficulties of those who consult the volume on a particular quest.

The method of presentation is open to the criticism that it uses a canvas which is too large for the present-day picture. Apart from certain groups of dyestuffs and alkaloids of the chelidonine and aporphine types, there has been little systematic investigation and still less correlation among the known compounds of the class. None the less, it is the authors' achievement to have rescued this family of heterocycles from its interment in the journals or from, at best, the seclusion of dispersed and neglected paragraphs in major text-books. The volume is not only a record of existing knowledge but also, both explicitly and by implication, it points the need and marks a field for future research.

The monograph on "Thiophene and its Derivatives" presents, in fifteen chapters, a comprehensive account of these compounds, covering published work almost to the end of 1949. An additional chapter deals with selenophene and tellurophene analogues, but compounds containing condensed ring systems are reserved for a later volume. The earlier chapters contain such general topics as the history, occurrence and synthesis, together with the general physical an chemical properties, of thiophene and its homologue A special chapter (contributed by F. F. Blicke describes the toxicology and pharmacology of th compounds. Another special chapter (by F. F Hochgesang) presents an informed discussion of th molecular structure and spectroscopy: it contain diagrams and tables relating to ultra-violet an infra-red absorption spectra, together with mas spectral data, as obtained in the author's industri laboratory. A helpful survey of factors affectin substitution in the thiophene nucleus precedes th systematic treatment of the various classes of thiophene derivatives, which occupies the major portio of the book. The treatment here is both authoritativ and critical: it is kept within reasonable limits b the judicious use of tabulated information, all o which is fully documented. Each chapter is provide with an appropriate set of footnote references, and in an appendix, laboratory preparations are given fo some thirty representative thiophene derivatives. A efficient index completes the volume, which wil undoubtedly become a standard work of referenc for thiophene chemistry and, in its early chapters a least, will amply repay the attention of the genera reader of chemistry.

QUANTUM MECHANICS OF VALENCE

Valence

By Prof. C. A. Coulson. Pp. x+338. (Oxford Clarendon Press; London: Oxford Universit Press, 1952.) 25*s*. net.

DURING the past twenty-five years the application of quantum mechanics to the problem o the structure of molecules has led to great clarificatio of the chemical concept of valence. Prof. C. A Coulson, who has made important contributions t the subject, has pointed out that every chemis should have an understanding of the quantu mechanical theory of valence, and he has written book, as a supplement to the text-books of chemistry to provide a basis for this understanding.

Chemistry is a large subject; and quantu mechanics, even the parts of quantum mechanic that relate to chemistry, is also a large subject, an quite different in general character. The problem o presenting quantum mechanics in relation to chemistr in a short book in such a way as to be helpful rathe than confusing to the student is a difficult one Coulson has attempted to solve it by giving sketch accounts both of the mathematical methods of quantum mechanics and of the facts of structura chemistry. In his book the empirical system (th chemical system) of valence and molecular structur is discussed only briefly. The quantum mechanica system, however, is also presented rather briefly an superficially. It is my opinion that a student (th author says in the preface that the book is intende for chemical students) needs to build up a solid an complete framework of one sort or another, withou gaps. Although the author states that practically n mathematics is needed for his purpose, the boo contains many quantum mechanical equations, som of which are obtained from earlier equations in th book by methods that are not presented to th reader. This treatment—which might be calle escriptive quantum mechanics, as opposed to heoretical quantum mechanics—may be suited to some readers, but I fear that many would be confused y it.

Both the valence-bond method and the molecular rbital method are used in the discussion of the structure of covalent compounds. The author has llowed his enthusiasm for the molecular orbital method to lead him to make some statements that robably cannot be supported. Thus, after presenting molecular orbital treatment of the carbon monoxide molecule, he says that the description of this molecule s resonating among three valence-bond structures is ar less satisfactory. However, the molecular orbital treatment that he presents involves a serious error; the assumption is made that the oxygen atom uses $2s$ orbital for an unshared pair, and a $2p_x$ orbital or the σ bond, but that the carbon atom uses hybrid ond orbitals $\frac{1}{\sqrt{2}}(s + p_x)$ and $\frac{1}{\sqrt{2}}(s - p_x)$ for its unshared pair and σ bond, respectively. The consideration of the energy of promotion of an electron from the $2s$ orbital to the $2p$ orbital shows that, in act, the unshared pair for each atom occupies a ybrid orbital that is predominantly $2s$ in character, with a small contribution of $2p_z$, whereas the σ bond rbital is largely $2p_x$ in character, with a small contribution of $2s$. The same error, resulting from eglect of the $s-p$ promotion energy, occurs in the discussion of hydrogen chloride: the author describes the orbital for the σ bond and the orbital for the unshared pair of the chlorine atom as involving qual amounts of $3s$ and $3p_z$ character, whereas, in fact, minimizing the energy with consideration of the $-p$ separation shows that the σ bond orbital is predominantly $3p_x$, with only about 2 per cent of $3s$ haracter, and that the unshared-pair orbital is predominantly $3s$, with only about 2 per cent of $3p_x$ haracter.

In twenty-five years the quantum mechanical heory of valence has become an important part of hemistry. It is still undergoing change, as a result of the efforts of Prof. Coulson and other workers in he field; and we may hope that in another decade or two a satisfactory solution can be found of the problem of presenting the subject to the chemical tudent, a problem which Prof. Coulson has tackled in his book on valence.

LINUS PAULING

MODERN PLANT TAXONOMY

Stages in the Evolution of Plant Species

By Jens Clausen. Pp. ix+206. (Ithaca, N.Y.: Cornell University Press; London: Oxford University Press, 1951.) 22*s*. 6*d*. net.

TAXONOMISTS are, on the whole, conservative, in the sense that they are cautious in introducing what may be far-reaching changes in their methods. There are two valid reasons for such caution. First, hanges in classification affect not only taxonomists hemselves, but also, since taxonomy is basic to all other branches of biology, changes in taxonomic concept or even nomenclature have repercussions over a wide field. Secondly, the taxonomist knows rom experience that data as supplied by geneticists, ytologists, ecologists and other progressive modernists are sometimes inaccurate, and he may prefer to wait until they have been several times checked before incorporating them in his schemes as characters of taxonomic value. Nevertheless, most taxonomists acknowledge that much improvement in classification can result from a consideration and incorporation of evidence derived from experimental studies, cytological investigations, the analyses of large wild populations, and detailed researches into ranges and distributions. Doubts, however, are at times expressed whether such data from new lines of investigation can be satisfactorily combined with the morphological characters on which orthodox taxonomy is largely based. In other words, it is questioned whether a general classification utilizing all ascertainable characters can be prepared, or whether the theoretically possible limit is a number of special classifications. This most interesting book now under review strongly favours the view that a synthetic classification can be prepared, at least for taxa up to the size of genera.

Dr. Jens Clausen, in co-operation with Dr. D. D. Keck and Dr. W. H. Hiesey, has carried out a large series of comparative researches, involving field studies, transplant experiments, crossings and selfings, cytology, and taxonomy on a number of genera of the Californian flora. The results are summarized in a very attractive form in what are called eight essays that were given as lectures under the Messenger Foundation at Cornell University during November 1950. After an outline of the history of our concepts of speciation, Clausen logically deals in turn with local populations as the basic evolutionary unit, ecological races and morphological subspecies, interspecific barriers, the evolution of groups of species, and the physiologic–genetic species concept and the dynamics of the evolution of species and genera.

Clausen and his colleagues are fortunate in having almost ideal conditions for the kind of researches they have carried out and are continuing: the natural environments in California are varied; the native flora is a large one; the Carnegie Institution of Washington has wisely provided funds for the long-range researches; and three experimental stations at different altitudes have been established. That these and other advantages have been so fully used is to the credit of Dr. Clausen and those who have worked with him.

The half a dozen or so groups of species dealt with in some detail give a very varied picture of speciation. It is proved that this occurs in many ways, by steps of different sizes, over longer or shorter periods of time, and often irregularly. "We find species in all stages of differentiation. The most distinct ones, those that are the end products of the processes of speciation, differ in morphological characters, in ecological fitness to the environment, in the genetic systems by which they control this fitness, and in the homology of the chromosomes. The differentiating processes, however, do not always proceed simultaneously at the same rate along all the fronts mentioned. In ecological races of one species, physiological differentiation precedes the morphological and the genetic. In other cases morphological differentiation will be far ahead, and in still others, genetic separation begins even before physiological differences have enabled the forms to occupy different environments, or before morphological differences have provided satisfactory taxonomic labels for distinguishing the species. The most normal pattern of speciation, however, is a more or less simultaneous and gradual separation in morphologic, ecologic, genetic and cytologic characteristics." Again, "The species exist in all stages of ecologic, genetic, cytologic, or morphologic distinctness, some preponderantly morphological, others preponderantly genetical, and still others preponderantly ecological".

The importance of genetical barriers between taxa is rightly emphasized, but it is explicitly stated (p. 158) that hybrid sterility or genetic incompatibility is not believed to be the sole criterion of specific distinctness. Examples quoted in several places in the body of the book show that it is not invariably an essential criterion. Isolating mechanisms are of many kinds, and every one has numerous variants.

One criticism may be made. I doubt if the statements regarding clines (p. 28) are valid. It is there said, "The term cline can be used only for individual characters, and not for an assemblage of characters of groups of individuals such as a series of populations, for a single individual may with respect to one character belong to one cline and with respect to another character to a different cline. Clines are therefore not commensurable with natural entities, and are oversimplified abstractions dealing with the variation of individual characters". There is, however, sometimes found to be a high correlation of character variations as the individuals of a cline are scored in a given direction.

Every taxonomist and every botanist, whether a taxonomist or not, is urged to read and consider this book. Very many portions could be quoted from it as proof of the truth of the final paragraph: "Even though we may think we dimly see some of the organization in the intricate network that connects the life of today with that of the past, we still do not know what enables living things to develop as they do, or how they first came into being. The research of the present century has merely opened our eyes to see a remarkable and still quite incomprehensible organization of living things. Faced with such a situation, the scientist becomes humble, for at this point he meets the Great Unknown".

W. B. TURRILL

THE STONE AGE IN EASTERN PALESTINE

Le paléolithique et le mésolithique du Désert de Judée

Par René Neuville. (Archives de l'Institut de Paléontologie humaine, Mémoire 24.) Pp. 270+20 plates. (Paris: Masson et Cie., 1951.) n.p.

THIS is an important work which gives new information on the prehistory of a hitherto little-known region. The area of exploration lies to the south-east of Jerusalem in semi-desert calcareous country stretching eastwards to the Dead Sea. A number of cave and rock-shelter sites have been excavated and rich flint material unearthed. Culturally speaking, the industries found range from Tayacian and late Acheulean through Mousterian (in one instance, of the Kurdistan variety) to a late Palæolithic and Mesolithic (Natufian). In at least one site this last-named passes upwards into a Tahunian, which recalls the industry of the lower levels at Jericho. The Stone Age folk must have occupied many of the sites for long periods of time. Their industries show steady evolution; for example, there are no less than three Natufian levels with development from the early level to the latest Important is the proof that the Tayacian cultur must have existed side by side with the late Acheulean. These two cultures belong to two distinc culture groups, and their co-existence at the same time in this part of Palestine is interesting.

But the author and his collaborators have no been satisfied merely to dig the sites and then to publish accounts of the industries and fauna recovered. Their main interest has been to place the cultures in their geological and climatic settings. A succession of pluvial and interpluvial period can be demonstrated, roughly coincident with the glacial and interglacial ones of more northern latitudes. There must obviously have been much wetter periods in this region in the past than nowadays, as to-day the country is only able to carry a very small population. Into the framework thus arrived at it has been possible to fit the successive cultures and to compare the results with what is known in other parts of the world.

The volume opens with a general description of the area, and this is followed by an account of the various sites excavated and a description of the finds unearthed. There are plenty of line drawings, both of the implements and of the fauna, and also twenty plates which supply further illustrations. No works of art were encountered except in two cases in Natufian levels where sculptures were discovered This accords with Prof. Garrod's work at Mount Carmel, where, too, sculpture was encountered in Natufian levels. There is no doubt of the importance of this work to all students of the Stone Age in this part of the world.

M. C. BURKITT

CHEMISTRY IN THE INDUSTRIAL REVOLUTION

The Chemical Revolution

A Contribution to Social Technology. By Dr Archibald Clow and Nan L. Clow. Pp. xvi+680+110 plates. (London: Batchworth Press, Ltd., 1952.) 50s. net.

WHEN a reviewer sees what by present-day standards is a large and well-produced volume entitled "The Chemical Revolution", he has visions of a historical account of the way in which chemical discoveries and their technological and commercial applications have revolutionized man's way of life how they have brought him new sources of wealth of health, richness of life, new possibilities of professional employment and new techniques of construction.

In the present volume the authors have limited themselves both in time and space in their treatment of the enormous field suggested by their title. Even so, it is quite impossible to deal adequately in this short notice with so important a work. The book treats of the chemical industry as an important concomitant of the Industrial Revolution until about the middle of the nineteenth century.

It was said of the study of acoustics, by Clerk Maxwell, that whole armies of musical scientists and of scientific musicians had fallen into that Serbonian bog without in any way filling it up. In a similar way, the scientific historians, economists and 'historical' scientists who will be required to deal with the subject under review will be legion.

The authors modestly say that they have said the rst word on the subject and not the last. In the mitations which they have set themselves they have chieved a remarkable synthesis from the almost nexplored ground common to economic history and hemical technology. In manuscript the work was warded the Senior Hume-Brown Prize by the niversity of Edinburgh; and, if the book is mainly evoted to the work of industrial scientists of North ritain, we can concede with the authors that "a alaxy of Scotsmen gave scientific direction to the ndustrial Revolution, particularly in its hitherto eglected non-mechanical aspects". The writers have ound inspiration in Lewis Mumford's "Technics and ivilisation" and have adopted his terminology, xtended from that of Patrick Geddes—"one can ivide the development of the machine and the achine civilization into three successive but overapping and interpenetrating phases: eotechnic, alæotechnic and neotechnic. Speaking in terms of ower and characteristic materials, the eotechnic hase is a water and wood complex, the palæotechnic hase is a coal and iron complex and the neotechnic hase is an electricity and alloy complex". The uthors do not go beyond the first two phases.

The chief subjects in the book are minerals and anufacturing processes, the economy of common alt, ashes and kelp, the palæotechnic transition and itriol in the Industrial Revolution. The chemical ndustry is the most polygamous of all industries, nd Justus Liebig's famous *bon mot* of 1843, "We ay fairly judge of the commercial prosperity of a ountry from the amount of sulphuric acid which it onsumes", comes with even more point to-day. here are sections on balloons, bleaching and dyeing before the days of Perkin), calico printing, mordants nd mackintoshes. The considerable quantity of mmonia which was required for some of these rocesses was obtained from urine (a common ractice being the dilution of this personally produced roduct by the canny Scots, until the use of a specially esigned hydrometer put a stop to this 'minor acket'). The glass, iron, gas and tar, agricultural rmentation, the sugar and food industries are all ealt with by the historical–economic–sociological ethod. There is a useful chemical chronology from 610 until 1856, and a glossary of dead chemical anguage, though some of the terms are still very uch alive.

The book is a model of scholarly presentation, and is fully documented and indexed. It is a handsome olume with 110 plates, including a reproduction of coloured print of the old iron-works at Coalbrook ale and a number of diagrams; and it is a pity hat present-day costs necessitate a price of fifty illings for the work.

W. L. Sumner

THE FILM IN EDUCATION

he Film in Education

y Dr. Andrew Buchanan. Pp. 256+25 plates. London: Phoenix House, Ltd., 1951.) 25s. net.

EVERYONE agrees that films can and should play an important part in education. Yet practice nd realization fall far below theory and ideal: rogress has been slow. The reasons for this sorry tate of affairs form a complex network. For example, here is a lack of the research which would guide both roducers and users: we do not fully know how people look at pictures or diagrams, how they gather information from them, what features are truly significant. There are economic obstacles: visual material is expensive to produce, the market is small, the risks of failure great. Perhaps more important than such difficulties is the persisting traditionalism of teachers accustomed to rely on the written or spoken word, desensitized by their training to the appeal and meaning of visual presentations, uncertain of the best ways of using films in teaching, uninformed regarding sources of visual material, timid in their use of projection apparatus.

Dr. Andrew Buchanan has long been known as a producer of outstanding educational films, and he has done much to popularize their use in schools and universities. He has drawn on his experience to produce a book which will certainly become a standard work of reference. It should be noted, however, that he has imposed restrictions upon himself and that his book is far from being a comprehensive treatise on visual education. He makes little mention of film-strip, wall-chart, printed pictures, etc., nor does he deal with methods of displaying visualizations other than optical projection. There is very little fundamental discussion and few references to psychological or research data. In a word, the title well describes the book—but this particular restriction of necessity impoverishes the treatment.

Dr. Buchanan begins by speaking of the purposes, advantages and limitations of educational films, and goes on to the use of films for specialized purposes in medicine, science and art. He describes the development of such films in many countries and considers the contribution of Unesco. He devotes chapters to a detailed description of the planning, production and distribution of visual aids, taking account of the increasing part taken by the National Committee for Visual Aids. These chapters are of real value since this kind of information is essential to teachers who desire to collaborate fruitfully with professional producers. The author goes on to give advice on the method of handling projectors and suggests ways of conducting discussions with classes who have watched films, so that they may really learn from them. In addition to all this, he has gathered valuable material regarding the effects on children of watching entertainment films, and regarding the views currently held by teachers on the films they would like to have.

One of the most interesting sections of the book is that in which Dr. Buchanan shows with figures that it is almost impossible to produce films for the small British market without incurring a loss, and that the British tradition of parsimony in educational administration militates against success. It appears that the establishment of the semi-official Foundation for Visual Aids has made the situation still worse by loading the scales still more against the producers.

Schools are by nature slow to change their ways or to adapt their practices to new conditions. Teachers are far less willing to adopt and employ new equipment or instruments than are workers in factories or offices; and, as was said earlier, our administrators have never learnt the lesson that education can be cheap or efficient but not both. In spite of all this, visual education has come to stay, and it will gradually affect practice and transform the process of instruction. Dr. Buchanan's book is a genuine contribution to the enlightenment of educators, and it may be warmly recommended to the attention of all who intend either to make or to use film.

THE ETHICAL DILEMMA OF SCIENCE

By Prof. A. V. HILL, C.H., O.B.E., F.R.S.
President of the British Association

EXACTLY a hundred years ago the British Association met for the first time in Belfast; and this year the Association is indeed happy to gather together in this city, to test its hospitality again and celebrate, with it a century of progress of British science. In 1660 the little town of Killyleagh, some twenty miles from Belfast, was the birthplace of Hans Sloane, botanist, collector, physician, and president of the Royal Society, on whose bequest to the nation the British Museum in London was founded: its two-hundredth anniversary will be celebrated next year. The following century produced Joseph Black, a pioneer in chemistry and the theory of heat, who was the son of a native of Belfast and educated there. In 1824, in this city was born William Thomson, Lord Kelvin, the famous physicist and inventor, his father, a native of Co. Down, being then a teacher of mathematics in the Royal Academical Institution, Belfast. Joseph Larmor, born in Co. Antrim in 1857, was taught at that school, and when he became Senior Wrangler at Cambridge in 1880, repeating the success of a schoolmate the year before, a torchlight procession was held in Belfast—to the bewilderment (as Eddington records) of the shy young mathematician. This city was the birthplace in 1866 of E. W. MacBride, the zoologist, also at the same school: those of us who remember him affectionately could never have imagined him coming from anywhere else. A dear friend of many of us, Joseph Barcroft, the physiologist, was born at Newry in 1872, and learnt what he knew of the things that really matter (as he truly said) sailing in Carlingford Lough. And among the living, Frederick Donnan, a native of Holywood, Co. Down, and a graduate of Queen's University, Belfast, whose imagination has fertilized both chemistry and biology, tells me that he took part in the British Association meeting in Belfast in 1902. Thus it goes on. British science owes much to the fertile and imaginative minds, the vigorous temperaments and the warm hearts of our kinsmen in Northern Ireland.

We can recall, too, that applied science is a partner in the great industries for which Belfast and Northern Ireland are famous: the city for shipbuilding, engineering and textiles; and the surrounding country for agriculture. In the report of the British Association for 1852 there is a description of the vortex water-wheel, an early form of turbine, in working use at a nearby mill: James Thomson, elder brother of Lord Kelvin and for many years professor of civil engineering at the then Queen's College, had patented a vortex water-wheel in 1850. In the same report is a long account, by the professor of agriculture at Queen's College, of the composition and economy of the flax plant; and thirty pages were devoted to the fattening of animals—English animals, it is true, but their cousins in Ireland have been apt pupils. In such practical arts, based alike on scientific knowledge and traditional skill, the contribution of Northern Ireland has been as distinguished as in the advancement of science itself; and it may confidently be expected that the present meeting of the British Association will serve not only to celebrate the achievements of the past century but also to foster the endeavours of the next.

The President for 1852 was Edward Sabin
astronomer, explorer and geodesist, a colonel then i
the Royal Artillery. Sabine at that time w
treasurer of the Royal Society, and at various othe
he was physical secretary, foreign secretary an
president: indeed, for completeness, he should hav
been biological secretary too, for his name occurs i
an index of British and Irish botanists, and in th
British Museum are plants collected by him o
Arctic expeditions. Sabine was an Irishman, and
the president this year is English, with an ancest
from Northern Ireland two hundred years ago, th
only emphasizes, after a century, the unity of scienc
Indeed, there are many Irishmen at this year
meeting from the other side of the border: they a
doubly welcome, for science admits no frontiers, an
customs duty is not levied on ideas or friendshi
Sabine's address referred particularly to the subje
of his own chief interest for many years, the periodi
variations of terrestrial magnetism: indeed, h
announced in his address the discovery of the con
nexion between sunspots and magnetic disturbanc
in the earth. He finished his address by referring t
"allusions . . . made by influential men . . . to
direct representation of Science in Parliament". Th
benefit, he said, which the legislature might deriv
from such a change was a question rather for state
men than for scientists; but as regards science itsel
he expressed his strong conviction that the possibl
gain would be far outweighed by inevitable loss, an
that scientific men could not too highly value th
advantage they possessed in the undisturbed enjoy
ment of their own pursuits untroubled by th
excitements and distractions of political life. Th
practical importance of science to-day, and its impac
on public affairs, have greatly reduced that undi
turbed enjoyment; and though all would agree tha
the direct representation of science as such in th
House of Commons is impracticable, none woul
doubt the advantage to Parliament and the nation
more of its members had some personal acquaintanc
with science. It might indeed be well, in a reforme
Second Chamber, to provide the same representatio
to science as at present is afforded to the Church an
the Law.

Two famous young Irishmen were present at th
Belfast meeting of 1852. William Thomson, Lor
Kelvin, elected to the chair of natural philosophy a
Glasgow six years earlier at the unusual age o
twenty-two, was president of the Section of Physics
the other, George Gabriel Stokes, then thirty-thre
delivered a public lecture on fluorescence due t
ultra-violet light passing through a solution of quinin
Both were among the foremost physicists of th
following half-century, and Kelvin succeeded Stok
as president of the Royal Society.

The next meeting in Belfast was in 1874, whe
another Irishman, John Tyndall, presided. H
notable address will be referred to later. Huxle
delivered an evening discourse with the provocati
title, "The Hypothesis that Animals are Automata"
whether for that or for some other cause, it is recorde
that he was threatened with assault by a no
conformist minister. On the lighter side, a descripti
was given of an old lady of 111 who chatted aw

continually in a clear voice, was in possession of all her faculties, took snuff, and had white hair and a skin as soft as velvet—which is encouraging to those who take snuff and have white hair.

The last meeting at Belfast was fifty years ago, in 1902, under the presidency of James Dewar, a Scotsman, famous for his work on the liquefaction of gases. Lord Kelvin, loyal to Belfast, read a curious paper n the Physics Section entitled "Animal Thermostat". The great physicist, arguing on thermodynamic principles, speculated whether the breath of an animal, kept a considerable time in a hot bath above the natural temperature of its body, might be found o contain no carbon dioxide at all; possibly even a surplus of oxygen, pointing to an 'unburning' of matter in the body. I hope the physiologists were present at the discussion; one of them, Joseph Barcroft, would certainly have offered to make the experiment on himself. Henry Armstrong, provocative as usual and at considerable length, gave a presidential address to the Section of Educational Science.

It is a very special pleasure to be called to the presidency of the Association in succession to H.R.H. the Duke of Edinburgh, who won the confidence and esteem of scientific people at the meeting last summer, confirmed by many contacts with them since in Canada and the United States and recently in Britain. He presided at the December meeting of the Council, and we told him then how glad we were that these contacts were soon to be extended to Ceylon, Australia and New Zealand. Those hopes, alas, have had to be deferred; and on behalf of the Association I wrote in February to tell him of our deep sympathy in the bereavement which H.M. The Queen and he had suffered. We mourned the loss, not only of a Royal Patron but of one whom all regarded with personal gratitude and affection. I added, and I know you will warmly confirm, that our sorrow and sympathy were accompanied, since we had seen him at work with us, by the certain expectation that the same confident affection will support the Queen and him in the years ahead.

The Duke of Edinburgh concluded his presidential address last year with the words: 'It is clearly our duty as citizens to see that science is used for the benefit of mankind. For, of what use is science if man does not survive?" Here was a challenge to his successor: to discuss how far science has already contributed to human betterment, how far it has provided fresh problems, dangers and difficulties, and to suggest ways in which all who are concerned with science can help, as citizens, to make sure that its results in fact are beneficial.

"As citizens"—for scientists, as such, have no title to superior wisdom or virtue, and outside their special knowledge they are just as likely as others to be misled. The fundamental principle of scientific work is unbending integrity of thought, following the evidence of fact wherever it may lead, within the limits of experimental error and honest mistake. On this there can be no compromise; and since science is a universal interest of mankind, recognizing no barriers of race, class, religion or opinion (provided that is honest), a necessary condition of its advance and application is one of friendliness, frankness and equality. Goodwill and integrity, therefore, are indispensable alike to scientific progress itself and its successful employment for the benefit of mankind. Those who look to scientists as magicians, able to conjure a universal formula out of a hat, may be disappointed to find only so ancient a doctrine: and admittedly, there *is* far more to science than integrity and goodwill. But these are the qualities chiefly required to utilize the opportunities, to resolve the problems and difficulties, which science has provided for present-day society.

The common phrase, "this scientific age", is all too apt to imply, with little justification, that the majority of people, at least in highly developed countries, now think and act scientifically; and, with no justification at all, to suggest that science can replace the older motives of human conduct. It is true that the external circumstances of life have been vastly altered by the applications of scientific discovery and invention, though as yet for only a minority of mankind. The future alone can decide whether natural resources and human ingenuity will prove sufficient, given statesmanship and goodwill, for the same transformation gradually to affect the whole of human society. If not, are stable conditions ultimately possible? Or will there be perpetual conflict between the 'haves' and the 'have-nots'? It is true also that the methods, ideas and results of scientific inquiry have penetrated widely, if not deeply, into popular thinking and belief: the jargon at least of science is widespread, and magic and superstition are gradually losing, if not their currency at least their respectability. Yet such changes may have little real influence on the basic pattern of human behaviour, and, if witches are no longer hunted down and killed, political and racial intolerance can lead to even wilder and crueller excesses. In clearing away old idolatries there is always a danger of allowing new ones to creep in: the unclean spirit went out when the house was swept and garnished, but only to return with seven others more wicked than himself. The improvement of man's estate by the application of scientific knowledge is one of the loftiest of adventures; but a belief that it can be achieved by scientific methods alone, without a moral basis to society, is a perilous illusion. If the methods of human experiment and racial improvement adopted by the Nazis could be regarded purely as applied biology there might be much to say for them. But most of us believe that by abandoning a faith (which has nothing directly to do with science) in the sanctity of the human individual and of moral law they were heading straight for disaster. Yet we shall see later the dilemma in which such scruples put us, in respect of the gravest of all world problems.

The conflict between new knowledge and traditional belief is no novelty. When Eve saw that the Tree of Knowledge was good for food and that it was pleasant to the eyes, and to be desired to make one wise, she took of the fruit thereof and did eat and gave also to Adam and he did eat. This led to their exclusion from the Garden and the warning "in sorrow shalt thou eat of it all the days of thy life". Again and again the attempt has been made to forbid the fruit of scientific knowledge. In 1874 in Belfast, John Tyndall delivered a presidential address to the British Association which provoked a hurricane of controversy: the records tell us that it was denounced from every pulpit in the city. Yet, reading it now, one is impressed not only by its courage but also by its reasonableness. It is true that he claimed that science will wrest from theology the entire domain of cosmological theory, whether of living or of non-living things; but he had previously referred to the immovable basis of the religious sentiment in human nature, bringing as he said "completeness and dignity to man". The views of Lucretius and Bruno, Darwin and Spencer, might be wrong: whether right or wrong, he insisted, we claim the right to discuss them. If to-day I claim the right to discuss not only the scientific facts themselves but also their consequences in human affairs I doubt whether denunciation will follow: if it does, I shall be sorry but unrepentant.

The development which has brought most vividly to the public conscience to-day the ethical problems aroused by the advance of scientific knowledge lies in the field of nuclear physics; and groups of scientific people in the free countries of the world are vigorously debating its various consequences, among them particularly the secrecy attached to weapons as new and devastating as those provided by nuclear fission. Atomic physics, however, is only one of many scientific developments which have brought, or are bringing, a mixture of possible good and evil about which judgments of relative value must be formed; we must not get too excited about one of them. There is no secrecy about most of these developments—they occur gradually and continuously before our eyes, and we tend to accept them without question as though they were natural phenomena; yet, in fact, the consequences of one of them provide the most solemn problem in the world. The dilemma is this. All the impulses of decent humanity, all the dictates of religion and all the traditions of medicine insist that suffering should be relieved, curable disease cured, preventable disease prevented. The obligation is regarded as unconditional: it is not permitted to argue that the suffering is due to folly, that the children are not wanted, that the patient's family would be happier if he died. All that may be so; but to accept it as a guide to action would lead to a degradation of standards of humanity by which civilization would be permanently and indefinitely poorer. Conduct usually falls short of principles; but that would be the worst reason for abandoning principles altogether.

In many parts of the world advances in public health, improved sanitation, the avoidance of epidemics, the fighting of insect-borne disease, the lowering of infantile death-rates and a prolongation of the span of life have led to a vast increase of population. Not only is the population increasing, but also in many places its rate of increase is still rising; and these processes will take so long to reverse that for many years to come the shortage of natural resources, particularly of food, is bound to provide increasing deprivation and disturbance. That provides the practical motive of the Colombo Plan. In India, a Government Planning Commission, in a report of July 1951 entitled "The First Five Year Plan", has dared to face the facts. A doubling in the past thirty years of the survival-rate (births minus deaths) has led to a rate of increase of nearly 1¼ per cent a year, a total of 5 million every year in a population of 360 million.

"With all the effort that the First Five Year Plan will represent, it will be possible barely to restore by 1955–1956 the pre-war standards in regard to food and clothing. Increasing pressure of population on natural resources retards economic progress and limits seriously the rate of extension of social services so essential to civilized existence."

The pre-war standard, in fact, was very poor; much of the population existed below the level of a decent life, scores of millions only just above that of famine. Yet the gigantic national effort proposed in the Five Year Plan, even if successful, may only just resto that miserable standard. Can it sustain it then if t rate of population increase continues ? It is easy answer that a higher standard of life has led in oth countries to a gradually falling birth-rate; but higher standard requires a far greater charge natural resources of all kinds, which cannot be m until the pressure of population is reduced.

In the meantime there is more than danger th the emergency will result in an over-use of natur resources, leading by land erosion, deforestation an other factors to permanent and irretrievable loss this has happened already, and is visibly happenin now, in many parts of the world. In a special secti on "Family Planning" the Indian report recogniz that "an alteration in population trends takes least a few generations to materialize"; and ste are suggested for the education of public opinion the need for limitation, and for experimental effor to be made in the application of simple methods birth control. For its wisdom and courage in ackno ledging the gravity of the situation the India Planning Commission deserves every support; b the problem itself has not begun to be solved, an its consequences will dominate the development India for many years. Indeed, its gravity will co tinue to increase. Malaria is admitted by the Plannin Commission to take an annual toll of a million live and tuberculosis of half a million. The resolute us of insecticides and anti-malarial drugs could soo reduce the former to a small fraction; tuberculos is bound to require more effort and a longer ter Nobody would dare to say that steps to combat thes diseases, and others such as cholera, to improve rur and industrial health, to increase the supply of drug and medical equipment and services, should not b taken on the highest priority: but the consequenc must be faced that a further increase of a millio people a year would result. Thus science, biological medical, chemical and engineering, applied for motive of decent humanity entirely beyond reproach, wit no objectionable secrecy, has led to a problem of th utmost public gravity which will require all th resources of science, humanity and statesmanship fo its solution.

The example of India has been taken because o the sheer magnitude of the problem and because it seriousness is now admitted by humane and responsible men; but the same conditions exist already i many parts of the world and will soon exist elsewher It is *not* a question only of food; if a higher standar of life is to become universal, with education, communications, housing, reasonable amenities an public health, a far greater demand will be made o all such natural resources as power, chemical minerals, metals, water and wood. One is left wondering how long these can possibly take the strai Could world supplies conceivably hold out if th present requirement per head, in the United State were multiplied in proportion to meet the sam demand everywhere—even without any increase present population; and if so, for how long ? The is much discussion of human rights. At what lev can these be reasonably pitched ? And do they exten to unlimited reproduction, with a consequent obligation falling on those more careful ? These problem must be faced not only with goodwill and humanit but also with integrity and courage, not refusing t recognize the compulsion of simple arithmetic. It i right that the scientific imagination should be allowe to play sometimes with the more distant future vhen possibly new methods and resources may be ound to solve all problems ; but only on condition hat our minds are not deflected from the urgent ealities of the present.

By vast improvements in communications, which ave made the world so small, applied science has een one of the chief agents in the present ferment f social, political and economic thought. Can one rge, after the event, that the application was a nistake and that the majority of mankind could etter have remained isolated and in ignorance ? By naking world war technically possible, applied science as helped to stir up national ambitions and social evolutions which, if poverty and deficiency continue vithout hope, may lead to major world catastrophe. hould we therefore refuse to employ science in lefence of liberty and resign ourselves to a universal olice state where no scruples are permitted ? Are ve, in scientific research, to say that some subjects nay be investigated, but not others for fear of the onsequences ? Who then is to decide and by what nternational authority ? And is it practical to insist hat all scientific knowledge should be fully and penly disclosed, without secrecy or reservation of ny kind, military or industrial ? These are problems vhich cannot be solved by rhetoric, or by any simple ormula. The purpose of setting them out is to make lear that we must face them with honesty and ourage ; for they will not solve themselves.

I have led you to the ethical dilemma which perlexes many of us by taking an example in which ew would question either the motives of those who nade the original discoveries, or the humanity of heir application ; or indeed could wish that the fruit f the Tree of Knowledge had been left untried. It s easy to say now that, side by side with the control f disease, there should have been an equal and arallel effort in education, particularly the education f women as responsible citizens ; for there is no ossibility, if women remain ignorant and illiterate, f intelligent widespread family planning and control. But education alone would not have been enough, r indeed possible itself, without a substantial measure f material and social betterment ; and the expense nd effort involved in this would have been indefinitely greater than in the application of medicine and ygiene, which after all has been relatively cheap. Had it been possible to foresee the enormous success f this application, would humane people have agreed hat it could better have been held back, to keep in step with other parallel progress, so that development ould be planned and orderly ? Some might say yes, aking the purely biological view that if men will reed like rabbits they must be allowed to die like abbits, until gradually improving education and the lemand for a higher standard of life teach them better. Most people would still say no. But suppose it were ertain now that the pressure of increasing population, incontrolled by disease, would lead not only to widespread exhaustion of the soil and of other capital esources but also to continuing and increasing interational tension and disorder, making it hard for ivilization itself to survive : Would the majority of umane and reasonable people then change their ninds ? If ethical principles deny our right to do vil in order that good may come, are we justified in loing good when the foreseeable consequence is evil ?

I remember asking an eminent Indian who had aken part in drawing up the so-called Bombay Plan f 1944 why there was no mention of the gravest roblem of all, overgrowing population ; he replied that his colleagues and he had indeed discussed it, but had decided to leave it to God. To a biologist aware of the methods by which animal population is in fact controlled by Nature, this seemed pretty poor comfort ; yet there are many who really take that view, admittedly with the element of reason that we never can be sure that things may not turn up to make all our calculations wrong. Should we then just continue to do the good we see in front of us, in confidence that if our motives are humane, good and not evil will finally result ? Or, taking that rather easy course, are we not showing a lack of the fundamental virtues of courage and integrity ?

The dilemma is a real one, and cannot be resolved by any simple expedient. In another form it is perplexing many of those who are concerned with the development of nuclear physics, the ultimate service of which may be very great, possibly essential if our present type of civilization is to continue when other sources of power dry up ; while the benefits to medicine and industry are already substantial. *But*—nuclear fission has released the threat of unprecedented violence, with the possible destruction of many millions of lives and the accumulated treasures, moral and material, of civilization. The individual conscience may tell a man to have no part in it : that is easy enough, for there are plenty of other interesting things to do, but it does not solve the problem. Moreover, it is possible that defensive weapons, based on nuclear fission, but not of the type intended for mass destruction, can be developed which would make armed aggression intolerably costly. What then of the abolition of secrecy ? In principle, yes, for the historic and unique contribution of science to international goodwill has been in sharing knowledge regardless of race and frontier, and the chief satisfaction of scientific work, the condition of its fruitful development, is frank and free discussion. "Cast thy bread upon the waters, for thou shalt find it after many days" is wise and acceptable counsel in dealing with scientific knowledge ; while "he that observeth the wind shall not sow and he that regardeth the clouds shall not reap" is as aptly applied to human relations as to agriculture. Every possible endeavour, therefore, should be made towards international agreement on sharing scientific and technical knowledge and controlling nuclear weapons ; but this, like peace itself, is a concern of every citizen, not only of scientific people. It is hard enough to get international agreement in quite simple matters, such as the perilous state of the north European fisheries, where no secrecy is involved and little national prestige, and the scientific evidence is unequivocal ; but we must go on trying.

Much scientific and technical advance has led to unexpected dangers and difficulties. Without our present knowledge of bacteriology and preventive medicine, gigantic armies could never be kept in the field, and land war on the recent scale would be impossible. Is medical science, therefore, to be blamed for twentieth-century war ? The indiscriminate use of insecticides, by upsetting the balance of Nature, can quickly do more harm than good. Radio communication may be used for spreading lies and disorder as well as truth and goodwill. Developments in microbiology, in many ways beneficent, may be used in the future for biological warfare, with effects at present unpredictable ; and control by international agreement and inspection might be very difficult. The list need not be multiplied, for all are aware that every new benefit to mankind provides also its own dangers, either as unexpected consequences or by deliberate misuse. Science is not alone in this: liberty may lead to licence, religion can be used to inflame passions, and laws can be exploited to protect wrongdoing. If men of science feel called upon to examine their consciences, so much the better; but they need not imagine that in this they are exceptional.

It has been debated whether "the scientific mind is fundamentally amoral". The real answer is that there is no such a thing as "*the* scientific mind". Scientists, for the most part, are quite ordinary folk. In their particular scientific jobs they have developed a habit of critical examination, but this does not save them from wishful thinking in ordinary affairs, or sometimes even from misrepresentation and falsehood when their emotions or prejudices are strongly enough moved. Their minds are no more amoral than those of surgeons, lawyers, or scholars. As investigators, most of them realize that their function would be stultified were they to introduce moral data into a scientific argument. A surgeon is not required, or indeed allowed, to consider whether it would be better for the world if his patient died under the operation; he has only to carry it out with skill, care and integrity. But it would be foolish to conclude that the surgical mind is amoral. The surgeon himself, as a human being, has to make moral judgments, but he does so outside the operating theatre. So it is with scientific people; like all good citizens they must take account of ethical considerations, and the chief of these, as with other good citizens, are of integrity, courage and goodwill. Integrity forbids them to allow feelings of any kind to obscure facts, but that does not make them amoral; after all, integrity is the first condition of morality.

In the practical world of to-day, complete abandonment of secrecy, in government and industry, is out of the question. The advantages to international relations, and to general scientific progress, of the greatest possible freedom are evident; to these can be added the impossibility, in a free democracy, of keeping the best people unless the conditions of their work are congenial. If scientific men consistently avoid jobs which seem to them to fall short of reasonable freedom, they will force changes of organization so that only necessary secrecy is maintained. The penalty of filling an organization, governmental or industrial, with second-rate people, cheerfully amenable to unnecessary restrictions, is far too evident in its result on efficiency to be tolerable for long. The cure, therefore, is largely in scientists' own hands. In this, as in many other aspects of their work, moral considerations come in, and the only way to resolve the dilemma which is in so many minds is to discuss it frankly. To neglect it altogether is not amoral but immoral; it is the duty of all of us as citizens to consider the ethical basis of our work.

To-day, when the public importance of science and its popular esteem may turn some people's heads, it is well that scientists should realize that the prestige of science is not their personal property, but a trust which they have an obligation to pass on uncompromised to their successors. The popularizing of genuine science is an important public service, and we should all be ready to take our part in it according to our powers; but to use the general prestige of science as a bait to attract attention to pronouncements on other topics, for example, on politics or religion, is a disservice both to science and the public. As a citizen I need no more justification than any other citizen in saying what I like about such things; but I have no right to pose as a representative of science in discussing them. In the days when the representatives of religion claimed supernatural knowledge of the natural world, it was necessary to insist, as Tyndall did, that the natural world belongs to science. Fortunately those days are past. If they now claim that the facts and trends of over-population are not what we say, we can argue about that as a scientific question: but if they insist that its consequences should be left to God, they must allow us as citizens to take the opposite view. If political pressure were applied in any way to force conformity to particular scientific theories, as happened in Germany and is happening now elsewhere, then one's right and indeed one's duty would be clear, alike as citizen and as scientist. But the nature of political institutions and the policies of political parties are not scientific questions, and how I choose to vote has nothing to do with science. Indeed, curious as it may seem, the spectrum of political opinion of scientists in Britain is much the same as that of other similar groups: though the loudspeakers are generally tuned in to one particular wave-band.

Some seventeen hundred years ago there crystallized out, from many centuries of experience of the human problems and ethical necessities of medicine, the so-called Hippocratic Oath. The obligation of integrity and trust; the insistent claim of suffering; the care of mothers and children; solicitude for the old and weak; the sanctity of human life: these are as vital a part of medical tradition as its science and its art. Practice, it is true, may lag behind principles, but at least such failure is regarded as discreditable; and it is hard to imagine any kind of civilization in which the ethical principles of medicine were generally disregarded. That is one reason why the future possibility of biological warfare is particularly repugnant. To-day science finds itself, unexpectedly and without those centuries of tradition and experience, in a position no less important to the community than medicine; and its ethical principles have not yet clearly emerged.

Every candidate for admission to the earliest of American learned associations was required to answer yes to the question: "Do you love truth for truth's sake, and will you endeavour impartially to find . . . it for yourself and communicate it to others?" That affirmation might have its place in a modern scientific version of the Hippocratic Oath. But again the same dilemma arises—"endeavour impartially . . . to communicate it to others". Apart altogether from considerations of national security, in many fields to-day much of the best research is done, and done increasingly, in industrial laboratories. Those who have seen and admired such work, and the people who do it, cannot but applaud the foresight which made it possible. But if all the results are to be communicated at once and impartially to others, could directors and shareholders be reasonably expected to continue their support? Indeed, if an industry were nationalized, could it afford to give away its secrets to competitors abroad? Not in any real world, in which a nation must remain solvent and industry must depend for success on the rapid application of new knowledge. The dilemma must be met by reasonable compromise, of which perhaps the most hopeful sign to-day is that many of the directors of industry come up through research departments. A friendly and familiar contact between management and research, and between industrial nd outside scientific workers, can reduce this articular dilemma to manageable size.

A graver problem is provided by research under overnment, when considerations of security come in. n the emergency which became evident in 1935, the ecret development of radar for purposes of air lefence aroused no obvious pangs of conscience; and nany other developments come in that class. But he surest of military maxims is that counter-attack s an essential part of defence; to limit scientific nethods to defensive weapons would be to ensure lefeat, indeed it is quite impracticable. But let us e realists; so long as offensive weapons may be sed, the part played by the scientist is no more mmoral than that of the engineer, the workman, the oldier or the statesman, and the attitude of 'holier-han-thou' is unbecoming. We all bear, as citizens, n equal responsibility. But is it practical to suggest hat all scientists in all countries should agree, and nold to their agreement whatever happens, to take no part in research on offensive weapons? Or at least should they endeavour impartially to communicate its results to others? The answer is evident. There are individuals in all free countries who find such work intolerable. In those countries their scruples are respected, and they are at liberty to do something else; but let them not imagine that the problem is solved that way, or that those who think otherwise are necessarily stupid or immoral. The first condition of freedom is freedom of conscience, and the scientist has the same right to that as any citizen: but freedom does not extend to giving away other people's property, whether of goods or knowledge.

There seems to be no simple answer to the riddle. All knowledge, not only that of the natural world, can be used for evil as well as good; and in all ages there continue to be people who think that its fruit should be forbidden. Does the future welfare, therefore, of mankind depend on a refusal of science and a more intensive study of the Sermon on the Mount? There are others who hold the contrary opinion, that more and more of science and its applications alone can bring prosperity and happiness to men. Both of these extreme views seem to me entirely wrong—though the second is the more perilous, as more likely to be commonly accepted. The so-called conflict between science and religion is usually about words, too often the words of their unbalanced advocates: the reality lies somewhere in between. "Completeness and dignity", to use Tyndall's phrase, are brought to man by three main channels: first by the religious sentiment and its embodiment in ethical principles, secondly by the influence of what is beautiful in nature, human personality or art, and thirdly by the pursuit of scientific truth and its resolute use in improving human life. Some suppose that religion and beauty are incompatible, and others that the æsthetic has no relation to the scientific sense; both seem to me just as mistaken as those who hold that the scientific and the religious spirit are necessarily opposed. Co-operation is required, not conflict: for science can be used to express and apply the principles of ethics, and those principles themselves can guide the behaviour of scientific men; while the appreciation of what is good and beautiful can provide to both a vision of encouragement.

Is there really, then, any special ethical dilemma which we scientific men, as distinct from other people, have to meet? I think not: unless it be to convince ourselves humbly that we are just like others in having moral issues to face. It is true that integrity of thought is the absolute condition of our work, and that judgments of value must never be allowed to deflect our judgments of fact. But in this we are not unique. It is true that scientific research has opened up the possibility of unprecedented good, or unlimited harm, for mankind; but the use that is made of it depends in the end on the moral judgments of the whole community of men. It is totally impossible now to reverse the process of discovery: it will certainly go on. To help to guide its use aright is not a scientific dilemma, but the honourable and compelling duty of a good citizen.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

CONTRIBUTORS TO EXPERIMENTAL PHYSICS FROM BRITAIN

PROF. A. M. TYNDALL'S presidential address to Section A (Mathematics and Physics) deals in the main with some contributions by workers in Great Britain to experimental physics. His selection of topics has been made to illustrate the citation of the recent award of the Nobel Prize to Prof. C. F. Powell, expressed in the following words: "His special claim to consideration is, in my view, the fact that he has shown that discoveries of fundamental importance can still be made with the simplest apparatus".

The reason for quoting from this occasion is that the words emphasize an approach to the field of experiment which is characteristic of much British physics and following the great scientific tradition of the nation. Examples are common in the literature of simple experiments which have opened up large fields for discovery. After giving examples from the work of Rayleigh, Boys and Chattock, Prof. Tyndall refers to simple experiments which have been fundamental to the development of the items of the main sectional programme of the meeting: the work of the Cavendish Laboratory in the days of 'sealing wax and string', which forms the root of the discussion this year on electrical discharge in gases; and the simple adaptation to radio of the principle of Lloyd's fringes, by which Appleton initiated not only the exploration of the ionosphere but the fields of radio-meteorology and radio-astronomy. Again, ever since Sorby first studied microscopically the surface of opaque solids, Great Britain has contributed widely to the study of their physical properties. A recent example is that of the theoretical work of Frank on the growth of crystals by condensation of atoms on the step of a screw dislocation, and its experimental confirmation by Griffin and others by photographs of crystal surfaces.

But the best modern example of the consequences of a simple idea comes from the field of nuclear physics. Though much has been written on Britain's past contributions to nuclear physics, less has been said of the fact that it still leads the world in the study of processes of the highest energy. This has followed from the simple device of exposing a photographic emulsion to cosmic rays, first at high mountain altitudes and later from balloons. This technique at Bristol, and cloud-chamber investigations from Manchester, have been responsible for the great majority of the important discoveries in nuclear processes of high energy since the Second World War. A number of new types of particle of short life have been discovered, all but one of them in Britain. By a study of their modes of decay, complexity is beginning to give way to order in the phenomena disclosed.

The great machines of the world, absorbing millions of pounds of money, are now studying under controlled conditions the properties of π-mesons discovered by tracks in a photographic emulsion exposed to cosmic rays at mountain altitude. Meanwhile, with the aid of balloons, particles of energy two thousand times greater than anything so far attainable in a laboratory are under observation. It is therefore important to regard this work as part of the larger programme, so that funds, relatively small in amount, continue to be available for its prosecution and extension.

THE ADVANCING FRONT OF CHEMISTRY

THE pace of scientific, social and economic changes in modern times is unprecedentedly rapid. Thus, as Prof. W. Wardlaw points out in his presidential address to Section B (Chemistry), it is easy to understand why the pace of the science of chemistry is growing ever faster and faster. In the past quarter of a century, the number of investigators in both pure and applied chemistry has increased enormously, while research itself is more adequately financed and to some extent better organized than ever before. It is tempting but not very profitable to try to imagine what will have been accomplished, say, fifty years hence, if this acceleration continues. Chemists may well consider that the pace of advance may be such that no human mind will be able to correlate into any significant whole the enormous accumulation of chemical facts. Yet man's curiosity about the universe and his own complex self will most probably increase, and the astonishing growth of the science of chemistry will continue. At intervals during the past half-century prophets have confidently predicted the demise of inorganic chemistry and even of organic chemistry. Chemistry, however, has confounded the prophets by its amazing vitality.

The award of the Nobel Prize for Chemistry for 1951 to McMillan and Seaborg directed the attention of the whole scientific world to the most spectacular advance made in chemistry for a long time: the extension of the Periodic System from element 92 (uranium) to element 98 (californium). Particularly important in this work was the development of ultramicrochemical methods of analysis, which enabled the chemistry of the trans-uranium elements, usually available in millionths of a gram, to be investigated. The combined discoveries of the physicist McMillan and the chemist Seaborg and their associates have opened whole new fields for the investigator interested in the realm of inorganic chemistry.

Chemistry already has made an indispensable contribution to atomic energy research and development, and chemists will fill a major role in establishing nuclear power as a benefit to humanity. The next phase in the development of atomic power probably depends more on new materials than on any discovery in nuclear physics or improvement in atomic technology. This extension of technological interest in new materials, all over the world, is bound to emphasize the need for broadening our knowledge of both the familiar and unfamiliar elements and compounds. It is surprising how little we know about many of the chemical elements, even the metals. We know still less about certain elements which lie midway between the metals and the non-metals, the so-called metalloids. A host of new researches has been set in motion primarily by the needs of the atomic energy programme. However, the results will be the starting-point of new developments in every phase of industry. In the United States, there is a great revival of interest in inorganic chemistry, and in Britain there are signs that its value and importance are being increasingly realized.

During the past decade, most people have had an uneasy feeling that all is not well with their food. As we all know, the food processor has chemicals for every need—preservatives, emulsifiers, colouring agents, etc. Some idea of the magnitude of this problem of chemicals in food can be obtained from the report of the Delaney Committee set up in June 1950 by the United States Congress. The Committee heard the striking evidence from the officers of the Food and Drug Administration that 704 extraneous substances were thought to be in use. Of these, only 428 were considered harmless as normally employed, leaving 276 of which the safety was open to question. There is little doubt that the wide publicity which this subject is receiving will call for planned administrative action in the United Kingdom.

GEOLOGICAL RESEARCH AND ITS APPLICATIONS

FOR his presidential address to Section C (Geology), Dr. J. E. Richey takes as his subject "Some Aspects of Geological Research and their Practical Application". Quoting a remark made by Henri Poincaré in "La Science et l'hypothèse" that "Science is built of facts, as a house is built of stones; but an accumulation of facts is no more a science than a heap of stones is a house", Dr. Richey has selected a number of classic examples of geological research as illustrations of the methods employed in building the 'geological house'. The investigations chosen are mainly from Great Britain and range from those of James Hutton and William Smith to the present day. From an analysis of these and of the criteria used in each case, a definite pattern of evidence which led to the particular conclusion can be adduced. Dr. Richey sets out the various types of proof-pattern made use of under the following headings: anomalies in observed data; similarity and dissimilarity of occurrences; analogy; repetitive evidence; geometrical patterns of evidence; and intersection of different lines of evidence. Examples of each type of proof-pattern are given.

Dr. Richey then deals with practical applications of geology. It is especially emphasized that economic geology is not a subject apart from pure geology but is simply geology applied to a variety of objectives containing an economic purpose. Particular subdivisions considered are coalfield research, the search for oil, the location of ore deposits, and civil engineering problems. In each case one or more examples are given in illustration of the main patterns of evidence involved. These include the discovery of e Kent Coalfield, the guiding idea of Godwin-usten being based upon geometry on the grand ale ; in oil geology, the use made of geometrical atterns exemplified by the anticline of Bahrein land in the Persian Gulf, mapped by G. E. Pilgrim, d by the recently investigated dense fissured limeones of Venezuela, with a reference to the value of alæogeography in the search for new fields ; in ore ology, again with geometrical patterns dominant the varied types of fracture zones in American re-fields, and the recent mineralogical research on e hydro-thermal 'plumbing system' of East Tintic Utah by T. S. Lovering ; in civil engineering, the ocation of the Vrynwy dam-site in North Wales hich followed from the pursuit of a scientific idea y an engineer, Dr. G. F. Deacon, and the investiations by Prof. P. G. H. Boswell which preceded the riving of the Mersey vehicular tunnel at Liverpool, n example of the use of converging lines of evidence.

In conclusion, a few words are added concerning e investigator himself, the capacity inherent in the uman mind of creating 'newness', and the overuling need for self-criticism in the search for truth.

SOME PROBLEMS OF PARTHENOGENESIS

N his presidential address to Section D (Zoology), Prof. A. D. Peacock is reviewing the more imortant researches of the past twenty years on animal arthenogenesis and indicates their bearing on ertain fundamental biological questions. Parthenoenetic phenomena have recently been recorded in everal large groups previously not known, or ubiously known, to be parthenogenetic. The only ain groups in which such phenomena are unknown re Protozoa, sponges, ascidians and reptiles, but the dications are that parthenogenesis, if only rudientary, is more common than generally supposed. f great interest is Muldal's discovery of obligatory arthenogenesis in four genera of earthworms, cultative parthenogenesis in a fifth genus, and the olyploidy of the species concerned. Records and etails of geographical parthenogenesis increase, eiler's work on *Solenobia* moths and Suomalainen's n weevils being particularly striking. Each worker as shown independently the appearance of polyploid arthenogenetic races since the Quaternary ice eriod and their colonization of high-altitude inhositable places, the ancestral diploid bisexual race emaining in the lower and warmer regions.

In cyclic parthenogenesis, for example in rotifers d waterfleas, there exists heterogony, the alterntion of the bisexual and parthenogenetic modes of production, and much discussion has centred ound the problem of how the cycle of events is etermined, whether by hereditary or by environental factors. The recent work on rotifers by Hans uchner and on waterfleas by Madeleine von Dehn, sing the most refined techniques, amply confirms revious views that environmental factors determine e cycle and, further, shows that the main factor is e quality of food. Buchner also finds an inherent aximum potentiality for bisexuality (*Reaktionsorm*) in individual races of rotifers and that the level bisexuality attained in a race at a given time epends upon the strength of the environmental ctors.

On parthenogenesis and sex, one problem is that male production from unfertilized and haploid eggs as seen in the honey bee and Hymenoptera generally, also in rotifers and certain other forms, the phenomenon being unexplained by the classical theory of genic balance. In Whiting's theory of multiple alleles is found the best solution. It is based on genetical evidence. A sex segment on each of two homologous chromosomes of the diploid female exists in nine different alleles ; the diploid female possesses two unlike alleles and is heterozygous ; the diploid male, a rare phenomenon arising from certain pairings, has two like sex alleles and is homozygous ; and the functional male arising from an unfertilized egg therefore carries only one sex allele and is azygous. Another problem regarding sex arises out of Seiler's intersexual *Solenobia* moths, which individually are shown *inter alia* to possess the same grade of intersexuality in all their organs. Seiler's interpretation is that his specimens possess a fixed grade of intersexuality from the embryo onwards, which conflicts with Goldschmidt's earlier time-law (*Zeitgesetz*) interpretation, based on his gipsy moth intersexes, that there is a switch-over from one sex to the other during development.

Early experiments by Loeb, Bataillon, R. S. Lillie and others on artificial parthenogenesis stimulated research on fundamental problems of reproduction, development and cell physiology. More recent work by the Runnström school, Tyler, Rothschild and others, has focused attention on the problem of the artificial and natural activation of the unfertilized egg. Remarkable successes have been obtained by Pincus and co-workers on mammalian parthenogenesis ; they have obtained seven rabbit parthenogones, some alive, from eggs artificially stimulated *in vitro* and then transplanted into rabbit foster mothers. The regulation processes of the parthenogenetized eggs of rabbits as studied by Pincus, and of rabbit, sheep and rat, as worked out by Thibault, also receive attention. Other aspects treated comprise the extent and evolution of parthenogenesis and its role in reproduction and evolution ; suggestions for researches suitable for biologists of all kinds ; and the possible bearing of artificial parthenogenesis on human affairs.

ASPECTS OF SETTLEMENT IN THE OVERSEAS DOMINIONS

PROF. R. O. BUCHANAN's address to Section E (Geography) is a broad comparative survey of some historical conditions that controlled the process of the taking possession of land in areas of modern colonization. This process was spread over two centuries and a half, from the founding of the Dutch East India Company's settlement at the Cape in 1652 to the occupation of the Canadian prairies, which began at the close of the nineteenth century. The Dutch expansion eastwards from Cape Town took place before the Industrial Revolution, while the corresponding movement in Australia, New Zealand and the prairies of Canada reflected the differences in outlook and in material circumstances progressively produced by that revolution. In South Africa the official policy for a century and a half was that of the Dutch East India Company, conceived purely in the interests of its trading activities in the East Indies. In Australia in the earlier stages official policy was that of the Colonial Office. In New Zealand settlement was organized by colonization companies from 1840 onwards, and official policy was the policy of these companies as agreed by the Colonial Office. In both Australia and New Zealand that policy was dominated from 1830 by the views of Edmund Gibbon Wakefield and his supporters.

These two sets of policies, South African and Australasian, though separated in time by a century and a half, were curiously similar in their insistence on small tillage farms in narrowly circumscribed settlements, and consideration is given by Prof. Buchanan to the process by which in all three countries the people on the spot evaded and defeated the cramping control of official regulations, and produced a moving pastoral frontier, in Francis Jackson Turner's sense of the term. This pastoral frontier area has survived only where the natural conditions are difficult, through low rainfall, as in South Africa and Australia, or rugged relief, as in New Zealand.

With the passing of control to the local governments, the more productive area was transformed, mainly through political action, into a farming frontier, with farms of a size capable of providing an acceptable family living, and therefore varying in size with the productivity of the area concerned. Unique to South Africa were the period of slavery and the struggle with the Bantu. The North Island of New Zealand with its Maori wars, born of incompatible usages in land holding, presents a partial analogy, though with significant differences. The settlement of the Canadian prairies differs from that of the southern dominions in coming so late (end of the nineteenth century) and in being so strongly influenced by American precedents. The quarter section of 160 acres for specialized wheat growing was not the final answer to the occupation of the prairies by a permanent agriculture, but it was a good first approximation, and it did solve at one stroke several of the problems that had taken South Africa over two centuries, Australia over one century and New Zealand over half a century to solve. These economic, political and administrative measures have left their imprint on the face of the land in the settled areas, and provide much scope for detailed studies in local historical geography.

FULL EMPLOYMENT IN RETROSPECT

FOR his presidential address to Section F (Economics), Prof. D. T. Jack discusses the problems of full employment.

Pre-war discussions relating to employment policies were conducted against a background of prolonged under-employment, and the main issue concerned the means of attaining continuous full employment through the maintenance of aggregate demand. The emergence of inflation and over-full employment did not appear as a pressing possibility. Similarly, at the end of the War in 1945, there was a widespread expectation that the experience of the years following 1918 would repeat itself and that in order to prevent a recurrence of substantial unemployment special efforts would be required to ensure that aggregate demand did not display symptoms of chronic deficiency. These expectations have not been realized, and in fact our main problem, which has not been adequately solved, has been precisely the development of inflationary pressures and the phenomenon of over-full employment which were neglected in pre-war discussions.

It is probable that an undue amount of attention is devoted to general movements of prices, wages, etc., and insufficient attention to relative movemen within the same indices. Under conditions of fu employment, relative price and wage movement have a particular importance in allocating resource greater than their importance during periods under-employment. Attempts to suppress th symptoms of inflation do damage to the norm working of the price and wage mechanism.

Consideration is given to the nature and effects these inflationary pressures, the natural distortion in the structure of prices to which they give rise, th further artificial distortions which result from th attempts to suppress the symptoms of the inflationar process, and the recurrence of balance of paymen crises. The view is taken that the appropriate trea ment of these problems lies in the field of domest policy rather than by means of international agre ment. In this connexion reference is made to thr reports by committees of experts set up by th Economic and Social Council of the United Nation which appear to be preoccupied with the proble of maintaining aggregate demand as a means dealing with a situation which had been anticipate but which has not as yet arisen. The recommend tions of these committees have been unduly concerne with economic aggregates and they have had pronounced inflationary bias.

Examination is also made of the tendency for pric inflation to be followed by cost inflation, and in tha connexion particular reference is made to proposal for the construction of a unified wage policy. O general grounds these proposals are not accepted but further consideration is given to the suggestio that wages should be related to productivity eithe by means of a mechanical link with an index o over-all productivity, or with an index of productivit for the industry in which the wages are paid. Thes proposals are not commended. If the main problem of inflationary pressure can be tackled at its sourc these various devices, apart from their technica awkwardness, become superfluous. The experienc of full employment emphasizes the importance o concentrating on this problem of inflationary pressur for future policy.

PROGRESS IN AERONAUTICAL SCIENCE AND ENGINEERING

IN his presidential address to Section G (Engineering Sir Ben Lockspeiser points out that there has bee a very great advance in aviation since the previou meeting in Belfast of the British Association fift years ago. That occasion preceded the Wrigh brothers' successful achievement of powered flight b one year. Yet aeronautical progress has been suc that last year nearly one-third of all the person crossing the North Atlantic went by air. It is significant that the Wrights found it necessary to inven the wind tunnel and other techniques which no belong to the science of aerodynamics before the managed to engineer their first aeroplane. Aeronautical science and engineering have gone hand i hand in the evolution from the aeroplane which wa a wooden skeleton to the stream-lined metal monoplane built of hollow shells in aluminium alloy.

The modern aeroplane has 'clean' lines: th external struts, bracing wires, undercarriage, etc. are no longer seen. These parts contribute nothin to the lift and are a liability on the engine. However aerodynamic cleanliness means more than the absenc unnecessary projecting parts. The stream-lines llow the surface and wasteful eddying is at a minium. The lift-induced drag is inescapable, but is not e main contributor to the resistance in high-speed ght. For speeds of less than, say, 500 m.p.h. the maining and larger portion of the drag is due to scous effects. Much would be saved if the flow in e boundary layer next to the surface could be made minar instead of turbulent.

The conditions for boundary-layer flow, which is ainly laminar, are very exacting. The brilliant athematics of S. Goldstein and others has led to itable designs, but the surface must have the noothness of writing-paper and be almost free from aviness. Even then, it has been found in flight tests 'laminar-flow wings' that dust particles and insects icked up at low altitude may promote the onset of rbulence in the boundary layer.

At speeds about 70 per cent of the speed of sound, is no longer possible to regard the air as an incomessible fluid. The air is accelerated in its passage ver the curved surface of an aerofoil, and the local elocity of sound is exceeded long before the aircraft self reaches sonic speed. Shock waves then occur the downstream ends of the regions of supersonic ow, and their formation is accompanied by a great icrease in drag. The movement of shock-waves the 'transonic' range of speeds leads to movement f the centre of pressure and consequently affects the quilibrium of aircraft and throws up problems of ontrol and stability. At supersonic speeds a bowave is formed, and the flow becomes stable with no rious change of the centre of pressure as the speed r incidence is varied. The onset of shock-waves at igh subsonic speeds may be delayed by reducing the cceleration produced by curvature; for example, y making the wings thin. The velocity component the direction of maximum wing surface curvature ay be reduced by sweepback. This solution has arked benefits, but they disappear at high superonic speeds.

The efficiency of the conventional combination of ngine and propeller falls at high speed, as the proeller—like the wing—is beset with 'compressibility' rag. The thrust necessary for transonic flight is now otained by the combination of gas turbine and jet ipe, namely, the turbo-jet. This type of engine develops more thrust per unit of frontal area than any her type of air-consuming engine, but it may be condered to be still in its infancy. At sufficiently high personic speeds the pressure at the air intake is high nough to obviate the need for a compressor, and ence also to make the turbine superfluous. This is the rinciple of the ram jet—an engine without moving arts. Another type of power unit for use in special rcumstances is the rocket, the characteristic feature which is that the oxygen for combustion is selfontained within the fuel.

The development of light alloys of high strength as had much to do with the progress of aircraft ructures, which themselves are characteristically ifferent from any other. Considerations of strength, iffness and fatigue properties at a minimum cost in eight decide the design. High flying speeds have volved high landing and take-off speeds, with the onsequent replacement of landing fields by vast reas of concrete. Some revolutionary ideas to bviate the need for these are now being studied. he use of flying-boats and further application of the elicopter principle are other possibilities. The future the air may well lie in the conquest of the ground.

ARCHÆOLOGY, FOLKLORE AND SACRED TRADITION

THE presidential address by Prof. E. O. James to Section H (Anthropology) traces the relation of archæology to sacred traditions. With the advance in knowledge and in the changed intellectual climate and social environment of to-day, the modification in the earlier evolutionary approach to the study of man is most apparent in the cultural aspects of anthropology. It is now widely recognized that so many factors have been evolved in the origin and development of human institutions and techniques, social structures and religious traditions that clearly defined unilineal systems of development cannot be maintained in relation either to the archæological evidence or to the underlying modes of life, belief and organization. Thus, the distribution and correlation of the palæolithic cultures in different parts of the world suggest that widespread movements of peoples and diffusion of techniques and ideas played an important part in the process of development, though not to the exclusion of independent invention and the influence of local conditions. In more advanced states of culture this is increasingly apparent.

With the arrival in Europe of the Crô-Magnons, and the groups of *Homo sapiens* allied to them, cultural progress became more rapid and complex, and among the achievements in the later stages of the last glaciation was the emergence of a sacred tradition. Its beginnings can be detected in the Mousterian ceremonial interments, it is true, but it was not until the Upper Palæolithic that a cultus began to find expression not only in respect of the disposal of the dead but also in the fertility emblems, commonly known as 'Venuses', and in the art of the decorated caves. To a sanctuary like Altamira, Lascaux or Cogul, recourse seems to have been made by generation after generation of hunters to control the chase by supernatural aid, to stimulate the propagation of the species on which they relied for their food supply, and to establish a mystic bond with providential sources of life and abundance.

When this sacred tradition became a spent force at the end of the Palæolithic (that is, in the Mesolithic), in due course, after the rise of husbandry and herding in the Ancient East and the subsequent diffusion of neolithic settlers from the third millennium onwards, its place was taken by a megalithic cultus distributed along the Mediterranean and Atlantic littoral to Brittany, the British Isles and the shores of the Baltic, with extensions through southern France to Sweden and in an easterly direction to India and Polynesia. Here, again, certain sacred enclosures (for example, Avebury, Carnac, Bethel and the *topes* at Sanchi in India), associated with holy persons or relics and transformed into a *locus religiosus*, became centres of pilgrimage and developed a cultus which persisted throughout the ages. Although all these sites and their rites were not generically connected and the product of a 'megalithic race', they cannot have been independently evolved in complete isolation from each other. On the contrary, as their structure and the legends connected with them indicate, they represent a cultural diffusion spreading from the Mediterranean to Western and North-western Europe. Once it was firmly established in a particular locality, however, the sacred tradition and its cultus have persisted from age to age.

This is illustrated in the long and complex history of the famous medieval shrine of Santiago de Compostela with its maritime legend which, it is contended, was of megalithic origin. In a modified form with different settings, the same tradition has recurred and survived south of the Minho in Portugal, and can be detected in many cult legends throughout the megalithic region (for example, the St. Martha story). Behind this widespread theme and its cultus lie the movements of peoples, for a variety of purposes, and the diffusion of culture, which characterized the rise of Neolithic civilization in the Ancient East, bestowing on certain sites and centres a permanent tradition of sanctity of sufficient endurance to enable pagan sanctuaries to become Christian shrines.

NERVOUS CONTROL OF THE MOVEMENTS OF THE ALIMENTARY CANAL

In his presidential address to Section I (Physiology), Prof. R. C. Garry points out that, in spite of continuing interest and of steady research, our present attitude towards the nervous control of the alimentary canal differs little from that expressed with general acceptance more than fifty years ago by Bayliss and Starling. Yet many facts have since been elicited which appear not to conform to their original conception, and constructive attacks have been made on certain aspects. Nevertheless, for want of a better, we have still to subscribe, more or less, to the original hypothesis.

When entirely separate from the body, the intestine, if kept under suitable conditions, can still show co-ordinated movements. There must be some form of intrinsic control. Certain simple and local movements may be 'myogenic' and independent of the nervous elements in the gut wall. Peristaltic waves, however, may extend over a considerable length of gut, moving only caudad. Bayliss and Starling believed that peristalsis is governed by a reflex in the nervous myenteric plexus of Auerbach. This belief has been vigorously attacked from several sources, but modern work seems once more to emphasize the importance of the nervous element.

Much of the present uncertainty is due to our imperfect knowledge of the histology of the nervous plexuses in the gut wall. Are there receptors in the intestine ? If so, what is their nature and where are they located ? Do axons passing from the gut into the central nervous system make contact with nerve cells in the myenteric plexus ? How many types of nerve cell are present in the wall of the intestine ? How are the outgoing axons from the nervous system to the gut distributed to these nerve cells in the gut ? Until the histologists can give an answer to these questions, we may be unable to interpret satisfactorily the nature of the control of the intrinsic movements of the intestine.

In the intact animal the autonomic nervous system undoubtedly influences the activity of the gut ; and it is attractive to believe that the two divisions of the autonomic system, the orthosympathetic and parasympathetic, oppose one another, as they are known to do elsewhere in the body. Yet there are many observations inconsistent with this view. It may easily be that our experimental approach is crude and is responsible for the observations inconsistent with theory. In spite of everything, the original conception still holds the field, partly due to its inherent logical tidiness and partly to its appea to our preconceived notions.

At the cranial and caudal ends of the gut there i less dubiety. There the alimentary canal seems t lose much of its autonomy and to come mor intimately under the influence of the nervous system The complex acts of swallowing, vomiting an defæcation are undoubtedly governed by elaborat reflexes which control not only movements of the gu but also the behaviour of skeletal musculature.

In the body, the intestine not only receives nerv impulses from the central nervous system, but als sends impulses into the nervous system. Recen work has disentangled the routes followed by thes ingoing nerve impulses, but we still do not kno exactly how and where they arise. Neither do w understand the normal function of these ingoin nerve impulses. They may give rise to sensation, bu apparently only when the normal gives place to th abnormal. Moreover, the controversy concerning th nature of sensation from the viscera is by no mean settled. Once more, only at the extremities of th gut can we form a clear picture of the nature an functions of the impulses which pass inwards int the central nervous system. It may easily be that better understanding of the nature of the nervou control of the intestinal movements will depend no so much on the physiologist as on the histologist an morphologist.

THE ASSESSMENT OF PERSONALITY

PROF. P. E. VERNON, in his presidential addre to Section J (Psychology), discusses "Th Assessment of Personality".

Personality may be regarded as an organized and fairly stable structure which includes all the social and emotional traits, the interests and attitudes and complexes that underlie a person's behaviour. Difficulties in studying it scientifically and assessing it arise, first, because many of its links are repressed into the unconscious mind. Secondly, it is not purely a property of the individual, but varies with the particular social environment. Thirdly, personality traits are generalized inferences from behaviour ; they involve subjective interpretation by an observer, and thus depend largely on the outlook and mentality of the observer and on the interaction of his own personality with that of the individual. Nevertheless, considerable progress has been made in recent years in the theoretical analysis, and in experimental investigations, of personality. But we do not possess, and cannot expect to devise, simple, straightforward tests comparable in reliability and validity to our tests of aptitudes and attainments.

Many experiments show wide discrepancies between the personality judgments of different interviewers, or observers, of the same individuals. In personnel selection work, predictions of vocational or educational suitability, based on interviews of recruits, school pupils or university students, are often poorer than predictions based on a few psychological tests of aptitudes. Some vocational interviewers are relatively successful ; many employers, teachers and psychologists are very unsuccessful. More intensive 'clinical' or psychiatric interviewing, designed to elicit a complete picture of personality structure, may merely result in more biased assessments. Closeness of acquaintanceship also tends to make for greater inaccuracy.

Among the many objective tests that have been ried, physical or physiological indices of temperament for example, somatotypes or the psychogalvanic eflex), and simple tests of perseveration, fluency and ariability are generally unpromising. More realistic ests ituations can be engineered for bringing out uch traits as honesty, persistence, emotional instability and sociability; but these methods are too laborate for selection or guidance purposes. Indirect bservations or measurements of the manner of eacting to various performance or 'stress' tests are nore useful, in skilled hands. The group observational nethods popularized by War Office selection boards re widely applied, and provide a useful extension of he interview. But they are essentially subjective nd greatly dependent on the skill of the observer. o-called projective techniques also involve so much nterpretation that they are almost useless for ocational and educational predictions, though aluable for differential diagnosis of abnormal ersonalities. Personality questionnaires are genuinely seful at a fairly sophisticated level for assessing nterests and social attitudes, and even for measuring ertain social and emotional traits, provided that the uestions are sufficiently disguised—for example, by he 'forced choice' technique—and that the scoring eys are empirically validated. Ordinary personality atings (for example, on pupil record cards) are of ttle value, though a number of techniques have been evised for making more effective use of acquaintances' udgments. The chief difficulty in supplying the sychologist with a useful set of instruments for ersonality assessment is the amount of psychological nd statistical investigation needed, and the shortage f qualified investigators in Britain.

ANATOMY OF METABOLISM IN HIGHER PLANTS

THE full title of the presidential address of Prof. Meirion Thomas to Section K (Botany) is "The natomy of Metabolism in Higher Plants: Total letabolism, Metabolic Processes and Partial Reactions".

The axiom is that transformation of matter and nergy lies at the root of all biological events. Specific every organism, or a component cellular part, is s total metabolism. The physiologist accepts this oncept and abstracts from it metabolic processes or special study. Categories are very mixed in the hapter headings: photosynthesis; respiration; cid, nitrogen or fat metabolism, and so forth. espiration is a traditional term for the absorption f oxygen and a related production of carbon dioxide y a living organ. The gaseous exchange may be an xternal manifestation of an integral internal process, aving a definite beginning and end. Current searches bear on questions concerning the beginning f the process and the integration of events. The utcome of these researches will determine whether r not the traditional term will survive as something nore than a counter with which to reckon. When nalysis and synthesis can proceed no further, the erm may still retain a biological meaning. The rucial point may turn out to be that action is, or is ot, attributable to organization within a visible or nvisible cell structure. The known facts about ertain other processes point to the possibility of irection by organized enzyme complexes. However, the abstractions from total metabolism implied in many chapter headings in current use are plainly made for classificatory convenience. They are artificial and not natural.

Analysis of total metabolism into component fractional processes that still retain their characteristic pattern has not proceeded very far. Worthy progress may, however, be claimed for the study of the ultimate fragments of which abstracted metabolic processes and, consequently, total metabolism, are composed. These fragments are the partial reactions, the physicochemical realities. The elucidation of the functions of key partial reactions will loom increasingly large in the future study of physiology. With the achievement of a correct synthesis from biochemical knowledge about partial reactions, the pattern of a metabolic process would emerge. Ideally, analysis and synthesis would meet in the abstracted process, and we would see in the whole the harmonious working of the parts, relating functional actions, whether single events or blocks of events in a process, to the maintenance of individuals or the perpetuation of a race.

It is asserted that, for higher plants, well-authenticated facts about reaction sequences and linkages are still in very short supply. Problems of intermediate metabolism are stated. Methods used in fact-finding are outlined, and some of their limitations indicated. Detailed treatment is given to three aspects of carbohydrate catabolism, namely, malic acid production in crassulacean acid metabolism, and anaerobic and aerobic respiration. The results of broad physiological studies involving the measurement of gaseous exchange are related to our steadily growing knowledge of partial reactions in these abstracted processes. However, some emphasis is laid on the existence of gaps in our knowledge, especially of stages in the aerobic catabolism of carbohydrates in higher plants, and on the need for continued efforts to verify, by experiment, hypotheses based largely on work with animal tissues, yeast and bacteria.

EDUCATION OF AFRICANS IN EAST AND CENTRAL AFRICA

THE subject of the presidential address to Section L (Education) raises so many issues that Mr. A. L. Binns has had to select for discussion in his address only a few of the many problems which the title indicates. Mr. Binns points out that the history of education in the seven British territories of East and Central Africa seldom goes back more than a quarter of a century, and he is full of admiration for what has been done in such a short time by so few people with such slender resources. These territories depend for the most part on agriculture, which is often very primitive in its methods and implements, and the funds available are very small in comparison with the expenditure to which we are accustomed in Great Britain.

Education is administered by the Colonial Civil Service, working in co-operation with the Christian Churches except in those areas where the people are Mohammedan. A comparatively small number of European teachers is working very hard to train Africans to follow in their footsteps. Owing to difficulties of finance, religion and communications, the training of the African teacher often leaves much to be desired in both content and method, but a great effort is being made to improve matters. The teachers' training centres must be small by British standards, but at present some of them produce less than a dozen teachers annually and lose in both efficiency and economy for that reason. The curriculum followed in the schools has the aim of enabling the Africans to lead the fullest possible life in their own environment, and to improve that environment as quickly as possible; but some Africans would like to copy too closely the aims and methods of European education which are, of course, related to entirely different environment, culture and traditions. Some Africans are also prone to mistake the means for the end and to regard education as designed to enable them to pass examinations rather than to lead a good life. Many people in Great Britain fall into the same error, but it is natural that a people who are emerging from a primitive way of life should be especially open to the temptations of an education academic and examination-ridden. Language is a real difficulty in most of the schools of these territories, for the tribal vernaculars are very numerous, they arise from a number of language roots, and they are often limited to such a small number of users that these languages have little literature and sometimes even no school text-books, simply because the market is too small to make printing economically possible. A lingua franca to be used in addition to the tribal vernaculars is essential to progress, and it must be a lingua franca current over a wide area, with a rich literature and fully equipped for use in technical education and in commerce. Swahili, which has been used to some extent as a lingua franca, fails in some of these respects but has stood in the way of a better common language.

The population of many of these territories is increasing very fast, and increased productivity is essential. There is here a vicious circle, for increased productivity is a condition of the spread of education for financial reasons, while productivity cannot expand rapidly until we have an educated population. So many other things depend on the advance of education in East and Central Africa that the vicious circle thus described must be broken into to raise the moral stature as well as the material resources of these countries, and to enable their inhabitants to lead a fuller life.

BRITAIN'S FOOD SUPPLIES

IN his presidential address to Section M (Agriculture) Dr. N. C. Wright opens with a reference to the leading part which the British Association has always taken in relating nutritional needs to national life, notably by the pioneer survey of food consumption and expenditure made by a special Committee of the Association in 1880. This survey had already shown the increasing dependence on overseas food supplies which accompanied Britain's rapid industrial development in the nineteenth century. During the fifty years between 1880 and the 1930's this trend was continued, until in the immediate pre-war years Britain relied on imports to the extent of some 70 per cent of the total calorie value of the food supplies. This excessive dependence on overseas supplies was inevitably accompanied by the neglect of the food-producing potentialities of British agriculture.

With the outbreak of war in 1939 the country had to face drastically reduced overseas food shipments, which by 1942 had fallen to only half the pre-wa figure. To meet this serious menace to the food supply it was necessary not only to re-plan the impor programme but also to re-develop British agricultura production. From the nutritional aspect there were three main objectives in planning this re-orientation of the country's food supplies: first, to ensure an adequate calorie-level in the national diet; second to furnish sufficient supplies of 'protective' foods particularly for the vulnerable groups of the population; and third, so far as possible to provide a die which was reasonably varied and palatable. The first objective was achieved by expanding substantially the home production of crops which furnished maximum calories for direct human consumption, for example, wheat, potatoes and sugar beet. This inevitably involved substantial reduction in the livestock population, notably in the number of pigs and poultry—though such reductions were partially offset by large increases in the home output of coarse grains. The second objective was achieved partly by increasing the supplies of liquid milk and subsidizing its consumption, partly by expanding the acreages under vitamin-rich vegetables, and partly by adopting processing techniques designed to increase the 'protective' value of certain staple food such as bread and margarine. The third objective was achieved by changing the pattern of imports to include a higher proportion of the more palatable and concentrated foods, and by increasing the home production of certain highly flavoured crops. As a result of these combined measures the nutritiona value of the diet was actually improved during the War.

The immediate effect of the cessation of war was to create greatly increased demands on the world's available food supplies. Simultaneously Britain had to face the loss of Lend-Lease aid. Since anima products represented the most expensive drain on the country's currency, the main objective of the 1947 agricultural expansion programme was to re-expand the livestock population; but to do so not only on the basis of substantially increased dependence on home-produced animal feeds but also without any appreciable reduction in the home contribution to the total calories of the national diet. The extent to which this was achieved is shown by the figures for home production in 1950.

Although both the war and post-war increases in home food production were associated with marked changes in the pattern of land usage, they were also largely due to technical improvements designed to increase both yield and productive efficiency. These improvements included very substantial increases in fertilizer usage, in farm mechanization, in crop protection methods, and in the productivity of crops and stock, as well as of grassland.

An examination of the country's future food requirements indicates that largely owing to the gradual equalization of demand between differen income groups these are likely to increase. At the same time, both the availability of world supplies and Britain's balance of payments problem are likely to limit the country's ability to purchase food from overseas. The need for a further expansion in home production is therefore assured. Whether such expansion will involve a further marked re-orientation in the pattern of land usage cannot be forecast, but there is no doubt that even within the present pattern there is still ample scope for improvement by the wider application of science to farming practice.

LOCAL SCIENTIFIC SOCIETIES

THE title of the presidential address to the Conference of Delegates of Corresponding Societies being delivered by Mr. J. A. S. Stendall is "Problems and Responsibilities". After tracing the history of societies in Northern Ireland and directing attention to men eminent in their own spheres of activity, Mr. Stendall turns to the decline in publications issued by local societies. This, he suggests, is possibly not due to lack of interest on the part of those responsible, but rather to present-day conditions. Fewer reports and proceedings of societies are being published and still fewer records of accomplished work made available, owing to the prohibitive increase in printing costs. This is to be deplored. Mr. Stendall thinks that societies should subsidize regional journals rather than attempt their individual publications and in this way cut their own costs, allow for an increase in size of the journals, bring all regional records together and reduce time-lag in the publication of important papers.

Following a brief account of the natural scene in Northern Ireland, an appeal is made to members of the local societies to give more consideration to the importance of preservation by law of several well-known areas of great interest—scenically, archæologically and naturally. Great Britain has scheduled many such areas, but nothing in this respect has been done in Northern Ireland, notwithstanding favourable recommendations contained in the 1946 Interim Report of an officially sponsored Planning Advisory Board on Amenities.

An appeal is made for the control of ivy growth, especially on trees. Locally many fine trees have been killed by ivy strangulation; to-day there are numbers tending that way, while potential victims are legion, especially those growing along roadsides. Similar conditions appertain farther afield than Northern Ireland.

Turning to local achievements in the preservation of Nature, Mr. Stendall refers to the value of the Wild Birds Protection Act (N.I.) 1931, which swept away outmoded legislation, similar to that which holds in other parts of the United Kingdom to-day, ranging as it does back into the 'eighties. Northern Ireland, fortunate in being a compact area, lends itself to the now admitted justifiable experiment of deeming all species of wild birds to be protected, with the proviso that any undesirable members of the family could be contracted out, while a close season is given to birds of sport. The Act is administered by the Home Office of the Northern Ireland Government, with a special committee to advise the Minister. At the moment, there are seventeen species completely unprotected, two species can only be taken on enclosed land, while sporting birds of winter can have their close season altered and even be given complete protection for a definite period if necessary. All nests and eggs are protected, except those of the blacklisted species. The Minister has the power to transfer species from, and to, complete protection, while police have to be able to recognize but few species. Mr. Stendall suggests that local societies could do much to bring about legislation of a like nature in Great Britain.

OBITUARIES

Sir Jack Drummond, F.R.S.

THE insensate murder, on the night of August 4, of Sir Jack Drummond, together with his wife and their twelve-year-old daughter Elizabeth Anne, will have brought rage and grief to many hearts. Debonair would be the best single word to describe him; he attracted friends as the sparks fly upwards.

He was born in 1891. The history of his scientific work typifies and illustrates the development of biochemistry in Great Britain. Graduating from Queen Mary College and King's College, London, he became a research worker at the Royal Cancer Hospital, London, in 1914, and remained there for five years, when he was appointed reader in physiological chemistry at University College, London. This appointment, in which he succeeded the first reader in the subject to be created in the University, Dr. R. H. Aders Plimmer, was to the staff of the Department of Physiology. The post was made into a professorship in 1922, the Department then being known as the Department of Physiology and Biochemistry, which title it retained until his resignation in 1946 to become director of research to Boots Pure Drug Co., Ltd., after which a separate Department of Biochemistry was created.

The long list of Drummond's published papers emphasizes the unfolding of the subject of biochemistry. He had begun work on nutritional subjects, particularly on the so-called 'accessory substances', while at the Royal Cancer Hospital, and under the influence of Casimir Funk. In 1922 he was publishing the results of a search for the fat-soluble factor, then called vitamin A, and investigating its origin. At that time, although Mellanby had shown the antirachitic properties of the factor, it had not yet been separated into the A and D fractions—this happened about 1924. He passed on to study high protein diets, further properties of the non-saponifiable fraction of cod liver oil, and to the antirachitic properties of irradiated sterols, in 1925. The following year he went back to the question of the chemical nature of vitamin A, discussed its possible relation to carotene, which was rejected because he could not confirm the growth-promoting action of the latter, and he evolved the arsenic trichloride colour reaction. After working for two years on vitamin B in relation to diet and inanition, he returned in 1930–31 to the question of the relation of vitamin A to carotene, and this he now confirmed, explaining the former failures by the fact that the carotene had been given in solution in ethyl oleate, which oxidized easily and led to destruction of the carotene. For the time it appeared that carotene and vitamin A were, in fact, identical; but in 1932 T. Moore, of Cambridge, showed that the vitamin was formed from carotene in the body, and this Drummond confirmed.

Attention was next turned to more practical questions of the nutritive value of bread, the effects of milling, of the seasonal alterations in milk, and of the effects of fat-free diets; he also worked on vitamin E, which had recently been isolated.

It must be mentioned that nearly all this large amount of published work was carried out in collaboration with others, and they were many and often distinguished, or destined to become so; Drummond was, however, the senior partner in most of these publications. I think he exerted much more influence through his inspiration of junior colleagues, and by his example of first-class work than by any actual event of discovery, in which, despite immense efforts, he was, on the whole, not over fortunate. That he played a very large part in the general development of the biochemistry of nutrition nobody can doubt; but it was more by example, by the application of first-class chemistry, by his innate appreciation that mere chemistry is not enough, and by the coordination of wide chemical with biological knowledge rather than by resounding discoveries that he did so.

When the War came in 1939, he was clearly indicated as the most suitable person for the responsible post of scientific adviser to the Ministry of Food, which he held until 1946, in the later years of the period being also adviser on nutrition to the Allied Post-War Requirements Bureau and S.H.A.E.F., and adviser on nutrition to the Control Commissions for Germany and Austria (British Element). He was knighted in 1944, and shortly afterwards was elected a Fellow of the Royal Society. Great Britain owes to Jack Drummond and to the Minister, Lord Woolton, who gave him a pretty free hand, an incalculable debt for the fine work they did in connexion with the British rationing system, which was finely conceived, brilliantly executed, and a pattern to all nations.

Drummond was interested in food from every aspect; he was a very good judge of food and knowledgeable as to its preparation, and he brought, as often as he could, to good food, good fellowship. Very many have spent many a happy hour with him, enjoying good fare, good conversation, and good fun at one of his clubs, at some private dining club, which he always enlivened, or in his own home, where he was the perfect host. We shall all think, often and often, of those very well-spent evenings, and shall not forget.

Lady Drummond (*née* Wilbraham) was his second wife; she was interested in history, and collaborated with him in the production, in 1939, of an entertaining book, "The Englishman's Food" (Jonathan Cape), which abounds in sound scholarship and humour.

'Jack' was full of energy and enterprise, and with a lively sense of humour, which extended to telling stories against himself. He had travelled widely, and with wide-open eyes. Hatred was foreign to his nature, though he freely expressed amused contempt for any kind of pomposity or priggishness; to some, therefore, he might have been unacceptable. Beneath the twinkling eye there was, nevertheless, a steely inflexibility of purpose, and he could be devastating towards incompetence and astringent to fools. Lecturing came easily to Drummond; he was bright, informative and had a gift for popular exposition; accordingly he gave many popular lectures to large audiences, both in Great Britain and in the United States, and these lectures were greatly enjoyed.

His connexions with the industrial aspects of biochemistry, and especially with the food industry, were close, and mutually beneficial. Few realized more clearly than he that our standard of living, together with the sweets of academic life, represent the cream skimmed from industrial endeavour, and he probably supplied more young men for industrial undertakings than any other three biochemists put together; these young men did him great credit and they not infrequently gained distinction in both pure and applied science.

Very many young people owe to Sir Jack Drummond their start in life; he liked young people, and put on no professorial airs for their benefit. If any memorial to him is to be created, he would have liked nothing better than something which would enable capable young people to receive an encouraging start, such as he gave to so many. It would also keep alive the name, for those whose loss it was not to have known him, of a great and lovable personality.

C. Lovatt Evans

The late Sir Jack Drummond was a man of outstanding ability. He was a scientist with an international reputation as one of the leaders in developing what has been called the newer knowledge of nutrition. By applying the scientific method of approach to the administrative problems in the Ministry of Food he made a great contribution to the success during the Second World War of food policy, the outstanding feature of which was the special provision for the nutritional needs of mothers and children. The resulting big improvement in the health and physique in the rising generation in a time of acute food shortage was a remarkable achievement. As one of those who got this policy adopted, and for his work in helping to get it carried through, he rendered great service to Great Britain.

Boyd-Orr

Mr. J. R. Park

British applied science has suffered a severe loss in the untimely death of Mr. J. R. Park, a managing director of the British Oxygen Co., Ltd. Mr. Park was born in London in 1902 and was educated first at Battersea Grammar School and then at Queen Mary College, where he graduated in chemistry. After a short period on the staff of Westminster Technical College he worked as an analytical chemist in industry for a number of years in Britain, followed by a year in a French firm.

In 1929 Mr. Park joined Imperial Chemical Industries, Ltd., Billingham Division, where he remained until 1945. For a time he worked there as a plant manager, but soon he switched over to the research side. The production of hydrogen, the hydrogenation of coal, the ammonia synthesis and methanol synthesis were some of the fields which occupied him in the years up to the Second World War, when he had advanced to the position of ammonia research manager. He was also connected with the design of oil hydrogenation plant, and in the first year of the War was responsible for the design of various other plants.

I made his acquaintance in 1941, when Park was put in charge of the I.C.I. Billingham research team working on the British Atomic Energy Project. His quick grasp of problems, his strong scientific background and his understanding of large-scale industrial processes formed a combination that contributed greatly to the success of the enterprise.

In 1945 Park was asked to organize a research department in the British Oxygen Co. He did this with outstanding success, creating within a few years a large and flourishing research organization practically from scratch. His worth was quickly appreciated;

in 1948 he became assistant managing director, and soon was promoted to the post of managing director. It is largely due to Park that the British Oxygen Co. has been transformed from an undertaking relying mainly on foreign patents into a modern enterprise standing on its own feet in the field of research and development. Park was one of the all too small group of first-class chemical technologists who are essential for the economic future of Great Britain; his death leaves a gap which will be felt for a long time. His friends mourn the passing of a personality of wide interests and great charm, and of a warm-hearted and loyal companion.

F. E. SIMON

We regret to announce the following deaths:

Sir Frederic Kenyon, G.B.E., K.C.B., during 1909–30 director and principal librarian of the British Museum, on August 23, aged eighty-nine.

Dr. Albert Mansbridge, C.H., founder and first secretary of the Workers' Educational Association, on August 22, aged seventy-six.

NEWS and VIEWS

The Nature Conservancy:

Captain C. Diver, C.B., C.B.E.

Captain C. Diver is retiring on December 1 from the post of director-general of the Nature Conservancy. He was appointed to his present post four years ago to implement the Government's decision to establish the Nature Conservancy. After being invalided out of the Army, in 1919 he was appointed to a clerkship in the House of Commons and remained in the service of the House for the next twenty-nine years, relinquishing his appointment as principal clerk of committees to take up his present post. Throughout the Second World War he was clerk to the Select Committee on National Expenditure. In the field of biology Capt. Diver has worked as an amateur. Very early he developed an interest in land and freshwater Mollusca and a little later in the mosses. After the First World War, he received much help and encouragement from Bateson, and collaborated with Boycott and others in experiments on the genetics of inverse symmetry in *Limnaea*. He also studied the distribution of genes in natural populations of *Cepaea*, and the behaviour and web-building of the garden spider. In 1930 he began the ecological survey of South Haven Peninsula, Studland, on the Dorset coast, and soon enlisted the help of Prof. R. D'O. Good and many others. This work, for which he received a Leverhulme grant, continued steadily for the next nine years until brought to an abrupt close by the declaration of war. He was a member of the Nature Reserves Investigation Committee set up in 1942 under the auspices of the Society for the Promotion of Nature Reserves, and he was largely responsible for the contents of its report. This report furnished the basic data for the work of the Wild Life Conservation Special Committee which was appointed in 1945 by the Ministry of Town and Country Planning to work in conjunction with the Hobhouse Committee on National Parks. He took a leading part in the work of the Special Committee, the report of which ("Conservation of Nature in England and Wales". Cmd. 7122. 1947) he drafted at the unanimous request of the Committee. It was largely informed by his ideas and policies, and the acceptance by the Government of its main conclusions brought the Nature Conservancy into being.

Mr. E. M. Nicholson, C.B.

Mr. E. M. Nicholson, who has been appointed by the Nature Conservancy, with the approval of the Lord President of the Council, to succeed Captain Diver as director-general, is a charter member of that body. He brought to the service of the Conservancy a valuable combination of administrative experience and expert ornithological knowledge; and he assumes his new duties as one who not only was a member of the Wild Life Conservation Special Committee but has also taken an active part in the work of the Conservancy since its inception. During the War, he served in the Ministry of Shipping, later the Ministry of War Transport, where as head of the division in charge of Middle East supplies he was responsible for sending out the Kerr-Worthington scientific mission. From 1945 until May of this year he was secretary of the Office of the Lord President of the Council, and is a member of the Advisory Council on Scientific Policy. For the past few months he has been in Baluchistan as the leader of a United Nations Economic Development Survey team. Birds and ornithological affairs have been Mr. Nicholson's life-long interest, and he has published scientific papers and several books on this subject; in 1927 he organized and directed the Oxford Bird Census, in which university ornithologists, botanists and entomologists collaborated in field surveys; and in the two following years he organized the Oxford University expeditions to Greenland and to British Guiana. He has been secretary, vice-chairman and chairman of the British Trust for Ornithology and has taken a leading part in other ornithological activities.

Natural History at Edinburgh:

Prof. J. Ritchie, C.B.E.

With the retirement of Prof. James Ritchie from the chair of natural history at the end of the current session, the University of Edinburgh will lose the services of a distinguished naturalist and inspiring teacher. In his student days he came under the influence of Sir J. Arthur Thomson at Aberdeen and proved a worthy successor to that line of all-round scientific naturalists of which Scotland is justly proud—a type all too rare in these days of specialization. A brilliant record as a student saw the award of an M.A., a B.Sc. and in 1912 a D.Sc. In 1907 he entered the Royal Scottish Museum as an assistant and in 1921 became keeper of the Natural History Department. In 1930 he was appointed regius professor of natural history in Aberdeen and transferred to the chair at Edinburgh in 1936. Among the other posts he has filled are: five periods on the council, one as secretary and two as vice-president of the Royal Society of Edinburgh, president of Section D (Zoology) of the British Association, editor of the *Scottish Naturalist*, vice-president of the Zoological Society of Scotland and membership of various bodies concerned with the conservation of wild life.

His zoological researches commenced with a series of papers on Hydrozoa but soon extended to other marine invertebrates, land and water vertebrates and archæology. One of his interesting economic suggestions, a method of keeping the submarine shafts of an electricity station free from blocking by the invasion of mussels, has been in successful operation since 1927. It is not possible in a brief note to do justice to his remarkable energy and enthusiasm nor to the wide range of his knowledge and interests. His services were recognized by the conferment of a C.B.E. in 1948 and an honorary LL.D. by Aberdeen this year. His skill in drawing is reflected in all his work, and outside scientific circles has been recognized by the Royal Scottish Academy, which has exhibited a number of his delightful water colours. A most approachable man, he has always been ready to share his knowledge and to encourage the humblest of inquirers. Many have enjoyed his loyal friendship and some perhaps a round of golf with him.

Dr. M. M. Swann

Dr. Michael Meredith Swann has been appointed to succeed Prof. Ritchie. Educated at Winchester and Cambridge, Swann, after graduating in 1940 with a first-class in zoology, joined the Intelligence Corps, served in Iceland as a captain instructor in arctic warfare, benefiting by his earlier experience with the Cambridge Iceland Expedition of 1939, and was thereafter engaged in operational research in Great Britain and Normandy. When, as lieut.-colonel in the Scientific Adviser's Branch of the War Office, he was demobilized in 1946, he returned to the Zoology Department at Cambridge as temporary demonstrator, with a research fellowship at Gonville and Caius College. He has been a University demonstrator since 1948. Dr. Swann has devoted himself actively to the investigation of the cell, and his studies have followed three main lines—the refinements of mitosis, the fertilization reactions of sea-urchin eggs, and the mechanical properties of cell-membranes. In the first, his Ph.D. thesis (1950) was on "Structural Factors in Mitosis", and with J. M. Mitchison he has elaborated the use of polarized light in the study of cell changes affecting membranes, mitosis and cleavage. In the second, in collaboration with Lord Rothschild, he has elucidated the responses of the sea-urchin egg to contact with spermatozoa, and in the last he, along with Mitchison, has attempted to link the processes of cell-cleavage with the physical properties of the cell-membrane. At the age of thirty-two years Dr. Swann is not the most youthful of Edinburgh's long succession of professors of natural history, but to better his record one must go back to 1804 and the appointment at the age of thirty of Robert Jameson, the teacher of Charles Darwin, Edward Forbes, Sir William Jardine, William Scoresby, John Goodsir and many other well-known naturalists.

Research at Edinburgh on Cancer

From the estate of the late George Fisher Melville, advocate, of Edinburgh, the sum of £270,000 has now become available for the encouragement of activities relating to "the care and cure of cancer". Some time ago, Messrs. Tod, Murray and Jamieson, W. S., of Edinburgh, in whose hands the affairs of the estate rest, sought the advice of representatives of the Royal Colleges of Medicine and of Surgery of Edinburgh and of the University, and with the help of this *ad hoc* committee so formed drew up a scheme for the appropriate utilization of this money. This scheme has now gained the approval of the Court of Session. The next step will be the formal approach by the trustees to the Royal Colleges and to the University of Edinburgh requesting that each of these bodies shall nominate a trustee and three members of a permanent scientific advisory committee which will at once proceed to formulate recommendations for carrying the scheme into practical effect. Since the care of the patient is now a responsibility of the State, it is certain that the scientific advisory committee will be mainly, if not exclusively, concerned with the encouragement of research into the nature and causes of malignancy, and thus into the ways in which it may be prevented, treated and controlled. The hands of the trustees are not tied. They are empowered to nourish researches being undertaken in hospitals and elsewhere, to build and equip new laboratories, to institute research fellowships and to amalgamate or to form alliances with other bodies actively interested in the same general field of inquiry. In these days, opportunity of this magnitude knocks but very rarely upon the doors of Scottish academic institutions. The responsibility to be assumed by the scientific advisory committee is, therefore, exceedingly heavy. To exploit this opportunity to the best advantage to all concerned—to those who suffer and to those who seek knowledge that may give power to abolish suffering—will demand the exercise of much wisdom. Of this there is in Edinburgh a rich store.

Popular Interests in Science

An investigation into the interests of about 391 people (241 males, 150 females) who are taking science subjects in adult education classes showed that the females were more extreme in their preferences and dislikes than the males (*Health Educ. J.*, 9, No. 4). Males were most interested in studying future advances and new discoveries and theories in science and, next to these, medicine, health and the industrial applications of science. Medicine and health were the most popular subjects for females, and almost as popular were pure biology and psychology. Neither males nor females took much interest in aeronautics or in the public direction and use of science; even less interest was shown in the work of scientific institutions and the results of science surveys and commissions. This may indicate that the 'ordinary' man is not fully conscious of the impacts of science on communal life or, perhaps, is little interested in the development of society as distinct from the individual. Confirmation of this investigation was obtained from a group of men in an Army education college. Although the men were not necessarily interested in science, their likes and dislikes were very similar to those of the younger men in the original group.

C. T. R. Wilson and the Cloud Chamber

The fourth in the series of attractively illustrated monographs dealing with the association of prominent men of science with the Cambridge Instrument Co., Ltd., is entitled "C. T. R. Wilson and the Cloud Chamber" (pp. iv+16; from 13 Grosvenor Place, London, S.W.1; 1952; free) and is written by S. Barron, with a foreword by Sir Lawrence Bragg. Reference is made, both in the foreword and in the text, to Wilson's skill and patience in building apparatus and to the remarkable success of the first complete cloud chamber constructed by Wilson in the Cavendish Laboratory, Cambridge, in 1911. This instrument was the only one used by Wilson for his many subsequent researches and is preserved now in the Cavendish Museum where it is still, after forty years, as capable of producing perfect ray-tracks as when it was first demonstrated. In 1913, the Cambridge Instrument Co. obtained permission to make a cloud chamber similar to Wilson's original model, and the Company's first instrument, together with subsequent developments, such as the Wilson–Shimidzu raytrack apparatus (1921), the student's demonstration cloud chamber (1927) and the reciprocating cloud chamber built for the 1951 Festival of Britain, are all fully described and illustrated in the monograph.

Standards of Light at the National Physical Laboratory

"LIGHT" is the second in the series of pamphlets on units and standards of measurement employed at the National Physical Laboratory, Teddington (pp. 8. London: H.M.S.O., 1952; 6d.). The first dealt with the fundamental units of length, mass and time, and the third will deal with electrical units. In the pamphlet on light, the units and systems of measurement used in the Photometry, Colorimetry and Radiometry Sections of the Light Division of the Laboratory are defined. The units are those normally employed in reports and certificates issued by the Laboratory. Brief particulars describing the derivation of the units are provided, and reference is made to those which are accepted internationally. The topics discussed in the photometry section of the pamphlet are the candela, the unit of luminous intensity; the lumen, the unit of luminous flux, the distinction between the units of illumination on the British and metric systems; the stilb and the nit; the scotopic system of photometry; and colour temperature. The requirements of the standard trichromatic system of colorimetry adopted by the Commission Internationale de l'Eclairage are set out clearly in the colorimetry section, and, under the third heading of the pamphlet, "Radiometry", the instruments, particularly the Callendar radiation balance and its more recent successor the Guild drift radiometer, for the measurement of the rate of transference of energy by electromagnetic radiation, are briefly discussed. Industrial and research laboratories will find this series of pamphlets most helpful in interpreting test certificates and in ensuring that results of measurements are expressed in agreed and internationally recognized units.

Principles of Extraction and Refining of Metals

THE Institution of Metallurgists has published the five lectures on the "Principles of the Extraction and Refining of Metals" given under the presidency of Mr. E. W. Colbeck at its refresher course in 1950. Starting off with an introductory lecture on the use of physical chemistry in extraction operations, which is concerned mainly with thermodynamic principles, the place of mineral dressing in extraction metallurgy is then considered; this is, in the main, economic and technical. A lecture of unusual interest on the principles of ore reduction, by Prof. C. W. Dannatt, goes far towards systematizing the large number of procedures which are used for obtaining crude metal from its ore. The fundamentals of the production of ingots are then discussed, and the course is concluded by a lecture on the principles underlying refining processes, using the fundamental chemical principles previously outlined. All who are concerned with the extraction and refining of metals will find in this short monograph a large amount of material of direct interest, much of it by no means easy to find, nor so well digested, elsewhere. As is said in the concluding paragraph of the last lecture: "The refiner will find it vastly to his advantage to employ thermodynamics in order to recognize both the results which may theoretically be achieved in the ideal process, and those which are inherently impossible under his conditions of working".

King George III Collection of Scientific Instruments

A DESCRIPTIVE catalogue of the King George III collection of scientific instruments, issued by the Science Museum, London (pp. 92+8 plates; London: H.M.S.O., 1951; 7s. 6d. net), is of interest in throwing light on the activities of individual instrument-makers practising during the latter half of the eighteenth century. The catalogue is divided into sections according to the various branches of science recognized at the present time, for it should be realized that in the days of George III scientific specialization was not known, since the philosophers—as they were called—did not confine their studies to one branch of knowledge. The sections of the catalogue include mechanics, heat, pneumatics and hydrostatics, chemistry, astronomy and time measurement, optics, surveying and mathematical instruments, acoustics, magnetism, electricity, manuscripts and miscellaneous. The catalogue is illustrated and concludes with notes on the location of the other portions of the original collection and a list of makers of the instruments.

Colonial Plant and Animal Products

IN the latest issue of the quarterly journal of the Colonial Products Advisory Bureau (Plant and Animal) (2, No. 3), R. H. Kirby continues his series of articles on seaweeds in commerce. Besides accounts of the use of agar-agar in the British Commonwealth and other countries, Kirby also describes the manufacture of algin in the United States and other parts of the world. Other articles include one on aromatic grasses of commercial importance by E. Brown and W. S. A. Matthews, and the market for mangoes and mango products by E. H. G. Smith. Reports of recent investigations at the Colonial Products Advisory Bureau include that on the use of trigona wax from Tanganyika, manila hemp from Malaya, pewar or peach nuts from Trinidad, a description of drying trials with goat skins in the Sudan and the possibilities of using cocoa husks from the Gold Coast as a source of furfural.

Annals and Magazine of Natural History

FOR a century and a quarter the *Annals and Magazine of Natural History* has held an honoured place among biological journals; all-embracing in its earlier years, it has of late tended to include particularly systematic and morphological papers in zoology, palæobotany and palæontology. The proprietors of the journal, Messrs. Taylor and Francis, Ltd., with the support of the editorial board, have now decided to widen its scope by combining with it the *Journal of Botany*, which had to cease publication during the Second World War. The editorial board, Sir Guy Marshall, Dr. W. T. Calman, Prof. H. L. Hawkins and Mr. W. N. Edwards, will thus have the assistance of Dr. George Taylor, keeper of botany in the British Museum (Natural History), and in view of the importance of the entomological papers in the *Annals*, Mr. E. B. Britten, of the Department of Entomology at the British Museum, is also to join the board. Biologists will welcome the extension of the field of this old-established journal and wish it a new lease of life.

Forty Years of X-Ray Diffraction: Anniversary Meeting in London

The X-Ray Analysis Group of the Institute of Physics is holding a meeting at the Royal Institution, Albemarle Street, London, W.1, during October 24–25, in celebration of the fortieth anniversary of the discovery of X-ray diffraction by Friedrich, Knipping and von Laue (see *Nature*, June 7, p. 949). After an opening historical address by Sir Lawrence Bragg, four papers will be read: "The Growth and Scope of X-Ray Crystal Analysis", by Prof. J. D. Bernal; "Chemical Problems", by Dr. D. Hodgkin; "X-Ray Analysis and the Metallic State", by Prof. G. V. Raynor; and "The Application of X-Ray Analysis to Protein Structure", by Sir Lawrence Bragg. A commemorative dinner will be held on October 24, in the Criterion Restaurant, Piccadilly Circus, at which the guests of honour will be Prof. M. von Laue and Prof. J. M. Bijvoet. During the two days of the meeting there will be an exhibition in the Royal Institution of historical X-ray apparatus, etc. The meeting is open to all. Application forms for attendance (to be returned by September 20) and further information can be obtained from the Deputy Secretary of the Institute of Physics, 47 Belgrave Square, London, S.W.1.

Royal Photographic Society: Annual Exhibition

The ninety-seventh annual exhibition of the Royal Photographic Society will be opened by the American Ambassador, Mr. W. S. Gifford, on September 11, in the Society's House, 16 Princes Gate, London, S.W.7. It will be open to the public without charge from September 12 until October 12, inclusive, from 10 a.m. to 8 p.m. each day (Saturdays, 10 a.m.–5.30 p.m.; Sundays, 2.30–5.30 p.m.). After the London display, the whole of the exhibition will be transferred to Leeds for the period October 25–November 23, and to Bristol for the period December 6–31.

Foot-and-mouth Disease Inquiry

The Minister of Agriculture and Fisheries has appointed a committee to review the policy and arrangements for dealing with foot-and-mouth disease in Great Britain, and to advise whether any changes should be made in the light of present scientific knowledge and the technical and administrative experience gained in recent years in this and other countries. The Committee is constituted as follows: Sir Ernest Gowers (chairman), Prof. E. D. Adrian, Colonel H. Cator, Dr. Ll. Wyn Griffith, Lord Hungarton, Prof. A. Robertson, A. R. Semple, and H. Woolley. R. A. Thorne, of the Ministry of Agriculture and Fisheries, has been appointed secretary to the Committee. Communications should be addressed to him at Hook Rise, Tolworth, Surbiton, Surrey.

Rajasthan Academy of Sciences: Officers

At the second annual meeting of the Rajasthan Academy of Sciences, Pilani, the following officers were elected: *President*, Dr. G. S. Mahajani, vice-chancellor, University of Rajputana; *Vice-Presidents*, Dr. N. N. Godbole, director of industries and commerce, Rajasthan Government, and Dr. A. Mookerji, professor of physics, Birla College of Sciences; *Secretary*, K. Ramamurti, Birla College of Science, Pilani. Mr. M. L. Schroff and Dr. M. L. Roonwal, as ex-presidents of the Academy, serve as vice-presidents, and Mr. Roshan Singh continues to be the treasurer.

Announcements

A discussion on "The Place of the Scientist in Civil Defence" has been arranged by the Royal Institute of Chemistry (London and South-Eastern Counties Section) with the Institute of Biology and the Institute of Physics (London and Home Counties Branch) and will be held on October 16 at 6.30 p.m. in the City of London School, Victoria Embankment, London, E.C.4. The principal speakers will be: Sir John Hodsall, Sir Charles Ellis, Dr. E. T. Paris, Prof. W. V. Mayneord and Prof. H. N. Rydon.

A seminar on polymer science is to be held in the Department of Chemistry, University College, London, W.C.1, during the autumn term. Eight lectures, by different speakers, will be given on Fridays at 4.30 p.m., beginning October 17. Visitors will be welcome.

A conference on the "Growth of Protozoa" will be held during October 24–25 at the New York Academy of Sciences under the joint sponsorship of the Academy and the Society of Protozoologists. The first day will be devoted to free-living forms, and the second to parasites. The programme is designed to be of broad biochemical, morphological and medical interest. The proceedings will be published in the *Annals* of the Academy. Further information can be obtained from the secretary of the Society, Prof. E. R. Becker, Department of Zoology and Entomology, Iowa State College, Ames, Iowa.

The Sixth Congress of the International Scientific Film Association will be held in the Maison de la Chimie, 28 rue St. Dominique, Paris 7^e, during September 23–October 1. During the Congress there will be meetings of the General Assembly of the International Scientific Film Association, meetings of the permanent committees dealing respectively with medical, research, technical and industrial films, and a festival of scientific films. At the Congress Great Britain will be represented by the British Scientific Film Association, and further information can be obtained from the administrative officer of the Association at 164 Shaftesbury Avenue, London, W.C.2.

The Council of the City and Guilds of London Institute has conferred the fellowship of the Institute on the following past students of the City and Guilds College: L. H. Bedford, chief television engineer, Marconi's Wireless Telegraph Co., Ltd.; H. F. Cronin, chief engineer, Metropolitan Water Board; W. A. Del Mar, chief engineer, Habirshaw Cable and Wire Division, Phelps Dodge Copper Products Corp., United States; H. J. B. Harding, director, John Mowlem and Co., Ltd., and also of Soil Mechanics, Ltd.; W. H. G. Roach, managing director, William Press and Son, Ltd., technical director, D. and C. and William Press, Ltd., director of the General Descaling Co., Ltd., and also of John Paul and Co., Ltd., Dublin.

ELECTRONIC INSTRUMENTS AND EQUIPMENT

EXHIBITION IN MANCHESTER

THE seventh annual exhibition of the North-Western Branch of the Institution of Electronics, which was held in the College of Technology, Manhester, during July 15-18, had a record number of xhibitors, more than forty concerns—universities and esearch associations as well as private firms—being epresented. There were, in addition to the trade xhibits, demonstrations of equipment in the research tage and a number of special displays dealing with igh-fidelity sound recording and with television. Films on electronic subjects, both elementary and dvanced, were shown, and the lecture programme—overing sixteen different topics in all—included talks n technical subjects associated with the special isplays as well as discussions of production methods nd problems by the staff of some of the exhibiting rms.

In his address at the opening ceremony, Mr. A. J. Philpot, director of research, British Scientific nstruments Research Association, remarked that the development of electronics has been much more losely tied to commercial application than that of most sciences, and the academic treatment has tended o follow rather than precede. This trend has cerainly been reflected in these exhibitions, The first five included a succession of striking new applications; but the tendency last year and again this year was owards consolidation—greater reliability, improved fficiency and all the other improvements which go with a better appreciation of the theoretical background. In fact, it would almost be true to say that not one exhibit represented a really new application. This fact probably accounts for the disappointment xpressed by some of the lay visitors; a certain familiarity with the field was necessary for the appreciation of some of the improvements offered. None the less there were improvements, some of them quite striking; but as the scale of the exhibition ncreases it becomes more and more difficult to present an adequate account, and it is more than ever necessary to point out that the items mentioned n this report are simply those which had the strongest personal appeal to the writer.

The Research Laboratory of Associated Electrical Industries, Ltd., demonstrated equipment for measuring infra-red radiation of very low intensity. Normally the minimum measurable intensity is determined by the level of the random noise arising from the lead sulphide detector-cell. In this equipment the incoming signal is chopped by a rotating sector disk and the signal amplified in a narrow-band amplifier. The narrow band is obtained by using the homodyne principle; that is, the incoming signal is mixed with a local signal of the same frequency to produce a beat frequency of zero (namely, a D.C. output). In this way the signal-to-noise ratio is very much increased. The same principle is also being used in the apparatus developed by the Physics Department of the University of Manchester for the detection of very weak light sources (for example, faint stars), which was also on show. In this case the detector is an electron-multiplier cell, cooled in liquid air to reduce the noise-level as much as possible. The best sensitivity so far claimed would allow the detection of 10^{-14} lumens (about 50 quanta of green light per second).

The Department of Electron Physics of the University of Birmingham included in its exhibit an apparatus for producing pulsed magnetic fields of high intensity. Fields of the order of half a million gauss in a volume of a few cubic millimetres can be produced by discharging the energy stored in a condenser through a specially constructed solenoid. In the demonstration a brass washer was hurled several feet into the air by the mutual action of the pulsed field and the field due to eddy currents in the washer. Another application of the sudden discharge of the energy of a charged condenser was included in the apparatus for *Schlieren* spark photography designed by the Fluid Motion Laboratory of the University of Manchester. The condenser is discharged through a simple triggered spark-gap in a circuit of very low inductance to produce a high-intensity flash of very short duration.

In the trade section, the products displayed had a standard of appearance and finish which was very high indeed, and the stands were attractively arranged.

Cinema-Television, Ltd., showed the projector unit and control console of a standard cinema equipment for obtaining a 16 ft. × 20 ft. television picture. The picture from an 8-in. cathode-ray tube is projected by means of a Schmidt optical system. The anode voltage for the tube is 50 kV. and the beam current may rise to 15 mA. A powerful air blast is necessary to prevent over-heating of the screen.

De Havilland Propellers, Ltd., displayed some of their equipment for vibration studies. This included moving-coil vibrators, pick-ups, strain gauges and all the ancillary control and recording gear. The vibrators are like giant moving-coil loudspeaker units with the coil suspended at both ends by a synthetic resin 'spider'. The largest shown was capable of exerting a force of ± 165 lb.-wt.

The familiar, octopus-like mercury-vapour rectifier with six projecting anode tubes can now be replaced by six neat single-anode tubes. These excitrons, displayed by the Rectifier Sub-Station Department of the English Electric Co., Ltd., are air-cooled glass tubes which are provided with control grids. These permit the variation of the output voltage or can be used for arc suppression in conjunction with protective circuits.

The outstanding item on the stand of Ferranti, Ltd., was the transient oscillograph tube. This magnetically focused tube has been specially developed for use in the surge testing of large power-transformers. The fluorescent spot has a high actinic value and, with an $f/1$ lens and normal photographic techniques, clear, full-size negatives of single traces at writing speeds of 30,000 km./sec. can be obtained.

Fielden (Electronics), Ltd., demonstrated a new, servo-operated, self-balancing temperature recorder. The instrument plots the temperature readings for four separate platinum-resistance thermometers in four different coloured inks on the same polar chart. The readings are made in turn at intervals of about five seconds, and a simple but ingenious mechanism rotates the four-point pen to the appropriate position before each reading is recorded.

At intervals throughout the exhibition, recitals were given on the Gregorian electronic organ, which is manufactured by Alfred E. Davies and Sons, Ltd., and the Acoustical Manufacturing Co., Ltd. This organ was designed to imitate as closely as possible the tone of a good pipe organ. The basic tone generators are valve oscillators. Special attention has been paid to the 'attack' problem, and variable delays can be introduced to simulate the speaking characteristics of various pipes. One of the most attractive features from the organist's point of view is that the tone colour of any particular stop is governed by a plug-in unit. This means that changes in specification or in the precise quality of any particular stop can be made quite simply even after installation is complete.

Among the measuring equipment displayed by Marconi Instruments, Ltd., the moisture meter was of particular interest. The basic circuit is an ingenious modification of the Wheatstone bridge, which makes the instrument independent of valve characteristics and voltage variations. It is designed to give reliable results without laboratory conditions and without demanding special skill on the part of the operator. Interchangeable scales and calibrations are available for a long and fascinating list of materials, ranging from alginic acid through groundnuts to vermicelli (plain and egg). Another interesting item was a universal bridge for measuring resistance, inductance and capacitance which is really direct reading; the figures on the dial change when the range is changed, and the precise units in which the quantity is being measured also appear on the dial.

Twentieth Century Electronics, Ltd., exhibited precision cathode-ray tubes in which the screen face was ground and polished inside and outside. Also on this stand were a bewildering variety of Geiger counter tubes. Interesting members of the series were a sterilizable tube for medical applications and a tube with a mica window so thin that, when delivered by air transport, it has to be sealed in a metal can to prevent explosion arising from the lowering of atmospheric pressure.

The exhibition was obviously the result of much hard work both by the organizing committee and by the exhibitors; but the very large number of visitors must have been a very satisfying reward for those concerned. C. A. TAYLOR

DAMPIER: PIRATE AND NATURALIST

By DR. L. HARRISON MATTHEWS

Director, Zoological Society of London

WILLIAM DAMPIER, the pirate whose tercentenary fell on June 8, is famed as a buccaneer, navigator, diarist and traveller; but his prowess as a naturalist is less well known. His careful descriptions of his travels around the world between 1673 and 1700, which enjoyed considerable popularity in their day and had run into a seventh edition by 1729, contain many accounts of the wild animals that he came across.

In the day-to-day accounts of his voyages there are frequent notes about the birds, fishes, insects and other animals that he saw, often with interesting opinions on their gastronomic value. But it is in his descriptions of the countries he visited and their inhabitants and products that he really excels and provides us with some excellent chapters on natural history.

He made many trips to the Bay of Campeachy, cutting logwood and buccaneering, that is, making boucan, a sort of biltong prepared by sun-drying the flesh of wild cattle, and his account of his journey in 1676 gives many pages to the fauna of the region. The first animal he mentions is the "squash", which appears to be the coati-mondi. It is bigger than a cat, and its head is much like a fox's with short ears and a long nose. "The flesh of it is good, sweet, wholesome Meat. We commonly skin and roast it; and then we call it Pig; and I think it eats as well." He gives a splendid account of the spider monkey, "the ugliest I ever saw. They are much bigger than a Hare and have great Tails about two and a half foot long". When he met a company of them in the woods they defied him by bombarding him with sticks and more offensive ammunition, "chattering and making a terrible Noise; and a great many grim Faces, and shewing Antick Gestures". He gives details of the prehensile tails of these monkeys, and tells how one old male came on to a small branch just over his head and "leaping directly at me made me start back; but the Monkey caught hold of the Bough with the tip of his Tail; and there continued swinging to and fro, and making Mouths at me".

The great ant-eater has a tongue "like an Earthworm about five or six inches long" with which it licks up ants, and then "puts it out again to trapan more. They smell very strong of Ants, and taste much stronger; for I have eaten of them". The sloth, "a sad coloured Animal", feeds on the leaves of trees, and takes eight or nine minutes to move one of its limbs three inches; "neither will stripes make them mend their pace . . . they seem insensible, and can neither be frightened, or provoked to move faster".

So his descriptions go on, through the mammals, birds, reptiles and fishes, with some interesting bit of acute observation about each, from the large snakes that are "a lazy sort of Creatures" that "lirk in Trees" to the alligator that bit the knee of Daniel the Irishman and left the marks of its teeth in the butt of his gun; poor Daniel "went limping ever after".

Even in those far-off days of the late seventeenth century, Dampier protested against the reckless slaughter of animals for commercial purposes. He was particularly concerned for the introduced cattle that had run wild in the West Indies, and were so important to the buccaneers. "The Spaniards pick and chuse only the Bulls and Old Cows, and leave the young Cattle to breed; by which means they always preserve their stock entire". But the English and French "kill without distinction; yea, the young rather than the old; without regard to keeping up their stock". The seals of the West Indies were similarly exterminated; there may be a few West Indian seals alive to-day, but they are among the rarest of mammals. Dampier relates how a sealing crew was wrecked on the Alcrane Islands "distant from the coast of Jucatan about 25 Leagues; the biggest is not above a Mile or two in Circuit". By great good fortune the sealers were able to fill their casks with seal oil, and refloat their ship at the expense of two New England ketches that ran on the reef, misled by the lights of their fires.

The smaller and more inconspicuous animals did not escape Dampier's notice, for he tells of the two sorts of land crab, the white and the black, "black Crabs are commonly fat and full of Eggs; they are also accounted the better Meat, though both sorts are very good". He also knew *Limulus*, the primitive horse-shoe crab. Near Campeachy "in the Surf of the Sea, close by the shore, you find abundance of Shell-fish, called by the English, Horse Hoofs, because the under part or Belly of the Fish is flat, and somewhat resembling that Figure in shape and Magnitude; but the Back is round like a Turtles; the Shell is thin and brittle, like a Lobsters; with many small Claws: and by report they are very good Meat; but I have never tasted of them myself. . . . Here are also a sort of Spiders of a prodigious size . . . they have two Teeth, or rather Horns an Inch and a half, or two Inches long . . . black as Jet, smooth as Glass, and their small end sharp as a Thorn. These Teeth we often preserve. Some wear them in their Tobacco pouches to prick their Pipes. Others preserve them for Tooth-Pickers".

In the account of his voyage to Australia or "New Holland" in the *Roebuck* in 1699, Dampier gives even fuller details of the natural history, the birds, beasts, and especially the fishes, and also of the plants that he found. He illustrates many of these in copper plates that, considering the times, are remarkably good. Many of the species are quite easily identified from his sketches, and it could well be claimed that he was one of the first traveller-naturalists.

As is only natural, Dampier gives the colours of the birds and other creatures that he saw, and his descriptions are correct; yet one may doubt whether his colour perception was complete. When he was at Tonquin he saw the galleys of the king's navy which were commanded by a general who "was a great Mandarin. . . . There were two more great Officers under him, each in a Vessel by himself. These three had Flags of distinction: the first was yellow, the second blue, the third red or green". Can it be that Dampier was colour-blind, and could not distinguish red from green?

BRITISH MYCOLOGICAL SOCIETY

PLANT PATHOLOGY FIELD DAY

THE twenty-sixth annual plant pathology field day of the British Mycological Society was held on July 4 in the Mycology Section of the Hawthorndale Laboratories, Bracknell, Berkshire, of Imperial Chemical Industries, Ltd. Sixty-six members attended.

Mr. R. V. Tipler, senior mycologist, reviewing the functions of the laboratories, stated that the main task was the evaluation of chemicals produced in the research departments of I.C.I. manufacturing divisions for possible use in controlling crop diseases, pests and wastage caused by bacteria, fungi, insects and eelworms in agriculture, horticulture and industry. The Mycology Section was concerned with prevention or control of plant diseases and crop wastage and with industrial microbiological problems. The demonstrations were arranged to illustrate the scope of the Section's activities in the field of bioassay. They showed the sequence of testing from first-stage sorting by *in vitro* methods for general antifungal and antibacterial activity to second-stage sorting by *in vivo* methods in laboratory, glasshouse and field to discover applications for promising chemicals in industry and as seed, soil and foliage fungicides. Consolidation work, not capable of being shown at the Laboratories, followed under practical conditions at home and overseas with selected materials, under control of the research staff.

Miss M. E. Kennedy demonstrated methods of maintaining the culture collection. In order to reduce subculturing and minimize possible variations in reactions of test fungi to chemicals or pathogenicity to plants the mineral oil and freeze-drying methods of preservation were used. The former was more suitable for mycelial and non-sporing forms and consisted of culture on agar slopes covered to a depth of 1 cm. above the medium with a sterilized mineral oil. In the latter, suspensions of fungal spores or bacteria, with a protective colloid, were dried *in vacuo* from the frozen state. Standard reference cultures had been preserved unchanged in the characteristics under study for more than four years. The Hawthorndale method of inducing profuse sporulation of *Alternaria solani* was demonstrated. Controlled ultra-violet irradiation of mycelial cultures on agar reliably produced spores within eighteen hours. The method had been in regular use for three and a half years.

Mr. J. L. Charlton showed agar plate and spore germination techniques for *in vitro* screening of chemicals. The first method, based on serial dilution of chemicals in an agar medium which was then inoculated with a range of fungi or bacteria, rapidly placed new chemicals in activity categories. Active chemicals were investigated more precisely by the second method, using spores of *Alternaria solani*, *Venturia inaequalis* or *Botrytis allii*. This method was particularly suitable for investigating groups of related chemicals and effect of formulation on antifungal activity. An auxanographic method of demonstrating interactions between effects of chemicals on fungi was on view. Morphological effects of chemicals on germinating spores of *Botrytis allii* were also shown.

Mr. J. N. Turner had on view the miniature kiln test permitting quantitative comparison of chemicals for control of timber sap-stain and moulding, as used for second-stage evaluation of potential industrial fungicides. Notable features were the use of paired surfaces for treatment versus control comparisons and the high degree of replication achieved within a small space. Tests were seen in progress comparing the British Standards and the Pechmann Schaile methods for laboratory evaluation of timber preservatives. Mycelial mat and soil burial methods for assessing textile preservatives were shown, together with investigations on the effect of leaching and weathering on degree and duration of proofing. Species of fungi responsible for moulding and staining of baled rubber were exhibited.

Miss S. E. Parkinson illustrated with specimens and cultures of the microflora isolated from them the extent and types of damage to leathercloths caused by micro-organisms.

Types of slimes encountered in paper mills were shown, with cultures of bacteria and fungi responsible for their production. Efficiency of control by organo-mercurial compounds depended, *inter alia*, upon the stock, as its composition affected both the type of slime and the absorption and inactivation of mercury by the pulp. Techniques demonstrating bioassay of active mercury in pulp and white-water included two plate methods using *Cladosporium herbarum* and a turbidimetric method using *Lactobacillus helveticus*.

A sensitivity allowing 0·05 μgm. per gm. of active mercury to be detected was achieved.

Methods of determining the resistance of slime organisms to chemicals were also shown.

Mr. I. W. McC. Callan dealt with tests for evaluating chemicals for use as seed fungicides. Laboratory phytotoxicity tests on wheat supplemented glasshouse disease control trials using oats leaf spot (*Pyrenophora avenae*) and pea foot rot (*Pythium ultimum*) for determination of disinfectant and protectant properties respectively. Examples of these standardized replicated experiments were seen. In the experiment garden were demonstrations of the application of seed treatments for controlling seed- and soil-borne diseases, particularly seedling rots, of peas, maize, flax, sugar beet, spinach and cucurbits. The extensive 'rod-row' trials which were seen illustrated a replicated block technique based on single rows used for field assay of chemicals for controlling cereal diseases such as wheat bunt and oats and barley smuts.

Machinery for commercial application of dry and wet seed dressings was demonstrated, and in the laboratory an exhibit of a modification of Machacek's agar-sheet technique showed strikingly the extent of variation of load of toxicant on individual seeds obtainable by varying the seed-dressing formulation and the type of machinery used.

Threshing and winnowing equipment developed for accurate estimation of yields from metre-square cereal sampling plots was also shown.

Dr. J. Stubbs had exhibits of a range of plant diseases which were kept in culture and used for glasshouse evaluation of foliage fungicides. These included *Alternaria solani* and *Phytophthora infestans* on tomato, *Uromyces fabae*, *Botrytis cinerea* and *B. fabae* on broad bean, *Puccinia antirrhini* on antirrhinum, *Erysiphe graminis* on oat, *E. cichoracearum* on marrow, and *Septoria apii* on celery. The methods of using *A. solani* on tomato for detection and measurement of systemic activity were shown, using griseofulvin as example of an active systemic fungicide. They involved absorption by the plant of chemicals applied to roots or leaves. A 0·05 per cent solution of griseofulvin applied to the soil in which small tomato plants were growing afforded complete protection against disease, whereas the same concentration applied to foliage gave only partial disease control on leaves which had been shielded from the spray.

Mr. J. A. W. Turner dealt in detail with the equipment and methods used in the routine *A. solani* test as developed for the first *in vivo* assessment of potential foliage fungicides and for comparison of effects of formulation (for example, of copper and thiram fungicides) on disease control.

Three tomato plants were sprayed with each of a range of concentrations of a chemical under conditions giving standard deposits. After twenty-four hours drying, plants were inoculated by spraying with *A. solani* spore suspension, incubated at 100 per cent relative humidity for a further twenty-four hours and transferred to the glasshouse. Disease counts were made after three days. ED 50 and ED 95 values were obtained graphically from data from three such tests made at approximately weekly intervals. Thiram was used as standard reference fungicide.

Chemicals active against *A. solani* were then examined further, as required, on the range of diseases demonstrated by Dr. Stubbs, before field evaluation commenced.

Mr. C. E. D. Smith described investigations on the control of *Fusarium* patch of turf, storage diseases of gladiolus corms and narcissus basal rot (*Fusarium bulbigenum*).

Techniques for the bioassay of soil fungicides were shown, based on selective isolation of *Pythium ultimum* and *Thielaviopsis basicola* from soils containing the viable pathogens. These were coupled with further experiments to determine persistence of the chemicals in soil and their phytotoxicity. Successful chemicals were tested against clubroot (*Plasmodiophora brassicae*) by a rapid laboratory method, and against *Colletotrichum atramentarium* attacking tomatoes. Demonstrations of this last disease included a character for its early diagnosis and a selective method for isolation of the pathogen.

A tour of the eight-acre experiment garden and trials field enabled further aspects of work described in the laboratories to be seen. These included gladiolus corm and narcissus bulb experiments, potato and tomato blight spraying plots and an orchard for investigation of apple, pear and bush fruit diseases.

R. V. TIPLER

MELLON INSTITUTE

ANNUAL REPORT FOR 1951–52

THE annual report of the President of the Mellon Institute to the Board of Trustees for the year ended February 29, 1952[*], which is published in the *Research Proceedings of the Mellon Institute*, includes a full list of fellowships in operation during March 1,1951–March 1, 1952. Of the Institute's expenditure of 3,835,314 dollars during the year, 727,654 dollars went to the support of investigations in pure science in the Institute's research departments and on nine fellowships, and these projects occupied 117 members of the Institute's staff. In applied science, seventy-seven other fellowships occupied 441 members, and the servicing staff of the Institute numbered 162. New fellowships put into operation during the year are concerned, respectively, with problems of air purification; the development of new chemicals and speciality products, other than fuels and lubricants, used in the operation and maintenance of automobile and aeronautical vehicles and equipment; the technology of glazed and unglazed structural clay products; the combustion of gaseous fuels; the fundamental molecular properties which limit the breaking strength of glass; and the thermostability of active dry yeast.

The Gas Purification Fellowship, which originated in 1939 and was terminated during the year, has led to the development of various new analytical methods, for example, for the rapid determination of hydrogen sulphide and mercaptan sulphur in gases and aqueous solutions, and to a process for reducing the organic sulphur content of coke-oven gas to about 0·5 gm./cu. ft. by scrubbing with an organic base. The Pipe Joint Fellowship, which also has been concluded, has led to the formulation of a product providing adequate thread lubrication during joint make-up and capable of forming a pressure-tight seal in the coupled joints. Other fellowships terminated during the year were the multiple fellowships dealing ith the following topics : polymers, in which during ie tenure of the fellowship processes have been eveloped for lattices of styrene polymers and)-polymers ; the kinetics and mechanism of the ncatalysed condensation of resorcinol with form-dehyde in various solvents ; the efficiencies of light l recovery and of the operation of Koppers's 'Elex' recipitators for removing suspended matter from)ke-oven gas ; and tar products, under which rtensive studies of the rheological properties of itummous compounds led to the development of nproved industrial pitches, sealing compositions, iastics and protective coatings, and fundamental hysico-chemical and rheological studies were made f the nature of coal-tar residual systems.

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[*] Research Proceedings of the Mellon Institute, 1951–1952 (Annual Report Series No. 39). Annual Report of the President, Edward R. Weidlein, to the Board of Trustees of the Institution for the Fiscal Year ended February 29, 1952. Pp. vi+50. (Pittsburgh, Pa.: Mellon Institute, 1952.)

In the Institute's Department of Research in hemical Physics a detailed study has been made of ie infra-red spectrum of dicyanoacetylene, and its aman spectrum was being studied. Experimental rocedures have been developed for the infra-red udy of inorganic salts, and the spectra of a hundred id sixty salts recorded. Emulsion calibration pro-dures in emission spectroscopy have also been ivestigated, as well as the fine structures of four inforcing carbon blacks, with the view of detecting orrelations between structure and wear resistance id the crystal structure of solid chlorine. In the epartment of Physical Chemistry, four papers on istillation theory have been prepared, and work in us field includes the continued study of the relation etween the concepts of the theoretical-plate and ansfer units and an indefinite number of com-onents. Much time has been spent on the design of small automatic digital computing machine. The epartment of Physical Measurements is continuously ccupied with the determination for publication of ie physical properties of compounds the properties which are inadequately known and of new ompounds.

In the Department of Organic Chemistry, the first art of a study in mental disease, involving the con-ntration of a hyperglycæmic factor from the urine psychotic individuals, has been completed, con-rming the presence of such a factor in the urine of ome schizophrenics. In regard to the utilization of rbohydrates in mental diseases and in diabetes, it is been found that reduction of alloxan with excess ydrogen sulphide in acid solution invariably gives se to dialuric acid and not to alloxantin, but that ie latter is produced if exactly half the theoretical nount of the reducing agent is used. Also, in suit-oly acid aqueous solution (*p*H 1·6), cysteine, utathione and ascorbic acid have no reducing action i alloxan. A series of 4-hydroxy- and 4-amino-eridines have been submitted for testing as imour-inhibiting agents at the National Cancer istitute's Laboratory of Chemical Pharmacology.

Of the fellowships in pure science, the annual port refers particularly to those of the Industrial ygiene Foundation on atmospheric pollution, in hich an automatic smoke filter has been developed ; i industrial dusts, in which the deposition of inhaled articulate matter in the respiratory tract has been udied ; on orthopædic appliances, under which a ew method of constructing 'Bunnell' hand splints r stretching contracted fingers has been worked out, ot-plates intensively studied and the relative merits aluminium and steel for leg traces determined ; id on mine-acid control, which point to control of ie course of natural ground-water entering the mine i the most effective means. Under the multiple fellowship on synthetic rubber, work has been completed on the infra-red study of polyisoprene, which has been found to be a mixture of *cis*- and *trans*-forms in which the latter predominates at all ordinary temperatures of preparation. Fractionation work in dilute solutions has been completed on a synthetic polyisoprene and on polybutadienes prepared at 5 and 50° C., while the response of solid polymers to oscillating stresses and the ultimate strength of cross-linked rubbers are also being investigated. Under the Fellowship on Artists' Materials an attempt was being made to develop a picture varnish, using a synthetic resin, which will be non-yellowing, flexible and readily removable with mild solvents.

Among the applied science fellowships only a few can be mentioned. Promising results have been obtained under the Meter Technology Fellowship with a non-mechanical device for measuring gas-flow, and in work on sulphur, besides the publishing of revised data on the corrosion of steel by sulphur, a comprehensive study has been made of the metering of liquid brimstone. Developments have been made under the Marble Fellowship of a specification for the use of marbles in indoor and outdoor building construction, and, besides wide research on the effects of heat treatment on the physical properties of optical glass, the Optical Glass Fellowship has been expanded to include in its work the experimental heat treatment of larger pieces of finite geometric shape. Considerable progress is reported under the Ceramic Chemicals Fellowship in knowledge of the relative functions of the various components of enamels and in the control of reflectance, colour, colour stability over large ranges of firing temperature, and resistance to acids and alkalis.

Under the Multiple Fellowship on Acid Recovery a promising process has been developed for treating pickle liquor with raw coke-oven gas, while under that on Chemical Storage an improved method was devised for measuring stresses in large steel structures, which has given information on the stress intensities of various tank members, leading to better designs and economies in the use of scarce materials. Most of the work under the Nickel Fellowship has been directed towards studies of the detergent and other properties of oil-soluble nickel compounds with the object of establishing their suitability as lubricant additives, the wetting properties of nickel sulphide on various catalyst supports, and the effect of conditions of precipitation on the characteristics of nickel hydroxide. A Fellowship on Aromatic Anhydrides has continued to be used for the study of catalysts for the manufacture of phthalic anhydride, and under that on monomers an extensive study was made of catalytic dehydrogenation of alkylbenzenes. Geochemical studies under the Petroleum Fellowship have advanced the synthesis of porphyrin degradation products of chlorophyll and hæmin, while further success has been obtained in the sulphurization of olefins, and studies on Fischer–Tropsch catalysts have shown that primary alcohols can be built into higher hydrocarbons in this synthesis. Basic information on the chemical and physical properties of petrolatum is being accumulated by the Fellowship on Petrolatum, and further studies under the Bread Fellowship support the view that the flavour and aroma of salt-rising bread are due primarily to the acid by-products of a symbiotic fermentation of *Clostridium welchii* and *Clostridium tertium*.

In the research of the Insecticides Fellowship, new methods have been developed for the condensation of aldehydes with ketones to give the piperonyl insecticides, and under the Felt Fellowship notable progress has been made in the evaluation of cloth filters and the mechanical napping of fabrics. Under the Fellowship on Match Technology researches have begun on improving the resistance of matches to water and high humidity, the selection of binders, etc. During the tenure of the Fellowship on Organic Synthesis new reactions of diketen with the sodium derivatives of pentadione and acetoacetic esters have been discovered, a study of the effects of chemicals on cellulosic and synthetic fibres has been inaugurated and a series of non-ionic surface agents elaborated, the functionality of which in aqueous solution is not greatly affected by temperature, concentration or the presence of polyvalent metal ions and neutral electrolytes; also real progress has been made in 'Vinylite' resin organosol decorative metal finishes. The development of the 'Stypol' resins, a series of liquid thermosetting materials, has continued under the Protected Metals Fellowship, while work of that on Protective Coatings has placed its main emphasis on the development of coatings for military use and the replacement of scarce materials. Two new types of floor coverings, 'Accotred' and 'Vinoflor', were developed under the Cork Fellowship, and research on synthetic paint-brush bristle was a feature of the work of the Special Fibres Fellowship.

PREPARATION AND PUBLICATION OF SCIENTIFIC PAPERS

It is sometimes customary for scientific societies to give advice and guidance to intending authors as to the preparation of their articles in a form suitable for inclusion in the societies' journals. Usually the advice is limited to some warning about the best method of writing mathematical expressions or to the peculiar layout or spelling adopted by the journal.

A much more comprehensive and instructive manual for intending authors is the revised edition of the booklet "Notes on the Preparation of Contributions to the Institute's Journals and Other Publications" recently issued by the Institute of Physics. The "Notes" were first published in 1931 and were last revised in 1950. No fundamental changes have been made in the new edition; but the opportunity has been taken to make minor corrections and some alterations in acceptable spellings and abbreviations in conformity with recent international and other agreements. Information is given concerning the Institute's publications, the types of contributions acceptable and the conditions of acceptance. Though it is obviously advisable in order to avoid delay in appearance for contributions to conform rigidly with the usages set out in the "Notes", this is not a condition of acceptance.

The "Notes" deal in detail with the preparation, length and cost of text, the form of script and diagrams, the presentation of tabular matter and mathematical expressions and the correction of proofs. Four pages of the booklet are devoted to the proper presentation of circuit, mainly electronic, elements; this seems excessive when it is considered that the Institute's journals do not cater for purely electronic subjects. An interesting reference is to the present average total cost, £10, of each page of text; of a line figure £2 or half-tone £2 10s.; of a typical minor change to a line of type once it is set 5s., or o removing a comma 1s. 6d. This should act as sufficien warning to authors to be extremely careful, to be concise, to avoid unnecessary diagrams and figure and, above all, to revise their manuscripts befor submission for publication.

A short bibliography of dictionaries and books or writing scientific and non-technical literature i included in the "Notes", and the detailed appendixe containing notes and examples of spellings, symbol and abbreviations, the Greek alphabet in Gree and with English equivalents, and printers' mark for correcting proofs, should prove most useful an save authors much valuable time. It is a pity tha in what is otherwise an excellent manual there ar still a few misprints and that the graphical diagra given on p. 13 to indicate the usual faults made b authors is by no means a clear and good example

S. WEINTROUB

DETERMINATION OF PROTEIN CRYSTAL DENSITIES

By DR. BARBARA W. LOW
AND
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The accurate measurement of protein crystal densities under a variety of conditions is important for the determination of protein molecula weights by the X-ray diffraction method, and for th study of the composition of these crystals. In orde to make best use of the results, it is essential that al the measurements be made on crystals of precisel the same composition. Protein crystals equilibrate rapidly by the loss or gain of water, or by the pene

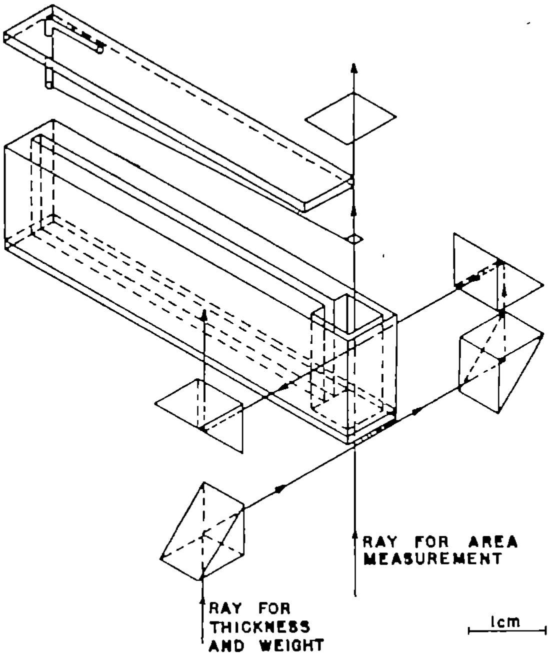

Fig. 1. Schematic diagram of microbalance assembly

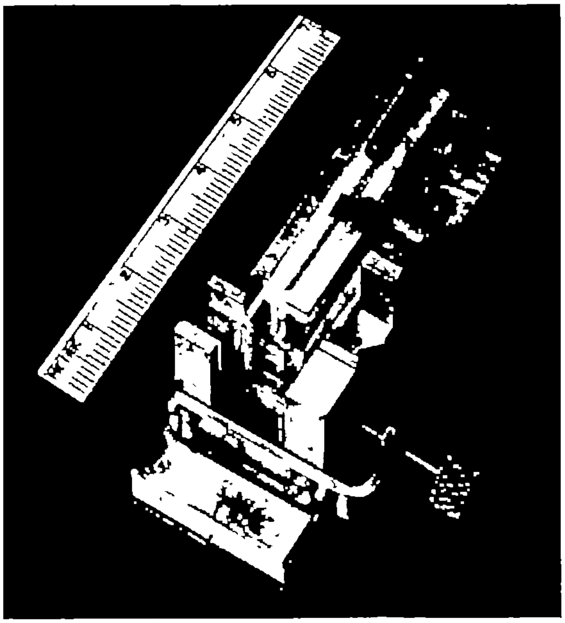

Fig. 2. Perspective view of microbalance

ration of crystal lattices by solute molecules when they are immersed in a media of different composition from that of the mother liquor from which they are grown.

The flotation method developed by McMeekin and Varner[1] for the determination of protein crystal densities and the Linderstrøm-Lang gradient column technique[2] are both capable of accuracies of the order of ± 0·5 per cent when used with large protein crystals (5–25 mgm.) of simple form, the faces of which may be easily wiped free of mother liquor. Both methods are non-equilibrium procedures—an important limitation when crystals are to be measured which contain both alcohol and water as solvents of crystallization. The alcohol dissolves rapidly in the column, or in the flotation liquid. Suitable immersion liquids in which both alcohol and water are insoluble have not been found.

Following an early suggestion of Prof. J. D. Bernal[3], a microbalance was designed and constructed in order to measure the density of a single protein crystal in equilibrium with its mother liquor. The apparent weight of a crystal, supported on a balance pan while immersed in mother liquor, is recorded as the deflexion of a calibrated fibre. The balance is arranged so that the crystal may be observed in two perpendicular directions and photographs taken of the projected areas. From these areas the volume of a well-formed regular crystal may readily be computed.

The density of the crystal may be calculated from the equation:

$$d(\text{crystal}) = d(\text{solvent}) + \frac{\text{apparent weight of crystal in gm.}}{\text{volume of the crystal in c.c.}}$$

The density of the solvent may be measured by any of the standard methods for liquid densities. The density of protein crystals is usually only 10 or 15 per cent greater than the density of their mother liquor. The correction term in the equation above, therefore, is only approximately 10–15 per cent of the total density. For crystals of simple habit weighing between 1 mgm. and 0·1 mgm. in air, the correction term may be measured with a maximum error of about 7 per cent.

The drawing, Fig. 1, is a schematic diagram of the microbalance assembly. The balance consists of a 'Pyrex' glass fibre firmly fixed at one end and bent into a 1–2 mm. horizontal square at the other end. A polystyrene film covering the square acts as a balance pan. The fibre and glass balance case are supported on a suitable brass frame (Fig. 2), the outside horizontal dimensions of which correspond to an ordinary microscope slide. A set of four ¼-in. right-angle prisms are fastened to rotatable mountings permitting accurate alignment for lateral views of a crystal imperfectly aligned on the balance pan. The whole balance assembly is placed on the mechanical stage of a microscope fitted with a 32-mm. metallographic objective, 10 × eyepiece and photomicrographic camera. A net reticule in the eyepiece provides calibration lines on each photograph. The view shown is of a microbalance constructed during the development of the present design. The details of the design, construction and calibration of the microbalance now in use will be described by one of us (F. M. R.) elsewhere.

Fig. 3 shows the photomicrographs from a typical density determination on a crystal of β-lactoglobulin, a preparation used for comparison of this method with other available techniques. The value 1·144 ± 0·066 was obtained with the microbalance, and 1·147 ± 0·003 using the gradient tube method[2] on the same preparation. Measurements indicate that small but real density differences may exist between crystals from different preparations. This could explain the discrepancy between our values and the latest value of McMeekin, Groves and Hipp[4] for β-lactoglobulin ($\rho = 1{\cdot}153 \pm 0{\cdot}002$).

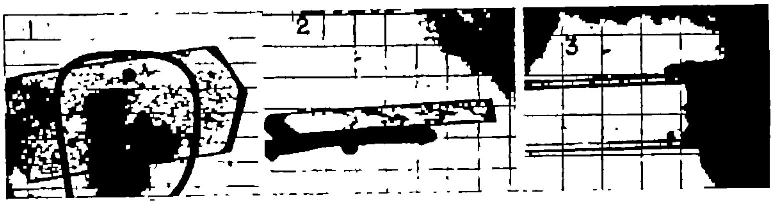

Fig. 3. Photomicrographs for density determination of a crystal of β-lactoglobulin: (1) main face; (2) end-on view, (3) deflexion of balance fibre

The microbalance is at present being used in the study of the density of crystals of β-lactoglobulin and of mercaptalbumin mercury dimer[5] in a variety of suspension media. A minor adaptation of the balance, not shown in Fig. 3, permits the immersing fluid to be changed while a given crystal is kept on the balance pan. Simultaneous volume and density changes may thus be observed. Density, composition and X-ray measurements during controlled swelling and shrinking in a variety of media are being made on these crystals as part of a study of protein crystal permeability.

[March 5.

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[2] Low, B. W., and Richards, F. M., *J. Amer. Chem. Soc.*, 74, 1660 (1952).

[3] Bernal, J. D. (personal communication, 1947).

[4] McMeekin, T. L., Groves, M. L., and Hipp, N. J., *J. Amer. Chem. Soc.*, 72, 3662 (1950).

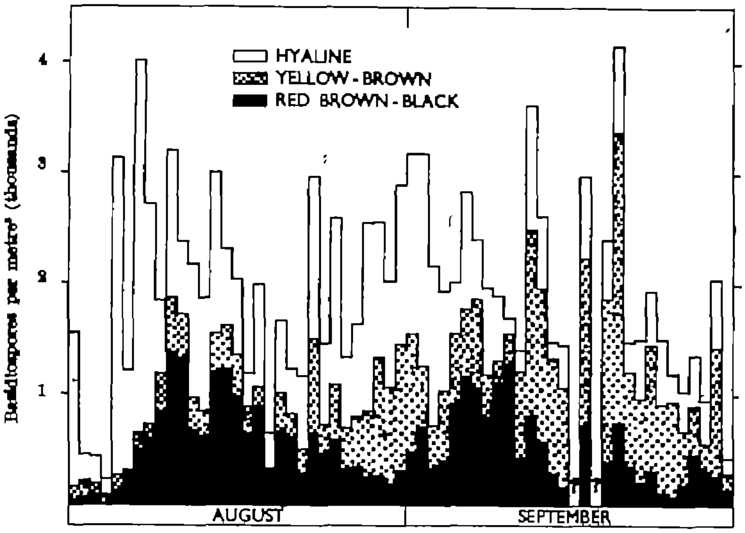
[5] Hughes, jun., W. L., *J. Amer. Chem. Soc.*, 69, 1836 (1947).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Possible Role of Basidiospores as Air-borne Allergens

THE role of air-borne mould spores in asthma, especially *Alternaria* and *Cladosporium*, has been recognized as the result of the work of Feinberg[1] and Durham[2]. These workers used mainly the gravity slide and Petri dish exposure method to determine the spore content of the air. Both methods are highly selective for different reasons: the former catches larger pollen grains and spores and rarely catches small spores, while the latter only records organisms able to grow on the culture media exposed and therefore selects the more readily growing moulds. Feinberg[1] has stated that basidiospores cause respiratory tract allergy, but data on their occurrence in the atmosphere have been lacking, no doubt because they are not detected by the usual methods.



Daily mean number of basidiospores per cubic metre of air at 2 metres above ground at Rothamsted, August 1 to September 30, 1951 (data obtained with automatic volumetric spore trap)

In studies concerned primarily with fungi pathogenic on crop plants we sampled the air at the height of 2 m. above a potato plot continuously from June 1 to September 30, 1951, using an automatic volumetric spore trap described by Hirst[3]. In this apparatus, which is based on the cascade impactor of May[4], air is drawn through the trap at the rate of 10 litres per minute and the spores are impacted on a 'Vaseline'-coated slide which is moved past a 2-mm. wide slit at 2 mm. per hour. The resulting 24-hr. trace can be scanned under the microscope and the time of deposition of a spore determined with an error of about ± 1 hr. This type of trap is relatively non-selective for particles in the size-range of plant spores, and has been shown to collect and extract from the air not less than 60 per cent of spores as small as those of *Ustilago avenae* (diam. approx. 6·5 μ). It is therefore reasonably efficient for the size-range of basidiospores, and gives a direct measure of spore concentration per unit volume of air.

The number of hyaline basidiospores fluctuates rapidly. Transient clouds of hyaline basidiospores were observed at various times. For example, on July 22, 1951, after eight rainless days with a high concentration of *Cladosporium* and *Ustilago*, a thunder shower with 2 mm. of rain falling between 13.00 and 15.00 hr. washed the air almost free of pollen and spores. Four or five hours after the rain had fallen a high concentration of minute hyaline basidiospores was observed, reaching a maximum of about 30,000 per metre^3 at about 02.00 hr. on July 23, and disappearing almost entirely as the *Cladosporium* cloud became re-established between 05.00 and 08.00 hr. It is possible that these hyaline spores, which are conveniently counted under phase contrast, were liberated by leathery resupinate Agaricales and by Tremellales after wetting by the rain.

The numbers of coloured basidiospores, mainly from Agaricaceae, were remarkably uniform, and were easily counted on the trace with a high-power dry objective. Their concentration in late summer greatly exceeded pollen concentrations recorded by us in June. From August 9 to September 23 the daily mean concentration of coloured basidiospores seldom fell below 1,000 per metre^3 of air (see accompanying illustration). Identification on the trace has not been carried far at present, but spores of species of *Panaeolus*, *Hypholoma*, *Bolbitius*, *Ganoderma*, etc., have been observed.

On dry days the basidiospore concentration showed a peculiar diurnal fluctuation, being lowest in the afternoon and increasing by 3–5 times in the early hours of the morning. This contrasts strongly with other spore types studied which have minimum concentrations at night. The fruit bodies liberate spores at a relatively uniform rate and the higher concentration at night may be due to less rapid dilution of the spore cloud owing to wind velocity and turbulence being lower than during the day.

The exposure of the trap in an arable field adjacent to grassland with trees must be representative of vast rural areas in the temperate regions. The steady high concentrations of basidiospores associated with the seasonal flush of agarics and polypores obviously need investigating in connexion with seasonal asthma.

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'Daraprim' Resistance in Experimental Malarial Infections

'DARAPRIM' [2 : 4-diamino-5-(4′-chlorophenyl)-6-ethyl pyrimidine (50-63)] has been described[1] as having high antimalarial activity in laboratory infections of *Plasmodium gallinaceum*, *Plasmodium berghei* and *Plasmodium cynomolgi*. More recently, it has also been tried in the treatment and suppression of human malaria[2]. It has been shown that proguanil-resistant strains of the first two species are sensitive to 'Daraprim' and that 'Daraprim' resistance is not easily produced in *P. gallinaceum* infections[3].

Since the publication of these experiments, further work has resulted in the production of two strains highly resistant to 'Daraprim' : the first, a strain of *P. gallinaceum* in young chicks, and the second, a strain of *P. berghei* in white mice. The *P. gallinaceum* resistant-strain has been previously reported[3] as having only a very slight degree of resistance after fourteen successive passages treated with approximately the minimum effective dose of the drug. Further similar treatment with increasing doses when the previous dose-level proved ineffective has resulted, after forty-two treated passages within a total period of seventy weeks, in a considerable degree of resistance to the drug. The method of infecting and dosing the chicks is similar to that previously described[1].

Using a somewhat different method, a highly resistant strain of *P. berghei* was produced in a much shorter time. The technique, in brief, was to administer to an infected mouse a single dose of the drug when examination of a stained blood film showed 40–50 per cent of the red blood cells to be parasitized ; on subsequent relapse after recession of the parasitæmia, the mouse was dosed for a second time and on relapse the strain was passaged. After two further successive mice had received a single dose each in this way, the strain was tested along with the normal untreated parent strain and proved to be more than twenty times less sensitive to the action of 'Daraprim'. Treatment with one more single dose and three drug courses carried out as described by Goodwin[4] has resulted in a very high degree of drug resistance.

The results of some assays of 'Daraprim' on the parent and treated strains of *P. gallinaceum* and *P. berghei* are shown in the accompanying table.

'DARAPRIM' ASSAYS ON NORMAL AND TREATED STRAINS OF *P. gallinaceum* AND *P. berghei*

Exp.	Species	Strain	Minimum effective dose* of 'Daraprim' (mgm./kgm.)	Degree of resistance*
1†	*P. gallinaceum*	Parent Untreated Treated	0·03 3·8	127
2	*P. berghei*	Parent Untreated Treated	0·04 >0·8	>20
3		Parent Untreated Treated	0·04 13	325

* As previously defined (ref. 3).

† Exp. 1. After forty-two treated passages. Exp. 2. After four single doses. Exp. 3. After a total of five single doses and three drug courses.

Thus it is seen that 'Daraprim' resistance may arise quite quickly, particularly if the drug is called upon to act on a large population of parasites, as in the development of the resistant strain of *P. berghei*. Where, however, the drug is made to act more as a suppressant, as in the technique used for the development of the resistant strain of *P. gallinaceum*, the initial development of resistance is slow and prolonged.

In human malaria the main use of 'Daraprim' will probably be as a suppressant. As in the case of proguanil, where resistance can easily be induced in the laboratory, the problem of 'Daraprim' resistance in the field is unlikely to become a serious disadvantage to its use.

Full details of these and further observations will be published elsewhere.

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Detection of Digitalis Glycosides on Paper Chromatograms

Neher and Wettstein[1] have used a solution of antimony trichloride in organic solvent to identify certain steroids on paper chromatograms. Although Jaminet[2] has used an acetic anhydride solution of antimony trichloride for the spectrophotometric identification of cardiac glycosides, he has not reported its use with paper chromatograms. Work in this laboratory has shown that antimony trichloride may be successfully applied to this field.

Reagents at present in use for the detection of cardiac glycosides on paper suffer from several disadvantages : the colour produced by *m*-dinitrobenzene is transient and does not distinguish individual glycosides, hydrochloric acid vapour destroys the paper, while with trichloracetic acid the intense fluorescence produced by traces of gitoxigenin completely masks that of other less reactive glycosides. The antimony trichloride in chloroform (Carr–Price reagent) reported here reacts with less than 0·5 μgm./cm.^{2} of glycoside, giving permanent and distinctive colours in visible and ultra-violet light, while the background remains unaffected. Moreover, if stored in an amber-coloured bottle, the reagent keeps indefinitely.

For the chromatographic development, the glycoside solution was applied to the starting line with an 'Agla' micrometer pipette in a spot not more than 0·5 cm. in diameter. The chromatogram was then developed until the solvent front had run 30 cm. (During development the 'spot' had spread until it

Glycoside	Visible light		Ultra-violet light	
	Colour	Sensitivity	Colour	Sensitivity
Digitoxin	Red-mauve, changing to blue-grey	0·75 μgm.	Red	0·25 μgm.
Gitoxin	Mauve, changing to grey	0·75 μgm.	Apple-green	0·25 μgm.
Digitoxigenin	Pale turquoise-blue	1·0 μgm.	Negative	—
Gitoxigenin	Bright orange-yellow	0·75 μgm.	Bright orange	0·25 μgm.

covered an area of about 2 cm.[2].) The dried chromatogram was treated with a 20 per cent solution of antimony trichloride A.R. in dry, alcohol-free chloroform, and the paper was heated for 3–5 min. at approximately 70° C.

The colours produced are shown in the accompanying table.

On heating, the colour due to gitoxigenin appears first, followed by digitoxin, gitoxin and lastly digitoxigenin, which is also least sensitive to the test. Work in progress indicates that the reagent may be used successfully for the detection of strophanthus glycosides.

I wish to thank the directors of Allen and Hanburys, Ltd., for permission to publish these results.

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Pharmacological and Toxicological Actions of Dart Poison used in Malaya

PHARMACOLOGICAL and toxicological actions of dart poison have received a great deal of attention in the past. Among the contributors on this subject were Ridley[1], Chopra and de Premankur[2] and Doebel *et al.*[3]. It was generally assumed that the chief toxic agent in the dart was the digitalis-like substance contained in the latex of the Upas tree *Antiarias toxicaria*, with which some dart poison was known to be made (Burkill[4], and Chen *et al.*[5]). The present communication puts on record some observations of the pharmacological and toxicological actions of a dart poison obtained recently from the Sakais in Perak, North Malaya. A water extract of the dart poison was prepared by dissolving the poison of one dart in 1 c.c. of water. It was filtered before use for the experiment.

The results obtained showed that the dart poison had no stimulating activity on the isolated guinea pig's ileum. It exerted, however, a strong inhibitory effect on the stimulating action produced by histamine and acetylcholine in the same ileum. In the perfused toad's heart, it had a stimulating effect when given in lower concentration and an inhibiting effect when given in higher concentration. Such effects indicated that the dart poison possibly contained two different substances affecting the toad's heart in opposite directions. In higher concentration, it caused stoppage of cardiac action in diastolic relaxation. This was different, therefore, from the effect produced by higher concentrations of digitalis, which usually results in systolic arrest of the heart. The dart poison lowered the blood pressure and increased both the depth and rate of respiration in cats under 'Dial' anæsthesia. This cardiac inhibitory effect on toad's heart and the lowering of cat's blood pressure were not influenced by atropine, thus showing that the active substance which caused these effects was not a choline ester. It was not thought that the dart poison possessed any antihistamine or atropine-like activity, because its inhibitory effect on histamine and acetylcholine stimulation of the guinea pig's ileum lacked specificity. The dart poison also had some curare-like activity, because it inhibited the contractions of isolated rat's diaphragm elicited by stimulating the phrenic nerve. It was estimate however, that this activity was weak, because eac dart contained the equivalent of only 200 μgm. c *d*-tubocurarine, which is not a toxic dose in sma animals.

Toxicological observations made on toads, rats an cats all showed the symptoms of increased respiratio followed soon by asphyxia and death. It was cor cluded that respiratory paralysis was the most likel cause of the fatal results produced by the poiso darts in animal hunting. Since it is improbable tha one substance should have all the actions liste above, it seems right to conclude further that th dart poison contained more than one pharmacologically active substance and that it had been prepared from several sources of material. The fact, moreover, that the main symptoms were very similar t those produced by strychnine suggested that th chief toxic substance was obtained from a plan belonging to the *Strychnos* group, rather than fror the latex of *Antiarias toxicaria*.

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Changes in the Distribution of the Intertidal Barnacles in Relation to the Environment

IN previous communications[1,2] the possibility tha changes may occur in the distribution of intertida organisms over a number of years was discussed, ano the established distribution of *Chthamalus stellatu* was extended to include much of the Irish Sea coast line. Further new evidence has come to light showing that while this barnacle may have increased its range and abundance over recent years, it was nevertheless present in the Isle of Man in 1933. A photograph taken by H. B. Moore in March 1933 shows a single individual which appears on close inspection to be *Chthamalus*; moreover, statistical tests based on the size and form of the aperture and the angle of the scutotergal margin show that this must be *Chthamalus* and not *Balanus balanoides*.

However, critical observations on *Balanus balanoides* and *Chthamalus stellatus* during recent years have shown a marked change in their distribution, indicating a general recession of *Balanus* from its southern and western limits, and a corresponding increase in *Chthamalus*. Conclusive evidence for this was first obtained by one of us (A. J. S.) by comparison of recent ecological findings for the Plymouth area with those of Moore[3]. This was confirmed and substantiated by records in the Brixham area (D. J. C.), Barnstaple[4] and Isle of Man (A. J. S.). Since the organisms studied are sessile ones, the changes observed are real changes in the population and the possibility of changes due to migration is eliminated. Most of the regions from which *B. balanoides* is disappearing are those where *Chthamalus* is extremely abundant. However, exclusion by direct competition r rock space is not considered to be the main ctor, since available bare rock is usually present these areas. A second factor might be the recent ncroachment of *Elminius modestus*, which has been arefully followed by one of us (D. J. C.) and which ttles in the intertidal zone with *B. balanoides* in reas where the species co-exist. But in south Devon, *lminius* is still found only rarely outside estuaries; et it is in the regions where *Elminius* is rare, and ot in the estuaries, that we find the most clearly arked depletion of *B. balanoides*. A third possibility the sterilizing effect of the parasite *Hemioniscus alani*, the incidence of which appears to have inreased in *B. balanoides* in south Devon, having been gher than 50 per cent in some areas at Plymouth uring 1950–51; while on January 7, 1950, at Par Cornwall), 47 out of 50 individuals were found arasitized (some with double infection). As *hthamalus* is never infected it is likely that *Elminius*, hich is usually infected to about the same degree s *Balanus balanoides*[6], provides a reserve host for the arasite. Thus a high incidence could be established n the normal host (*B. balanoides*) even to the point f extinction, while the rapid breeding of *Elminius*[6] ight enable the new host to survive. However, this xplanation can be a partial one only, since the ecession of *Balanus* appears to be more widespread han either the incidence of *Elminius* or the present bnormally high *Hemioniscus* infection. It is more ikely that the high rate of infection by *Hemioniscus* s a further indication of the poor condition of B. *balanoides* in those areas, due to some adverse xternal change.

Evidence from the south Devon area suggests that t is the planktonic stages which are most vulnerable. Harris[7] states that at Plymouth settlements of *B. alanoides* fail completely during certain years. At Brixham (Torbay) a heavy settlement of *B. balanoides* was recorded in 1946, a moderate one in 1947, and ather poor settlements in 1948, '49, '50 and '51, articularly so in 1951; yet during 1947–50 ertilization of the eggs in late autumn and release f nauplii in early spring took place apparently ormally; it was the poor survival of the larval tages which accounted mainly for the failure to eplace the normal mortality of the population. A milar occurrence appears to have taken place beween 1949 and 1951 in the Isle of Man, where at ne locality the numbers of *Balanus* were reduced y as much as 75 per cent; and at the same time he small population of *Chthamalus* increased by up o 50 per cent. Although a proportion of the recent ncrease in *Chthamalus* may be a secondary result f the decreasing spatfall of *Balanus*, which thus frees ore rock for settlement, this cannot be wholly the ase in the Isle of Man or in the estuaries of south Devon, since in both places an increase in *Chthamalus* has occurred mainly above the *Balanus* zone.

Taken together, the changes in distribution of *Balanus* and *Chthamalus* suggest the influence of some general climatic factor, such as the recent succession of mild winters or a rise in average temperatures during several years. It is difficult to envisage other factors operating so generally and yet capable of affecting both species. The mode of action need not necessarily be a direct or obvious one; it might, for example, cause abnormalities in the early embryonic development of *Balanus* and render many of the larvæ ultimately non-viable; it might also result from changes in the phytoplankton succession[8]. An understanding of the mechanisms by which such changes operate is clearly of great importance, since if they are climatic in origin, as we suggest, they would be expected to have an influence on many other marine organisms, including probably some of economic value.

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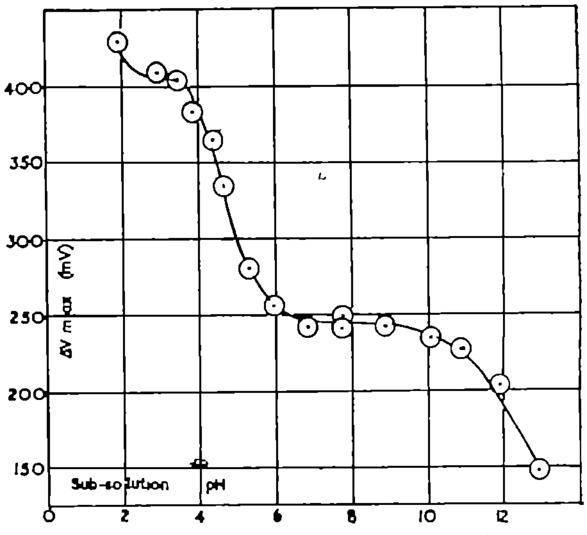
Ionization of Bovine Serum Albumin Monolayers

IT has long been known that the surface electrical potential of a protein monolayer at the air/water interface is dependent on the pH and the nature of the ions present in the aqueous sub-solution. There is no record, however, of a comprehensive investigation of the variation of protein surface potential with the pH of the sub-solution. This information, were it available, would be a 'titration curve' of a protein monolayer, and would shed light on the nature and extent of the ionizing groups of the protein when spread as an insoluble monolayer. We wish to report preliminary results of such a surface titration curve for the protein bovine serum albumin.

The accompanying graph shows the surface potential of a bovine serum albumin monolayer as a function of the pH of the aqueous sub-solution. This solution contained 0·01 N sodium chloride and was buffered by 0·005 M (H_2CO_3/$NaHCO_3$/Na_2CO_3). The presence of sodium chloride ensured a stable insoluble monolayer, in addition to minimizing any ionic charge effects due to the ionizing buffer salts over the pH range 2·0–13·0.



Surface titration curve of insoluble monolayers of bovine serum albumin, spread on 0·005 M bicarbonate buffer containing 0·01 N sodium chloride

The technique adopted was as follows: 'Armour' crystallized serum albumin (10·0 mgm.) was dissolved in, and spread from, distilled water (20·0 ml.) containing 1 per cent ethanol. Simultaneous surface pressure and surface potential *v.* area measurements were made, using standard compression isotherm procedure for insoluble monolayers. For a given subsolution, the surface potential varied with the state of compression of the monolayer. At the collapse point, however, the surface potential became constant and attained its maximum value. This maximum value (ΔV max.) was taken as characteristic for the protein monolayer under the appropriate conditions of pH and ionic strength of the subsolution. Surface potentials were reproducible to ± 5 mV.

From the graph it can be seen that appreciable changes in surface potential (ΔV max.) occur in the pH ranges 3·5–6·5 and 10·0–13·0. The former change is clearly due to the ionization of carboxyl groups, whereas the latter change is due to the neutralization of the cationic amino groups of the protein. The general shape of the curve is similar to that obtained by acid-base titration of the native globular protein dissolved in aqueous solution. Some differences are evident, however. For example, we note that, compared with results obtained in bulk solution[1], the curve is markedly displaced towards higher pH values, thereby raising the apparent pK_a values of the dissociating groups. Such a result has already been observed with monolayers of long-chain fatty acid[2]. Furthermore, it appears that the neutralization of the iminazole $\overset{+}{=\mathrm{NH}}$— group of histidine is not being shown by changes in surface potential. The reason for this is not yet clear. However, it may very well be that these amino groups are not available in the surface when the protein monolayer is highly compressed.

The great advantage of the present technique is that it permits the study of the ionization of a protein which is only available in small amounts, 10 mgm. being ample for such an investigation. Further work on other proteins and high-molecular weight polypeptides is being actively pursued and will be discussed elsewhere in due course.

Our thanks are due to Dr. J. H. Schulman for valuable advice and interest in this work.

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Comparison of Ganglionic Blocking Agents

IN a series of papers, Shaw *et al.*[1–3] have submitted evidence which indicates the presence of two pharmacologically distinct groups of cells in sympathetic ganglia, one group of cells giving rise to vasoconstrictor fibres and the other to vasodilator fibres. It was also mentioned that the cells in the superior cervical ganglion did not react quantitatively in the same manner to all paralysants[3]. Consequently, a number of ganglionic blocking agents have been tested on the superior cervical ganglion of cats.

A condenser-type strain gauge was used to recor the contraction (and relaxation) of the nictitatin membrane, and a photoelectric method was used t record the constriction (and dilatation) of the bloo vessels in the ear. A test stimulus of constan repetition-rate, for a fixed time, was applied to th preganglionic fibres. This stimulation of the cervica sympathetic trunk resulted in contraction and con striction of the nictitating membrane and ear vessel respectively. All paralysants were administered b direct injection into the common carotid artery, th blood supply of the ganglion being left intact.

Two series of measurements were made for al drugs: (*a*) the duration of complete paralysis o the nictitating membrane and of the ear vessels (*b*) the time to complete recovery of these two tes objects.

In general, we have found that after paralysi the responses differ, in that the time taken by th nictitating membrane to show a first response differ from the time taken by the ear vessels.

	Duration of paralysis (min.)		Duration to complete recovery (min.)	
	Ear vessels	Nictitating membrane	Ear vessels	Nictitating membrane
D-Tubocurarine chloride 0·2 mgm./kgm.	22	10½	30½	29½
Dimethyl tubocurarine iodide 0·3 mgm./kgm.	12½	8½	30	12
Pentamethonium iodide 3·5 mgm./kgm. (C5)	5	11	31	39
Tetraethyl ammonium bromide 7 mgm./kgm. (T.E.A.B.)	7	13½	10	25½
'Pendiomide' 2 mgm./kgm.	8	8½	16	16

The accompanying table shows the averaged times from about six experiments for each paralysant. For D-tubocurarine and dimethyl tubocurarine, the ear vessel response is more affected than is the nictitating membrane, the reverse result being the case for pentamethonium iodide and tetraethyl ammonium bromide. In the case of N,N,N′,N′-3-pentamethyl-N,N′-diethyl-3-aza-pentane-1,5-diammonium dibromide (CIBA 9295, 'pendiomide')[4] there is practically no difference. Although differences are apparent in the times to complete recovery, they are not as marked as the paralysis times.

Whether the differential response obtained is due to the blocking agents acting at the ganglion, or peripherally, or at both these sites, we cannot as yet say. Stimulation of the post-ganglionic fibres from the superior cervical ganglion while the ganglion is still paralysed will be carried out to give an indication as to where the paralysants are causing the differential effect. Guyton and Reeder[5], and also Paton and Zaimis[6], have shown that different ganglia vary in sensitivity to a particular blocking agent. So far as we know, both the ear vessels and the nictitating membrane are innervated directly from the superior cervical ganglion, that is, only one ganglion is involved; therefore it is unlikely that the differential results obtained can be explained on the basis of ganglion sensitivities.

It appears that the response of the nictitating membrane itself does not give a precise account of the action of the various ganglionic blocking agents used. When testing an agent for paralytic activity on ganglion transmission, it may not be sufficient o employ only one test object. As animal experiments are usually carried out prior to clinical testing, would be best if tests for ganglionic paralysants esembled more the purpose for which they were sed in man, namely, to prevent vasoconstriction esulting from active vasoconstrictor fibres.

The neuromuscular blocking agent tri-(diethylminoethoxy)-1,2,3,benzene triethiodide (gallamine riethiodide—'flaxedil') was also administered and, s expected, failed to block the ganglion except in ery large doses. However, in about 40 per cent of he experiments it brought about a potentiation of he ear vessel constriction on stimulation and had ery little effect on the nictitating membrane response lose, 7 mgm./kgm.). As Mushin *et al.*[7] have found hat 'flaxedil' does not possess anti-choline esterase ctivity, the potentiation cannot be explained on hese grounds. As yet we have no explanation for he result.

2,5-*bis*-(3-Diethylaminopropylamino)benzoquinone-is-benzyl chloride (WIN 2747) has been shown by Hoppe[8] to be a neuromuscular blocking agent. As n the case of 'flaxedil', it failed to block the superior ervical ganglion except in large doses. A marked eduction of the nictitating membrane contraction was found to occur with doses of 3 mgm./kgm., when the pre-ganglionic fibres were stimulated. At he same time, this dose of WIN 2747 was found to ave very little effect on the ear vessel constriction.

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Molecular Weight of Glycogens determined by a Light-scattering Method

THE use of light-scattering methods for the letermination of the molecular weight, size and shape of macromolecules has become of increased importance n recent years. Studies already made include those n cellulose acetates[1], polystyrene and synthetic olymers[2], and several proteins[3,4]. The influence of odium chloride on the size and shape of a detergent–rotein complex has recently been investigated using light-scattering method[5]. The application of this nethod to the measurement of the molecular weight of several glycogens is reported in this communication.

The relation between the molecular weight M, of he solute, and the turbidity τ, of the solution, is iven by the well-known equation[6,7]

$$\frac{H.C}{\tau} = \frac{1}{M} + 2B.C, \qquad (1)$$

where C is the concentration of the solute in gm./ml., nd H and B are constants.

The glycogens examined were supplied by Dr. D. J. Bell, and had unit-chain lengths of 11–13 glucose radicals (determined by potassium periodate oxidation[9]). The light-scattering apparatus used has already been described[8]. It was calibrated in terms of bovine serum albumin, a molecular weight of 69,000 being assumed for this protein[4]. Refractive index increments were determined using a Rayleigh type interferometer. Curves of $H.C/\tau$ *v.* C for the various glycogens are shown in the graph, and the molecular weights, calculated by extrapolating these curves to zero concentration, are given in the accompanying table.

Source of glycogen	M	I_{45}/I_{135}
Rabbit liver	$6 \cdot 8 \times 10^6$	1·15
Rabbit muscle	2·8 ,,	1·0
Cat liver	10·0 ,,	1·40
Fœtal sheep liver	14·8 ,,	1·10
Tetrahymena pyriformis (ref. 9)	9·8 ,,	1·90
Ascaris lumbricoides	8·8 ,,	1·17

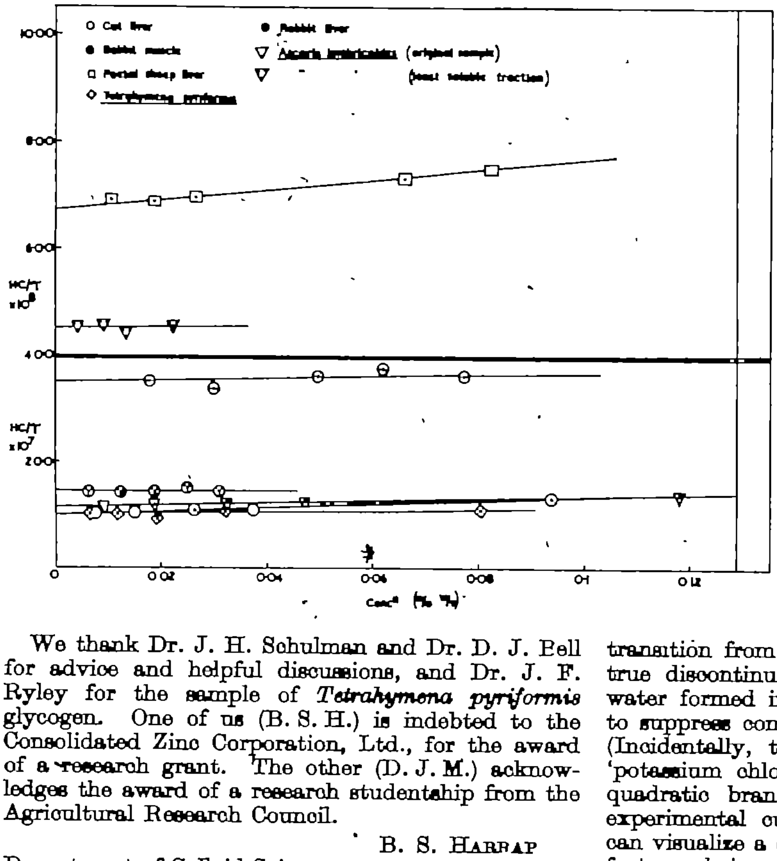
Considerable diversity is found among the results of different workers for the molecular weights of various glycogens[10]. The results for rabbit muscle and *Ascaris* glycogen may be compared with those obtained by Bell *et al.*[11] on the same samples of glycogen, from sedimentation-diffusion measurements. The present value of $2 \cdot 8 \times 10^6$ for rabbit muscle glycogen agrees well with their value of $2 \cdot 6 \times 10^6$. There is a marked disparity between the value of $8 \cdot 8 \times 10^6$ for *Ascaris* glycogen and the value of $0 \cdot 7 \times 10^6$ obtained by Bell *et al.* However, examination of their sedimentation diagram for *Ascaris* shows considerable broadening of the 'peak' in the direction of higher molecular weight units. Since molecular weights calculated from turbidity data are 'weight average' values, the presence of small amounts of material of high molecular weight will result in the values obtained by this method being much higher than the molecular weight of the main fraction of the sample.

The dissymmetry of light-scattering shown by some of the glycogens (see table) may be due to the presence of fractions of high molecular weight. Rabbit muscle glycogen, which gives the most symmetrical peak in the sedimentation diagram[11], shows no dissymmetry; furthermore, fœtal sheep liver glycogen, which has the highest molecular weight of any glycogen reported in the table, shows a negligible dissymmetry. This point may be further illustrated by reference to *Ascaris* glycogen, which shows a disparity between the molecular weight values obtained from sedimentation-diffusion and light-scattering measurements. This glycogen originally showed a dissymmetry (I_{45}/I_{135}) of 1·15–1·20. After fractional precipitation with ethanol at a concentration of 40 per cent, a fraction (3 per cent by weight) was obtained which had a molecular weight of $22 \cdot 5 \times 10^6$, and a dissymmetry of 1·45. This clearly shows that small amounts of material of relatively high molecular weight may be present in the glycogen samples. For this reason, none of the values given in the accompanying table has been corrected for dissymmetry and must be regarded as giving an order of magnitude only for such highly polydisperse systems.

H. Staudinger[12] has measured the molecular weight of various glycogens using the relation:

$$K_L.M = \tau_{sp}, \qquad (2)$$

where K_L is a constant for the wave-length used and τ_{sp} is the specific turbidity (that is, the absolute turbidity of a solution containing 1 gm. solute per litre). This equation is equivalent to equation (1), if there is no deviation from the van't Hoff osmotic pressure law, that is, if $B = 0$. Staudinger determined K_L from the turbidity of samples of glycogen the 'molecular weights' of which had been determined by osmotic pressure measurements. His values for rabbit liver, rabbit muscle and cat liver glycogens of $5 \cdot 2 \times 10^6$, $1 \cdot 9 \times 10^6$ and $6 \cdot 9 \times 10^6$ respectively are considerably lower than the values reported in our table. It must be noted, however, that the samples of guinea pig liver glycogen used by Staudinger for calibration were likely to be polydisperse. Since osmotic pressure measurements give 'number-average' molecular weights, the values obtained in terms of this standard would tend to be lower than the 'weight average' values normally given by turbidity measurements.



We thank Dr. J. H. Schulman and Dr. D. J. Bell for advice and helpful discussions, and Dr. J. F. Ryley for the sample of *Tetrahymena pyriformis* glycogen. One of us (B. S. H.) is indebted to the Consolidated Zinc Corporation, Ltd., for the award of a research grant. The other (D. J. M.) acknowledges the award of a research studentship from the Agricultural Research Council.

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Effect of Withdrawal-Rate on Second Explosion Limits

In a recent communication, Baldwin and Precious have directed attention to the effect of withdrawal rate on the hydrogen–oxygen second limit. Sinc they found this effect to be present in clean vessel and absent in vessels coated with potassium chloride they favour an explanation which connects it with the participation of quadratic branching in the reaction. During our examination of the hydrogen oxygen reaction[2], we have also had occasion to stud this phenomenon. Our own observations suggest tha the effect is not directly connected with the presenc of quadratic branching and support the alternativ explanation, namely, that the net branching facto is reduced to zero by the products formed during the initial stages of the explosion

While agreeing that the effect i most pronounced in vessels of low chain-destroying efficiency (clea 'Pyrex', boric oxide) we have also observed it with many other surfaces (potassium chloride, potassium hydroxide, etc.) at higher temperatures where the slow reaction is o the same order, but where significant quadratic branching is still no detectable. The effect is negligible in very rich mixtures and increase markedly as the hydrogen–oxygen ratio decreases, thus becoming greatest in the region where the slow reaction and quadratic branching contribution are at a minimum. We have also found a similar phenomenon to occur in carbon monoxide–oxygen explosions, but have not been able to find any indications of quadratic branching in this reaction.

This alternative explanation is supported by the work of Von Elbe and Lewis[3], who showed that the transition from slow reaction to explosion is not a true discontinuity, and that it is possible for the water formed in the initial stages of the explosion to suppress completely its subsequent development. (Incidentally, those observations were made in a 'potassium chloride' vessel under conditions where quadratic branching is not evident.) From the experimental curve of Baldwin and Precious, one can visualize a condition in which the net branching factor is being decreased by the production of water at the same rate as it is being increased by the slow reduction of pressure. Such a system would stay on the brink of explosion right through the explosion region without suffering anything more than a vigorous slow reaction.

Two observations confirm this view. In the hydrogen–oxygen reaction it was noticed that if the withdrawal-rate was made so slow that the mixture would not normally explode, and if at any time after crossing the limit the evacuation-rate was increased by a sudden twist of the tap, then explosion followed within a period of ½–3 sec. Secondly, with moist carbon monoxide–oxygen, one is fortunate in being able to 'see' the presence of a slow reaction by the blue glow emitted. On crossing the limit at a fast rate, the blue glow suddenly increases to a brilliant uncontrollable flash; but with sufficiently low evacuation no such transition occurs, the blue low rising to a constant value throughout the xplosion region. If evacuation is stopped at any tage after crossing the limit, the blue glow slowly ades. A further slight evacuation brightens it up omentarily, and this process can be repeated many imes.

The phenomenon leads to experimental difficulties nly when observing the second limits of very weak ixtures. To obtain any explosion at all in this egion, the rate of evacuation must be faster than is esirable for accurate manometer reading, and also nder these conditions the explosion lag, as indicated bove, must become a significant source of error. his uncertainty tends to prevent the accurate etermination of the constants *c* and *F* of the explosion limit equation[2], values from the second limit eing much greater than those derived from the first. urthermore, the unknown error due to explosion ag might well be the cause of the observed but unexected temperature dependence of the third-body oefficient *a*[3], since the necessary rate of withdrawal ncreases both with ratio of oxygen to hydrogen and ith temperature.

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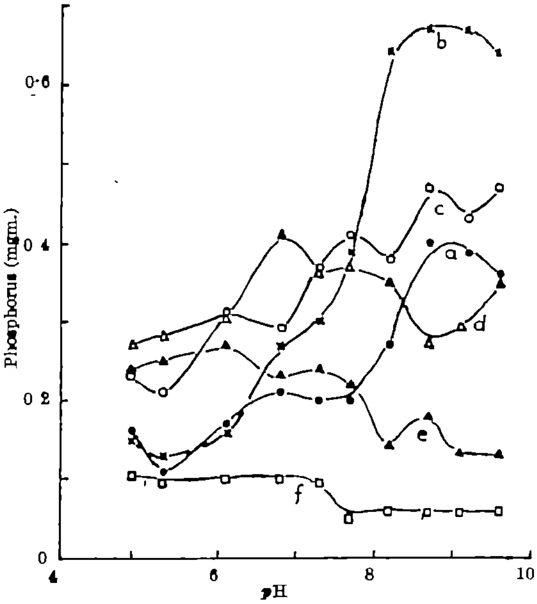
Zinc, Ionic Equilibrium and Phosphatase Activity

CONTROVERSY has centred around the nature of he active groups influencing the activity of alkaline hosphatases of higher animals[1]. In a recent comunication[2], I suggested on the basis of results btained with the alkaline phosphatase of the fungus *enicillium chrysogenum*, *Q*-176, that the activity of he enzyme is influenced by both zinc and magnesium ons and that the relative proportion in which these ons existed in an active state determined the *p*H f optimum activity.

I have further investigated this problem with lkaline phosphatases prepared from ox kidney and ntestines by the method described by Thoai, Roche nd Roger[3], and the results obtained by me go to upport my earlier observations that both zinc and magnesium ions and the relative concentration in which they are present exert considerable influence n the activity of the enzyme. From the accompanyng graph, it will be apparent that while cyanide t higher concentrations inhibits activity at all the H's tested, the enzyme shows increased activity on he acid side at intermediate concentrations of cyanide nd on the alkaline side at very low concentrations. I ave also observed that by the addition of magnesium ons to the enzyme inhibited by 0·002–0·004*M* cyanide, ctivity was increased on the acid side to a considerbly greater extent than at other *p*H's, whereas a imilar addition of zinc resulted in the restoration f activity at all the *p*H's at low, and on the alkaline ide at intermediate, concentrations of zinc. In both cases there was an optimum concentration at which the activity was maximum, higher concentrations of zinc especially bringing about general inhibition of activity at all *p*H's.



Effect of varying concentrations of cyanide on ox kidney alkaline phosphatase at different *p*H's. Each substrate contained neutralized sodium cyanide at the following concentrations: (*a*) nil, (*b*) 0·0002 *M*, (*c*) 0 0004 *M*, (*d*) 0 001 *M*, (*e*) 0·002 *M*, (*f*) 0 004 *M*

The complete inhibition of activity of the enzyme at all the *p*H's on the addition of cyanide at the higher concentrations and the effect of addition of zinc in increasing concentrations to the cyanide-inhibited enzyme in restoring the activity first at all the *p*H's and thereafter at the more alkaline *p*H's show that zinc ions are necessary for activity at alkaline and acid *p*H's. Other heavy metals, such as manganese, iron or cobalt, had no appreciable effect in restoring the activity of the cyanide-inhibited enzyme. It is well known that magnesium ions are necessary for full activity of the enzyme on the alkaline side, and I have observed that this is so only when zinc ions are also present, for the cyanide-inhibited enzyme is only partially activated by magnesium on the alkaline side.

From these findings, I suggest that there is no entity like 'acid' or 'alkaline' phosphatases, but that by merely changing the equilibrium between the prosthetic ions or groups of the enzyme, activity can be established at any *p*H desired. Admittedly, the phenomenon as it applies to enzymes in higher animals is more complex than the one observed for the enzyme in *P. chrysogenum*, *Q*-176. The results of this investigation will be published in due course.

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Quantitative Spot Test on Filter Paper and Examples of its Application

WHILE, so far, the spot test on filter paper, developed by Dr. F. Feigl and his co-workers, has been used exclusively for qualitative purposes, we have discovered a method for the estimation of various substances by using circular filter papers and the solvents which are commonly used in paper partition chromatography.

The procedure is as follows. At the centre of a circular filter paper a small drop is placed of the solution of the sample containing a few milligrams of the substances under examination. After drying, solvent for partition chromatography is dropped in small portions (5–10 drops per min.) from a capillary tube on to the centre of the paper, thus causing development of the chromatogram. The substances contained in the sample mixture develop gradually to accurate concentric circles forming partition zones. For this manipulation a desiccator or Wit's filter bottle is used, in the bottom of which there are placed a small volume of partition solvent to saturate the air in the vessel with the vapour of the solvent used and a Petri dish containing the same solvent on which the filter paper (of about 11 cm. diameter) is placed. The development is complete when solvent has spread to a circle 7–8 cm. in diameter (about 30–40 min.). By using circular filter paper, we can work with much larger amounts of material in a shorter time than by the usual method of paper chromatography. Quantitative estimation is usually made by calculating the area of partition zones on the filter paper. It may, however, be effected, in general, more exactly by cutting up the paper, extracting and then applying colorimetry or densitometry by ultra-violet light to the extract. The chromatograms thus obtained are similar to those produced by Rutter's method[2]. Our procedure was developed in the past few years independently of his report.

The following are a few examples of the application of quantitative spot tests on filter paper.

(1) *Estimation of methanol and ethanol.* In a preceding paper[3], we reported a method for the detection of methanol, in which the potassium xanthogenates derived from a methanol–ethanol mixture by adding carbon disulphide and potassium hydroxide are submitted to paper partition chromatography using butanol saturated with 5 per cent sodium bicarbonate solution. Applying the technique outlined above, the ethyl xanthogenate is discernible as an outer circle, while that of methanol is located in an inner zone, as shown by ultra-violet light. The chromatogram is dried, cut up into its partition zones and the latter extracted by 5 per cent sodium bicarbonate. After sixty seconds from the addition of freshly prepared Grote's reagent (twice normal concentration) the estimation can be made electrophotometrically.

(2) *Estimation of R-acid and G-acid.* Both acids are apt to be produced in admixture as intermediates in the manufacture of dyes, and their separation was considered hitherto as a difficult problem. Applying our new technique to the development of the mixture of both acids (using butanol saturated with a 5 per cent solution of sodium bicarbonate) and following the process under ultra-violet light, the partition zones (outlined with pencil) are extracted with 5 per cent sodium bicarbonate solution. By addition of the diazonium salt of naphthionic acid, there are produced red dyes, which can be estimate electrophotometrically.

Note added in proof. A somewhat similar techniqu of circular paper chromatography has been describe recently by Giri and Rao[4].

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Conductance in Non-aqueous Solutions

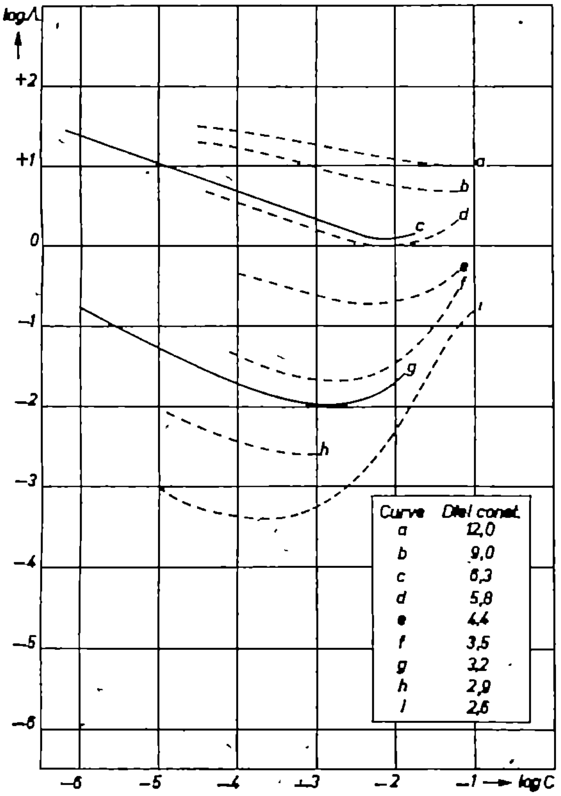
IN the extensive work of Fuoss, Kraus an co-workers[1] on the conductivity of solutions in medi of widely divergent properties, these authors ar led to the conclusion that, viscosity excepted, ther is no specific influence due to the solvent, but tha the dielectric constant of the medium alone determine conductivity data.

Since Fuoss and Kraus do not consider acid media measurements of conductance of solutions in som organic acids are in progress in this laboratory t test the theory mentioned above. The followin materials were used: 100 per cent glacial acetic aci (solvent-conductance 0·4–0·8 × 10^{-8} mhos) obtaine by fractionating 97 per cent acetic acid; 100 pe cent propionic acid (solvent-conductance less tha 3×10^{-10} mhos) obtained by fractionating a C.P product; tetraethylammoniumpicrate (melting poin 255·5° C.) prepared from silver picrate and tetraethylammoniumiodide. The conductance was measured with a Jones bridge[2]; a cathode-ray oscilloscope served as detector of current-minimum. A frequency of 1,000 c./s. was used. The conductanc cells were designed according to Jones and Bollinger[3] using non-platinized platinum electrodes. Th measurements here described were made with 125-c.c. cell (cell constant 0·00965). In preparin the solutions, all precautions were taken to preven contact with the air.

Measurements were carried out at 25° C. wit solutions of tetraethylammoniumpicrate in glacia acetic acid ($D = 6{\cdot}25$) and propionic acid ($D = 3{\cdot}15$ respectively, covering a wide range of concentrations The accompanying graph shows the logarithm of th equivalent conductance (Λ) as a function of lo molality (C). The dotted lines are from data o Fuoss and Kraus[1] on tetra*iso*amylammoniumnitrat in mixtures of dioxane and water.

Although Fuoss and Kraus worked with a somewhat different salt (both salts, however, are rathe strong electrolytes), it is obvious that our value fit in very well with theirs. So we may conclud that, also in the acid media, the dielectric constan is the determining factor for the conductanc phenomena.

With the aid of the extrapolation method o Shedlowsky[4] the following constants, corrected fo solvent conductance, can be given for tetraethyl ammoniumpicrate in acetic acid: Λ_0 (equiv. conduct



t infinite dilution) = 29·9 ohm^{-1} cm.^{2}. K (dissociaion constant) = 1·63 × 10^{-4}.

The values for propionic acid cannot yet be given.

This work is being carried out with solutions of different electrolytes in formic acid (D = 58), acetic acid, propionic acid and mixtures of these solvents.

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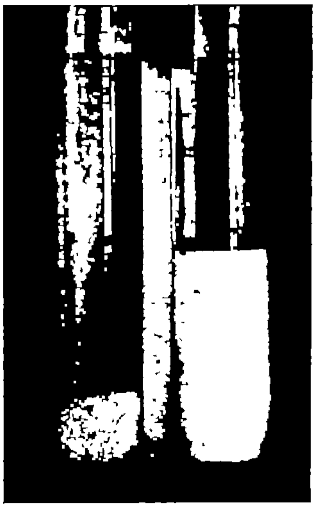
Micro-spherical Aggregation of Barium Sulphate

During an investigation of the influence of certain organometallic compounds on the velocity of sedimentation of inorganic materials in non-aqueous media, a phenomenon has been observed which does not appear to have been previously recorded. Precipitated barium sulphate, free from soluble salts, as prepared for X-ray examinations, and containing no addition agent, was dried for several days at 110° C., and shaken with pure dry benzene in a stoppered Nessler tube in an automatic shaker. The shaking was carried out at the rate of five oscillations per second, the tube being shaken longitudinally, with a displacement of 2 in. After 24 hr. the solid had aggregated completely into spheres of 1–0·5 mm. in diameter, as shown in Fig. 1(*a*). The sediment volume was slightly less than that of the lightly tamped dry solid, indicating a close degree of packing of the spheres. If the tube was then subjected to very violent and irregular manual shaking, the spheres broke up to form a flocculate (shown, after 24 hr. standing, in Fig. 2). On further regular shaking for 30 min., the spheres re-formed as before.

It is tentatively suggested that this phenomenon may be due to the fact that barium sulphate has a hydrophilic surface (method of Davis and Curtis[1]), and that it will consequently tend to aggregate so as to present to the benzene the minimum surface per unit volume. In this respect the phenomenon can be regarded as in some way analogous to the formation of drops of one liquid when shaken in another. It is to be expected that this form of aggregation would not occur in a solvent which is miscible with water, so the experiment was repeated with 1 : 4 dioxan. The suspension formed was very fine, and settled very slowly (about 4 cm. per hr.); Fig. 1(*b*) shows its appearance after standing for three days. Even after prolonged shaking, no sphere-formation was observed. In diethyl ether, however, the barium sulphate formed spheres, though somewhat larger and more easily broken up than those from the benzene suspension.


(*a*) (*b*)
Fig. 1

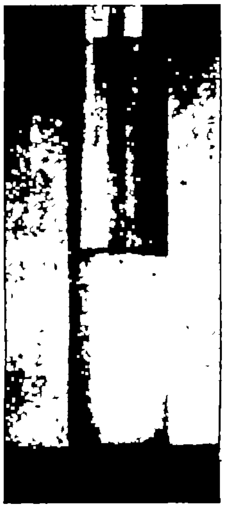


Fig. 2

In each of the tubes (Figs. 1 and 2), which were of equal diameter, the total volume of solid and liquid was 50 ml., and the weight of barium sulphate was 10·00 gm.

A further experiment was carried out, using basic lead carbonate, which is known to have an 'organophilic' surface[2]. On shaking this with benzene there was, as might be expected, no sign of sphere-formation.

This work is being continued, and will be reported in detail elsewhere.

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Gravity Observations in a Borehole

GRAVITY surveys are widely used as a method of geophysical exploration. A knowledge of the densities of the underlying rock layers is necessary for the interpretation of the results. While the density of samples may be determined in the laboratory, the only really satisfactory method of finding the bulk density is by gravity observations in a mineshaft or a borehole. The information obtainable by this method has been discussed by Smith[1], who has also suggested further uses for the observations.

With this object in view, a gravimeter has been constructed and some preliminary tests have been made in an oil borehole belonging to the Anglo-Iranian Oil Co. at Eakring, Notts. The gravimeter is similar in principle to that previously described by me[2], but various points in the design have been improved and modified to suit the limited space available in a borehole.

Fundamentally, the instrument consists of a thin filament held in tension by a weight; the transverse vibrations of the filament control the frequency of an electronic oscillator. The weight is prevented from rotating about an axis along the filament by means of thin strip hinges and, between observations, may be held in its normal position by a system of clamps operated by an electric motor. The instrument and the thermostat which controls its temperature are mounted in gimbals inside a pressure-tight steel container, which also contains electronic apparatus for maintaining the oscillations of the filament and operating the thermostat. The external dimensions of the container are 5 in. external diameter by 8 ft. in length. The apparatus for recording the frequency of vibration of the filament is at the surface, and is electrically connected to the gravimeter by the 4-core cable which supports the instrument in the borehole.

The vertical gradient of gravity may have three main component parts, assuming that the rock layers penetrated are uniform, horizontal and of large lateral extent. The first is the normal free-air gradient; the second component, of magnitude $4\pi G\rho h$, is due to the attraction of the rock layer penetrated, h being its thickness, ρ its density and G the gravitational constant. The third component, which may not be present, is the gradient due to a buried anomalous mass. The presence of such a mass may usually be inferred from a surface gravity survey around the borehole, or from the abnormal vertical gravity gradient near the mass. The numerical values of the free-air term of the vertical gradient is 9·41 milligals per 100 ft.; the second term has a value of 6·40 milligals per 100 ft. for rock of density 2·5 gm./c.c. If no anomalous mass is present, the resultant gradient is 9·41–6·40 = 3·01 milligals per 100 ft. If the accuracy of the gravimeter is ± 0·7 milligal at each of two stations spaced 100 ft. apart, that is, ± 1·0 milligal in the difference, the accuracy of the second component of the gravity gradient will be ± 1·0 in 6·40, or ± 15 per cent. This will lead to a similar error in the deduced density. The accuracy can be improved by increasing the separation of the stations, if the rock layer is sufficiently thick, or by improving the accuracy of the gravimeter.

The field-test of the gravimeter took place during two days, February 2 and 3, 1952. The first, while showing up various defects in the gravimeter, did not give reliable measurements. The results of the second day's working are shown graphically in Fig. 1.

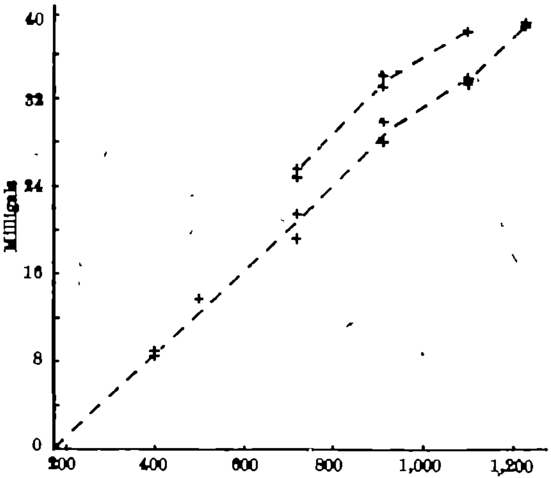

Fig. 1. Variation of gravity with depth

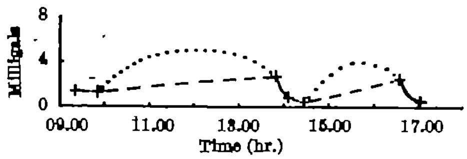

Fig. 2. Zero drift; February 3, 1952

Two runs were made, each starting from a depth 178 ft., proceeding to 1,226 ft. and returning to 178 ft stopping at each level marked on the graph in eac direction. The 'zero' readings of the gravimeter 178 ft. are also shown (Fig. 2), and it may be see that, whereas the initial rate of drift is reasonabl low, the zero frequency at the end of each run different from that at the beginning. The disturb ance of the frequency returns towards the origin value with a time constant of the order of ½ hr. It thought that this is probably a thermal effect, an if so, the true drift was probably as shown by th dotted line. As experimental verification has not y been obtained, the results given below have bee calculated on the assumption of a linear drift shown by the dashed line.

A surface gravity survey gave no indications of subterranean anomalous mass and so no anomalou gradient need be suspected. The probable error of single observation with the gravimeter, derived fro repeated observations at each level, is about ± 0 milligal. This error, which is much larger than w experienced in the laboratory, is attributable several causes. The gimbal system was not perfe and this caused some scatter of the readings at ea depth. A reversible jump of 4·6 milligals was o served at several stations; this is presumably d to a small piece of dirt alternatively remaining eith on the weight or the clamps (see Fig. 1).

Samples of chippings of about 0·1 cm. side we available from the borehole and, although these m not be fully representative of the formations, th densities were measured and averaged over 200- intervals. The error of determination of the densit is estimated at ± 1 per cent.

In the accompanying table, the densities obtain from the chippings, together with those from t gravimeter, are given.

At first sight it would appear that the rock form tions are not saturated with water. Final conclusio

ge (ft.)	300–500	500–700	700–900	900–1,100	1,100–1,200
vi- eter nsity	2·23±0·08	2·23±0·08	2·14±0·15	2·65±0·15	2·15±0·20
p- ngs nsity ct)	2·40	2·37	2·25	2·50	2·25
y)	2·25	2·17	1·97	2·33	2·0

ould not be drawn, however, as the effect of assum- a linear drift of the 'zero' frequency is to indicate ower density than would be obtained if the altern- ve drift curve were adopted.

I should like to thank the Anglo-Iranian Oil Co., d., for financial support during the period of search, for permission to publish this communica- n and for allowing me to use their borehole and providing a suitable cable and winch for the periments. I should also like to thank the chair- n and members of the Paul Instrument Fund mmittee for a grant enabling the gravimeter to built, Prof. A. O. Rankine for his interest in the rk, and Mr. B. C. Browne and Dr. R. I. B. Cooper, the Department of Geodesy and Geophysics, mbridge, for their help and encouragement during e investigation.

R. L. G. Gilbert

epartment of Geodesy and Geophysics,
Downing Place, Cambridge.
June 18.

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mith, *Geophysics*, 15, No. 4, 605 (1950).

ilbert, *Proc. Phys. Soc.*, B, 62, 445 (1949).

Electromagnetic Momentum and Newton's Third Law

The following simple relations[1] between electro- agnetic momentum, Poynting's vector of energy w, and mass–energy equivalence do not appear to ve received general recognition in connexion with e validity of Newton's Third Law when applied to ectromagnetic forces.

If the dielectric medium is free space, so that there no matter present to take reactive forces, we sup- se that the energy represented by the Poynting ctor, $\vec{\epsilon} \times \mathbf{H}$ (rationalized M.K.S. units), moves with e velocity of light and also has mass of amount m r unit volume of the field. Suppose also that its omentum per unit volume is $\mathbf{D} \times \mathbf{B}$ (where $\mathbf{D} = \kappa_0\vec{\epsilon}$, $= \mu_0\mathbf{H}$, $\kappa_0\mu_0 = 1/c^2$), and consider a unit area of rface normal to the direction of energy flow. Then the rate at which energy passes through this surface $|\vec{\epsilon} \times \mathbf{H}|$, it follows that the amount of *moving* ergy per unit volume of the field is $W = |\vec{\epsilon} \times \mathbf{H}|/c$. s momentum is mc, so if this is to be equal to $\times \mathbf{B}|$, we must have:

$$m = \frac{|\mathbf{D} \times \mathbf{B}|}{c} = \frac{|\vec{\epsilon} \times \mathbf{H}|}{c^2} = \frac{W}{c^2},$$

hich is the mass–energy relation.

Whenever the total 'ponderomotive' force on an ectromagnetic system is not zero, it is equal to the olume integral of $-\frac{\partial}{\partial t}(\mathbf{D} \times \mathbf{B})$ taken over the hole of the dielectric in which $\mathbf{D}$ and $\mathbf{B}$ exist. is therefore balanced by the volume integral of $(\mathbf{D} \times \mathbf{B})$, the time-rate of change of the total ectromagnetic momentum. The interpretation is clearly that this represents the rate of change of ordinary mass-momentum of the energy which is moving about in the changing field, and that the 'equal and opposite' reaction to the unbalanced ponderomotive force is borne by the energy photons.

Newton's Third Law is thus reinstated if the mass of the field energy is taken into account. The theorem applies both to radiating and to non-radiating systems. A simple example of the latter is to be found in the case of a charged particle moving with uniform velocity through a constant-current toroidal coil.

E. G. Cullwick

University College,
Dundee. March 21.

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[1] See, for example, Lorentz, H. A., "Lectures on Theoretical Physics", 141 and 149 (English trans., Macmillan, 1931), in the chapter on "The Inertia of Energy".

Screw Dislocations in Pyrite

In the course of an investigation into the surface structure of a wide range of mineral crystals, the results of which were reported to the Mineralogical Society in March 1951, a number of screw dislocations were observed on the cube faces of one crystal of pyrite, FeS_2. Fig. 1 shows a single screw dislocation; while Fig. 2 exhibits a pair of screw dislocations of opposite sense, which ultimately form an almost closed step-line. The crystal was photographed using a metallurgical microscope, with bright-field illumination, and the surfaces were not silvered. Under these conditions, the very high visibility of the steps forming the main spiral patterns indicates that the layers are multimolecular. This point is further substantiated by the presence of some much thinner layers between the main steps. Examples of screw dislocations with a Burgers vector greater than unity, often considerably greater, have already been reported for cadmium iodide[1], silicon carbide[2], and muscovite[3].

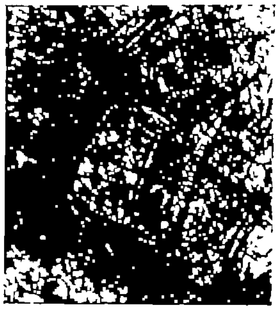

Fig. 1 (× 35)

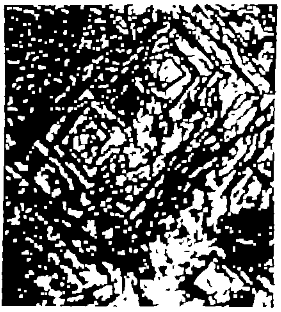

Fig. 2 (× 35)

The incompleteness of the spiral patterns in Fig. 2 appears to be due to the separation of the thickest layers into several thinner ones in some places.

Note added in proof. A paper on the surface structure of crystals is to be published in the *Mineralogical Magazine*.

A. F. Seager

Department of Geology,
Birkbeck College,
University of London,
Malet Street, W.C.1.
July 8.

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[1] Forty, A. J., *Phil. Mag.*, 42, 670 (1951).

[2] Verma, A. R., *Nature*, 168, 430 (1951).

[3] Amelinckx, S., *Nature*, 169, 580 (1952).

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, September 8—Tuesday, September 9

FARADAY SOCIETY (at the University of Toronto, Toronto, Canada).—General Discussion on "The Reactivity of Free Radicals".

Wednesday, September 10

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr A. W. Paxton: "Mud Control in the Fields of the Iraq Petroleum and Associated Companies".*

Thursday, September 11—Friday, September 12

MIDLANDS SOCIETY FOR ANALYTICAL CHEMISTRY (at the University, Birmingham), at 9.30 a.m. each day.—Symposium on "Analytical Chemistry".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CHIEF SUPERINTENDENT OF THE LONG RANGE WEAPONS ESTABLISHMENT, Salisbury, South Australia, to undertake the overall direction and control of the L.R.W.E. which includes certain laboratories at Salisbury and ranges near Woomera—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (September 15).

PRINCIPAL SCIENTIFIC OFFICER at the Propulsion Research Laboratory, Salisbury, South Australia, for supervising a chemical section for research and investigations related to materials for rocket motors and rocket propellants—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (September 15).

SENIOR SCIENTIFIC OFFICER at Royal Aircraft Establishment outstation at Woodbridge, to study problems arising out of the marshalling and landing of aircraft, design, conduct and evaluate full-scale experiments to define principles of methods for achieving high rate of safe handling using electronics or other flying aids; prepare functional specifications for components of such systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A 226/52A (September 15)

HEAD OF THE DEPARTMENT OF MECHANICAL AND ELECTRICAL ENGINEERING—The Principal, Wigan and District Mining and Technical College, Wigan (September 17).

LECTURER (high academic and research qualifications essential) IN CHEMISTRY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W 3 (September 19).

ASSISTANT LECTURER (temporary) IN PHYSIOLOGY—The Registrar, The University, Sheffield (September 20).

DEMONSTRATOR IN ZOOLOGY—The Registrar, The University, Leeds 2 (September 20).

RESEARCH OFFICER (Plant Pathologist) IN THE DIVISION OF PLANT INDUSTRY, Canberra, for plant physiology investigations relating to plant growth—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3059 (September 27).

LECTURER (with a university degree in either metallurgy, chemistry or chemical engineering, and experience in industry) IN THE DEPARTMENT OF CHEMICAL ENGINEERING at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

LECTURER IN VETERINARY PHARMACOLOGY—The Registrar, The University, Liverpool (September 30).

SENIOR LECTURER IN ANIMAL PRODUCTION at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (September 30).

VETERINARY OFFICERS and RESEARCH OFFICERS IN THE MINISTRY OF AGRICULTURE AND FISHERIES—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 130–173/52 (September 30).

SENIOR LECTURERS or LECTURERS (Grade II) IN PHYSICS, CHEMISTRY AND BIOLOGY, at Kumasi College of Technology, Gold Coast—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (October 1).

UNIVERSITY LECTURER IN BOTANY (with special responsibility for teaching and research in plant bacteriology)—Dr. S. Smith, Department of Zoology, Downing Street, Cambridge (October 1).

RESEARCH OFFICER IN THE DIVISION OF PHYSICAL AND ANALYTICAL CHEMISTRY of the National Chemical Research Laboratory in Pretoria, to supervise the analytical work of the Laboratory and carry out research work in the field of inorganic chemistry—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (Pretoria, October 8).

HERBARIUM ASSISTANT (First Assistant on the staff of the Bolus Herbarium), University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 15).

PROFESSOR OF STRUCTURAL ENGINEERING at the University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 25).

PHYSICIST (with a first- or second-class honours degree) in a section engaged on a long-term study of the mechanisms of drainage and drying as applied to the papermaking machine—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

RESEARCH INVESTIGATOR for interesting metallurgical investigat of a new welding problem, and a JUNIOR CHEMIST to assist in rou and special analyses of steels and light alloys and the determinat of dissolved gases by a high-vacuum technique—The Secretary, Brit Welding Research Association, 29 Park Crescent, London, W.1.

SENIOR SCIENTIFIC OFFICER at Experimental Flying Establ ment near Salisbury, to take charge of section dealing with comp design and testing of aircraft instruments and test methods, to ad on methods of measurement of physical quantities in aircraft fli and to give guidance to aircraft industry in methods for maintena and calibration of instruments used in acceptance test flying— Ministry of Labour and National Service, Technical and Scient Register (K), Almack House, 26 King Street, London, S.W.1, quot A.232/52A.

TECHNICAL ASSISTANT (university or similar qualification in ch istry desirable) as secretary to committees dealing with various aspe of chemical standardization—The Establishment Officer, Brit Standards Institution, 24 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATION

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Scottish Marine Biological Association. Collected Reprints, 19 Papers 57–87. (Millport · Marine Station, 1952.) [

Annual Report and Transactions of the Yorkshire Philosophi Society for the Year 1951. Pp. 17. (York: Yorkshire Philosophi Society, 1952.) [

Department of Scientific and Industrial Research: Pest Infestat Research. Detection of Insects by their Carbon Dioxide Producti By R. W. Howe and T. A. Oxley. Pp. ii+20. (London: H Stationery Office, 1952.) 1s. net. [

John Innes Leaflet No. 11. Artificial Illumination of Seedlin Pp. 8. (Edinburgh and London: Oliver and Boyd, Ltd., 19 9d. net. [

Units and Standards of Measurement employed at the Natio Physical Laboratory. 3: Electricity; Current, Voltage, Resistan Power, Energy, Inductance, Capacitance, Frequency, etc. Pp. (London: H.M. Stationery Office, 1952.) 9d. net. [

Other Countries

Institut Royal des Sciences Naturelles de Belgique. Mémoi Deuxième Série, Fasc. 40: Revision de la famille des Alcyonidæ genre Sinularia May 1898. Par Andrée Tixier-Durivault. Pp. Mémoires, Deuxième Série, Fasc. 41: Holothuries de l'Institut Ro des Sciences Naturelles de Belgique. Par Gustave Cherbonn Pp. 65+28 plates. Mémoires, Deuxième Série, Fasc. 42: Ammonites du Bajocien de la region frontière Franco-Belge (B Septentrional du Bassin de Paris). Par Dr. Pierre L. Maubeu Pp. 104+16 plates. Mémoires, Deuxième Série, Fasc. 43. Résult scientifiques des Croisières du Navire-Ecole Belge *Mercator*, Vol. Pp. 23. (Bruxelles: Institut Royal des Sciences Naturelles de Belgiq 1951.) [

Acta Geneticae Medicae et Gemellologiae. Revista Internazion Quadrimestrale. Vol. 1, N. 1, Januarii. Pp. 112. (Roma: A Geneticae Medicae et Gemellologiae, 1952.) Subscription, 5,000 li £5. [2

Annuaire de l'Académie Royale de Belgique, 1952. Pp. 186+ (Bruxelles: Académie Royale de Belgique, 1952.) [

Bulletin of the Madras Government Museum. New Series, Gene Section, Vol. 6, No. 1: Possible Sumerian Survivals in Toda Ritu By H.R.H. Prince Peter of Greece. Pp. xvi+25+10 plates. (Madr Government Press, 1951.) 6.4 rupees. [

Fisheries Research Board of Canada. Bulletin No. 93: The Stat of the Harbour Seal in British Columbia, with particular referen to the Skeena River. By H. D. Fisher. Pp. iv+58. (Ottawa: Fisher Research Board of Canada, 1952.) 50 cents. [

Journal of the Fisheries Research Board of Canada. Vol. 8, No. Limnology and Trout Angling in Charlotte County Lakes, New Bru wick. By M. W. Smith. Pp. 383–452. (Ottawa: Fisheries Resear Board of Canada, 1952.) [2

South Australia. Report of the Museum Board, 1st July 1950 30th June 1951. Pp. 7. (Adelaide: Government Printer, 1951.) [2

Union Géodésique et Géophysique Internationale. IXe Assembl générale. Comptes rendus. Pp. 30. (Bruxelles: Union Géodésiq et Géophysique Internationale, 1952.) [

Smithsonian Miscellaneous Collections. Vol. 117, No. 7: Relationships of Moths of the Genera Depressaria and Agonopter with Descriptions of New Species. By J. F. Gates Clarke. (Publi tion 4083.) Pp. ii+20. Vol. 117, No. 8: The Sand Crab *Emer talpoida* (Say) and some of its Relatives. By R. E. Snodgrass. (Pu lication 4086.) Pp. ii+34. (Washington, D.C.: Smithsonian Instit tion, 1952.) [2

Bulletin of the Museum of Comparative Zoology at Harvard Colle Vol. 106, Nos. 8 and 9: Foraminifera Ecology off Portsmouth, N Hampshire, by Fred B. Phleger; and Foraminifera Species off Por mouth, New Hampshire, by Frances L. Parker. Pp. 313–424 plates. (Cambridge, Mass.: Harvard College, 1952.) [

Catalogues

B.D.H. Concentrated Volumetric Solutions. Pp. 4. (Poole: Brit Drug Houses, Ltd., 1952.)

Marconi Instrumentation. Vol. 3, No. 5, May. Pp. 69–88. (Albans: Marconi Instruments, Ltd., 1952.)

Laboratory Specialities: a Selection of Recently-developed Equi ment for use in the Modern Laboratory. (Catalogue No. 16B- Pp. 64. (London: Griffin and Tatlock, Ltd., 1952.)

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APPLICATION OF SCIENCE IN INDUSTRY

THE Messel Memorial Lecture, "The Strategy of Science", which Sir Henry Tizard delivered to the Society of Chemical Industry in Aberdeen on July 9, is above all a challenge to constructive and penetrating thinking about the balance of research effort in Britain, its orientation and distribution as between industry, government and the universities, and the development of technical and technological education. It indicates, rather than asks, the questions which should be put and answered before policy in such matters is determined, and in this way provides the atmosphere in which the recent report of the Advisory Council on Scientific Policy in presenting the report of its Committee on Manpower, or the more recent survey of scientific and industrial research in British industry of the Federation of British Industries, should be examined. It lends strong support to some of the recent representations made to the Lord President of the Council by the Parliamentary and Scientific Committee (see *Nature*, August 16, p. 267).

Sir Henry's address (*Chemistry and Industry*, August 16, p. 788) is, in fact, largely an exposition of the theme that large endowments afford no assurance that research will be wisely and profitably directed. Money can be wasted on research as easily as on anything else, and his discourse stems essentially from a typically shrewd comment made to him many years ago by Lord Rutherford on learning of a large endowment for research received by a physics laboratory in the United States: "We haven't any money", remarked Lord Rutherford, "so we've got to think"; and the core of Sir Henry's address lies in his insistence that it is imperative for us to select the right targets in research and development. We cannot afford to waste first-class men on second-class objectives. We must think out the objectives that really matter, and then be bold and adventurous. Without adventure in industry Great Britain is doomed to decay.

Sir Henry took a sombre view of Great Britain's economic position; he thinks that the present state of instability is likely to persist. He went so far as to suggest that lack of industrial effort and failure to apply the right policy are due at least in part to insufficient realization of the serious state of affairs. This in turn is due, he believes, to the neglect of political leaders to explain frankly to the working population the dangerous condition of the economic structure of Britain. So far from that being one of temporary instability due to the War or to the mistakes of politicians since the War, for many years before the Second World War we had been in a state of unstable equilibrium, exposed to the force of any adverse world event outside of our own control. He believes that the ultimate solution of the economic problem of Great Britain will only be found in a better distribution of the population throughout the British Commonwealth. Even as an agreed policy, such a redistribution would take a long time to effect.

Meanwhile, we must endeavour to balance our trade as best we can by exporting what the world wants and needs, in the face of severe competition. This obviously depends largely on the good judgment with which science is applied to industry, and especially on the swiftness with which action is taken to secure the appropriate balance between science and technology. Sir Henry did not conceal his impatience for action rather than talk.

It is from this point of view that Sir Henry urged that strategy is more important than tactics. By the strategy of science he means the art of so directing the application or advance of science as to ensure the most rapid progress of society, or of knowledge. Tactics, on the other hand, is the procedure or skilful devices calculated to gain the strategical end, or in another word, 'research'. The strategy of the application of science to industry must depend not only on available tactical skill and knowledge, but also on the economic circumstances of different countries. It demands constant fresh and flexible thinking about our economic circumstances and searching inquiry as to our reasons and objectives.

Curiously enough, although it is apparent that Sir Henry believes that some redistribution of population is required as a long-term policy—and such redistribution has obvious implications for both the industrial and the economic strategy of Great Britain—he does not here consider specifically their bearing. The strategy he advocates for science is clearly to be based on fresh thought about all issues, but in the first place he suggests we should concentrate on the effective application in industry of existing knowledge. As in his presidential address to the British Association four years ago, he urges that this is our first need. We are still paying too much attention to fundamental research in industry, and too little to the need for development and skilled application. A more severely practical view of industrial research is essential if we are to recover economic stability, and Sir Henry quoted with approval the article on the role of science in the British economy in which Dr. R. L. Meier developed this theme two years ago. We must concentrate our efforts, he said, on those projects which will help to restore the balance of trade, directly or indirectly, as quickly as possible, and be careful to avoid dispersing them over too wide a field. Not until we have an overall balance of trade in our favour for at least five successive years can we afford, Sir Henry thinks, to spend much time, thought or money on developments which, however desirable in a perfect world, are not vital to our existence. Neither the scientific prestige of the nation nor the quality of scientific education is likely to suffer by such a policy of strengthening our technology rather than expanding our science.

Sir Henry's note of urgency in this connexion reinforces the representations made to the Lord President of the Council by the Parliamentary and Scientific Committee on July 28; but there is a further point which is causing Sir Henry some concern. Referring to the bearing of judgment on the selection of the right objectives as a prelude to any redistribution in our research effort, and the consequent difficulties in reaching agreement as to the targets that matter, he pointed out that we have still to secure concerted action. No common policy, for example, has yet been agreed by the nationalized fuel industries, and even in the most scientific of British industries, the chemical industry, there is reason for disquiet. The highest executive positions in such industries have long been occupied by well-known men of science or technologists; and the various companies which make up, for example, the chemical industry, would pass all ordinary tests of technical or financial efficiency with ease. Nevertheless, the industry is apparently not succeeding in competing in the world market. The British share of world trade in chemicals has been slowly declining since 1913, when the condition of the chemical industry was very different, and in spite of the high standard of chemical science in Britain and the large expenditure of the industry on research.

Sir Henry does not believe that this can be attributed to the quality of chemists engaged on research in the industry being lower than in other countries. Nor does he appear to blame faulty judgment on the part of the directorate of the industry—though some chemists may think he is less than fair to the British industry in his remarks regarding the exploitation in other countries of the discoveries of British industries. Still less does he attribute it to inadequate financial resources. In defence research and development, he remarks, we do not spend one-fifth of what is spent in the United States but we have held our own, and have often led the way.

Shortcomings, in Sir Henry's view, appear to be mainly due to slowness of production from the prototype to the full scale. For this, two factors are chiefly responsible: first, a fiscal policy which discourages enterprise and adventurousness, and second obsolete social attitudes and trends in the educational field which hinder as many boys of outstanding ability as is desirable in the national interest from entering on a scientific career. This second is a consideration which is fundamental to the development of higher technological education.

Sir Henry's forthrightness on the first point is highly significant, coming from one who has recently retired from the chairmanship of both the Advisory Council on Scientific Policy and the Defence Research Council. Possibly his release from official responsibilities may leave him freer to urge publicly views based on his own wide experience, which may yet require a large measure of public support to secure their adoption by official establishments not yet awake to the implications of the strategy of science. Meanwhile, his position with the National Research Development Corporation has not inhibited him from voicing his misgivings as to the possible adverse effect of such experiments on the adventurousness of industry. Sir Henry recognizes that the Corporation has important functions to fulfil. He sees none the less that, in discharging them, there is a real danger that industry may be encouraged to expect the nation to carry the financial risks of development.

Sir Henry's misgivings on this score are justified by reference to the engineering industry. He main-ains that in recent years defence research and evelopment at the cost of the taxpayer, rather than rivate enterprise, have provided the chief stimulus o British engineering of the highest quality. In his udgment, more money is spent by the taxpayer on ngineering development than is spent by all the ngineering industries put together, and he fears that here is danger of this spreading, and of the taxpayer aving to take risks which formerly were taken by rivate enterprise.

The strategy of science in Britain, accordingly, ust take account of the distribution of research etween industry and government institutions, as ell as between industry and the universities. There re important questions to be considered before llocating the execution of a particular project that rightly judged essential to the national interest s between industry or a government institution; here the project is carried out may not prove to be secondary matter. It may affect vitally the stimuation or encouragement of the skill, originality and nterprise which, whether in engineering or in other elds, must be allied to research, development and esign if we are to increase our share of the world's rade. Sir Henry has already formed the conclusion hat the springs of enterprise in Britain are running own, and that unless industry is able and allowed o increase its capital expenditure, and does it wisely, t is idle for scientific men to complain that their iscoveries are exploited elsewhere.

Our strategy must thus first and foremost encourage nterprise, and as one element it must break with he present practice of leaving the responsibility for eciding whether any branch of industry shall spend nything on new ventures largely with Civil servants n government departments. A thorough and thoughtul analysis of Government expenditure on civilian esearch, particularly in relation to production, and ts organization, might also yield some useful tactical uggestions. But the main threat to industrial nterprise in Britain lies in taxation policy, and no trategy will be adequate which does not insist on he removal of financial as well as other elements hich discourage adventure in industry or in science. or should it be forgotten that financial restrictions nd controls can also discourage enterprise and lead o far-reaching delays and frustration, apart from a erious waste of scientific and technical man-power. uch consequences are sufficiently serious to warrant he wish that every existing restriction or control ould be reviewed and no new one promulgated apart rom the critical and constructive thinking implied Lord Rutherford's remark, "We haven't any oney so we've got to think".

Sir Henry's strategy of science demands above all reative and critical thought and a spirit of adventure. o develop skill and originality, to foster adventurousess and sound judgment, to select the right objectives nd to distribute wisely our limited resources of an-power and materials are the main elements; nd some clear indications are given as to the tactics be used, notably in the field of technical and echnological education, where Sir Henry's impatience r action is manifest. Here he calls for a determined effort to overcome a difficulty referred to by the Advisory Council on Scientific Policy and discussed at a greater length in a second article by Dr. R. L. Meier, "Research as a Social Process", in the *British Journal of Sociology* last year. Sir Henry condemns the kind of intellectual snobbery which discourages many an able man from studying technology at a university; our tactics must be calculated to break down such snobbery and all other attitudes which discourage a sufficient proportion of the ablest minds of each generation from entering on careers in science and technology, or moving freely within those spheres whether in industry, the universities or the departments of State. Dr. Meier in his second article points out that the evolution of the organization of research has been in conflict with the traditional values of the man of science, and the distribution of our research effort has been determined by social status more than is commonly realized. An adequate strategy of science must take full account of such factors and their effect on specialization, as well as on the communication between groups. It must provide the tactics for enticing more of the ablest intellects, who would otherwise limit their activities to science, into responsible positions in industry and in applied research, and for encouraging the training in our educational system of those capable of forging links between the different disciplines, thus carrying further the type of co-operation that has proved outstandingly successful in what is known as 'operational research'.

Scientific workers and industry in general are much indebted to Sir Henry Tizard for his stimulating and suggestive Lecture. Their response to his imperative and urgent call to action as well as to thought could do much to impel Government action in some fields where it has been long overdue.

BIOCHEMISTRY AND BIOLOGY OF ANTIMETABOLITES

A Study of Antimetabolites

By D. W. Woolley. Pp. xiii+269. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 40*s*. net.

THE publication of "A Study of Antimetabolites" is most timely, and, when it is written by a master of the subject like Dr. D. W. Woolley, of the Rockefeller Institute for Medical Research, it is certain to receive a most hearty welcome. The subject has had a slow and difficult birth from the time Ehrlich, in developing his experiments on immunity and, later, on chemotherapy, propounded the idea of 'receptors', and so emphasized that chemical specificity is a dominant factor in cell life. This was followed in the enzymic field of study by the discoveries of Michaelis (1910–14) and his collaborators that some inhibitors are similar in chemical structure to the products of the reaction. In Great Britain the extension of the idea of antagonism of enzymic action to analogues came to the fore with the work of Quastel and Wooldridge in 1927, when they described the competitive inhibition of succinic dehydrogenase by malonic acid, a structural analogue of the substrate of the enzyme. Other work which supported this conception came gradually to light, but the great modern interest and eagerness to examine the hypothesis began seriously when Woods in 1940 extended the subject to the chemotherapeutic field by reporting that the bacteriostatic action of sulphanilamide and related sulphonamide drugs was reversed completely and competitively by *p*-amino benzoic acid, which later was shown to be an essential metabolite of bacteria.

Since that time, Dr. Woolley and many others have found numerous instances of inhibitors of cellular reaction based on this form of interference, and the subject of antimetabolites must now be regarded as one of the fundamental hypotheses of biochemistry. It has shed light on living responses other than those of an enzymic and chemotherapeutic nature, such as hormonal interaction, pharmacological antagonism of drugs and vitamin deficiency diseases. Thus the close similarity between the structure of testosterone and œstrone suggests a basis for the well-known antagonism of androgens and œstrogens in higher animals, and for the regulation of sexual characters by a balanced reaction between these substances. In the sphere of vitamin activity, we find evidence of structural antagonism in the fact that typical signs of vitamin B_1 (aneurine) deficiency in mice can be called forth by pyrithiamine, and that glucoascorbic acid can elicit a condition in mice similar to that seen in scurvy in man. Dr. Woolley himself has been particularly interested in the pellagra-producing effect of maize; and, although he has not isolated the essential active antagonist to nicotinic acid, he has given reasons for believing that there is such a substance and that it may well be related to β-acetyl pyridine, which certainly is an antagonist to the antipellagra vitamin. It is to be hoped that this problem will prove more straightforward than that of the rachitogenic action of oatmeal, where it was found that the struggle for calcium by phytic acid and phosphoric acid was decided by the presence of vitamin D.

While Dr. Woolley has assembled the essential facts—up to 1950—which have poured as a stream into the crucible, and has described and discussed them in their proper place, he has emphasized throughout that the hypothesis will require modification as the subject develops. This critical and philosophic attitude, and the realization that the antimetabolite hypothesis is only serving as a support for the acquisition of new facts which will in time require new scaffolding is one of the many attractive features of the book. It is already clear that there are, at present, many inexplicable difficulties, and that some of the reactions described are undoubtedly more complicated than is now apparent; but the great merit of the theory is that it will continue to stimulate greatly the acquisition of new knowledge of biochemical reactions and, it is hoped, of biological processes themselves.

Now that Dr. Woolley has put his hand to this particular plough, we look to him not only to discover many new facts and the generalizations that may be necessary to account for them, but also to continue to enlighten and delight us with further editions of this book as the subject unfolds. Biochemists and biologists will undoubtedly take the opportunity of profiting by the book, and of appreciating the new vistas now opened up by this intellectually pleasing hypothesis so well presented as a complete story by Dr. Woolley.

E. MELLANBY

A PHILOSOPHY OF MANAGEMENT

The Art of Administration

By Ordway Tead. Pp. xvii+223. (London: McGraw Hill Publishing Co., Ltd., 1951.) 32s.

NO reviewer could do better than echo Stuart Chase's commentary on Mr. Ordway Tead's latest publication: "this is a fine thoughtful book obviously the climax of a lifetime of study, meditation and active participation in the art and science of administration". For more than a generation Mr Tead has been high among the classical authors in the American literature of industrial management interested primarily in its philosophical aspects and concerned always to urge the practical executives to be more alive to a depth of fundamental thought on which to rest their practice.

In this new study, Mr. Tead takes up again his favourite themes of the essentially human core of management and of its bearing on the everyday working of the principles of democracy. Here, he has always believed, lie the major problems of the twentieth century. Several chapters take up this theme from various points of view, examining not only the ways and means of getting "leadership in action" within a democratic framework, but also many of the difficulties to be encountered. Perhaps for the first time Mr. Tead is now willing to recognize that "in a democracy people have to be only as free as they want to be". Effective leadership is always the key to efficient action—and without any intention either of cynicism or of paradox, one may posit as the central principle of democracy the institution o the selected authority that can govern the many to the satisfaction of all. How this is done is the content o Chapter 9, "Administration as Democratic Leadership".

In the narrower context, Mr. Tead's thesis i admirably summed up in a passage in the foreword contributed by Mr. L. Appley, president of the American Management Association: "We, the contemporaries of the age", he writes, "are coming to realise that management is a career and that its effective exercise is based upon the understanding o human motivations, sensitivity to the means o sensing human responses, and skill in supplying human satisfactions". What is involved in such skills forms the main substance of this book—the skills o leadership, not peculiar to the industrial world though the analysis is here carried out in relation to the management of industry. A most useful chapte is the one entitled "Human Nature in Action" revealing in a very practical way the raw materia with which every executive at every level has to work. How the leader has to apply his skills to thi material is fully studied and the lines of approach se out for his guidance. He is warned, in anothe valuable chapter, on "Personal Power and Authority in Administration", of the dangers and pitfalls tha will beset him because of his own frail human makeup: "the exercise of personal power over or with others is one of the ways in which we get a sense o worthwhileness, of registering with others, of maximising our egos". This line of thought is profoundly reminiscent of Mary Follett twenty-five years ago.

This is not a text-book of management practice it is more valuable than that, and more unusual. It philosophical character may, perhaps, not make quite the strong appeal in Great Britain which the autho has commanded in the United States, but its though and teaching are of immense value to the immediate ɔds of Britain. For British readers, the choice of le is unfortunate, for it will serve to revive a ıtroversy that has latterly been laid to rest. The ɔcess that Mr. Tead has been studying is now almost ıversally called 'management' over here, and the ɔtagonists of 'administration' are fast dwindling. ır is there any more a divergence about 'art v. ence': the process of management is now recog- ːed as a skill that partakes of each. Mr. Tead ɹuld have served his cause the better by calling his ok, say, "A Practical Man's Guide to Leadership".

E. F. L. Brech

ADVANCED TEXT-BOOK OF ORGANIC CHEMISTRY

ıemistry of Organic Compounds

ɣ Prof. Carl R. Noller. Pp. ix+885. (Philadelphia ıd London: W. B. Saunders Co., 1951.) 35s.

ꓷCHOLARSHIP, much teaching experience and an appreciation of the worth of organic chemistry ıve gone to the making of this book. Its author, ofessor of chemistry at Stanford University, ts out his subject-matter in forty-two chapters. ʌo of these are mainly devoted to theory; the st, as well as the customary elementary matter, ɔal with more advanced topics, such as heterocyclic ımpounds, synthetic rubber, fluorinated aliphatic ımpounds, amino-acids, steroids, organic peroxides, ıd compounds of phosphorus, of silicon and of etals. The contents are intended for the first two ɔars of a course for university students.

Prof. C. R. Noller is aware that the ever-increasing ass of facts of organic chemistry can be seen as an dered array and intelligently studied only if a ıowledge of the underlying physical principles and modern ideas of molecular structure have been so astered that they can be applied. He is likewise ʌare that many a student has not the mathematics command necessary for the latter task: he there- re makes use of bold simplification. Thus, of the ʌo approaches to the structure of a molecule, he ɐfers to begin with that of the molecular orbitals ıd to introduce these by the geometrical method ɔpularized in Great Britain by Prof. C. A. Coulson. mplification is also effectively used in Chapter 7, hich is devoted to an exposition of reaction mechan- ɯ, a subject on which the author lays much nphasis because of its integrating value. Here, aders meet the brilliant teacher. First, he recalls ɪe factors concerned with equilibrium; then by eans of diagrams, logical argument and simple athematics, he proceeds to explain the different echanisms. Several illustrative examples both of nic and of free radical mechanisms are discussed at ınsiderable length. Once again Prof. Noller directs tention to the work of British chemists, singling ıt for mention C. K. Ingold and his collaborators ıd paying a special tribute to the late Prof. A. ɐpworth. The theoretical principles established in ɐse two chapters are extensively applied in the ɔdy of the book. Thus, the chapter on aromatic tro compounds has several pages on the mechanism substitution in the benzene nucleus and includes ɪe modern theory of nitration.

The forty well-written chapters of descriptive atter abound with distinctive characteristics, but ɔnsiderations of space permit the recording of only few examples. For example, Chapter 17 gives a concise, but in itself complete, account of stereoisomerism and includes a masterly exposition of the determination of the configurations of the sugars, while Chapter 31, on dyes, opens with a discussion of the subject of colour and of its relation to chemical constitution.

An exceptionally full index (forty-five pages), historical footnotes, frequent and absorbing digressions on economic aspects, and devices to aid study (such as the use of two sizes of type and the numbering of the carbon atoms in big molecules) do not complete the list of attractive features. In short, this stimulating and inspiring book should afford the student just the help he needs. "Noller" will undoubtedly take a high place among the great instructional books of organic chemistry.

G. Fowles

POCKET ATLAS OF THE SWISS FLORA

Taschenatlas der Schweizer Flora

Mit Berücksichtigung der Ausländischen Nachbarschaft. Von Eduard Thommen. Zweite, vermehrte Auflage. Pp. xvi+309. (Basel: Verlag Birkhäuser, 1951.) 13.50 francs.

THIS booklet, of a convenient pocket size, contains more than three thousand black-and-white drawings of the ferns and flowering plants found in Switzerland and the adjacent areas of France and Germany. The drawings are carefully executed and reproduced; but their small size and the fact that they are rather crowded, with some dovetailing, makes it rather difficult to recognize all the species, even though detailed drawings of characteristic portions of flowers and fruits are given. The author himself considers that his drawings are best used in conjunction with one or other of the existing non-illustrated Floras of Switzerland. The fact that the present issue of the Pocket Atlas is a second and enlarged edition is proof that it has served a good purpose.

Below each row of drawings the author gives the Latin, German and French names of the plants, and he indicates by a small initial letter the colour of the flowers. In addition there are twenty-two pages in which some systematic, geographical or general information concerning many of the plants is given. The author generally informs his readers, when that is the case, that the plant to which he refers is not a native of Switzerland, but has become naturalized either by spreading by natural means from adjacent areas or by human agency. This latter will have been the case with such trees as *Catalpa* and *Paulownia*. It is a pity that in some instances no such information is given. Some readers may therefore not know that *Sarracenia purpurea*, which is figured, is a native of wet bogs in North America. It is not a Swiss plant, but may be found at least in one locality about 1,000 ft. above the Lake of Geneva, where it was planted many years ago and has since flourished. The author might also have mentioned the interesting fact that it is an insectivorous plant. But he has been rather chary about letting readers know that other plants like *Drosera*, *Pinguicula* and *Utricularia* are insectivorous. It is a pity that interesting information of this nature or of ecological facts is not given in the notes. It would be useful to reconsider this matter if a third edition is contemplated.

F. E. Weiss

SCIENCE AND AN EXPANDING AGRICULTURE*

By Sir WILLIAM SLATER, K.B.E.
Secretary of the Agricultural Research Council

WHEN the growth of a people has overtaken the supply of food and raw materials from the available land, they have either sought new land to exploit or by better farming produced more from that which they already had. This pattern of expanding agriculture has been continuously repeated throughout the history of civilization.

In England the earliest village communities based on the Saxon manor were self-supporting, the transport of heavy goods from one part of the country to another being almost impossible. As travel became more common in the fourteenth century, the wealthier people began to want luxuries from the Continent. To buy these goods, wool and woollen textiles produced from sheep grazing the English downlands were sent in exchange. So specialized farming began, and the system of exchanging the products of one type of farming for those of another was introduced. This trade greatly strengthened and enriched the life of the static farming communities.

By the seventeenth century the then known methods of expanding the production of food and raw materials were no longer sufficient to meet the demand, and science for the first time came to the aid of agriculture, by showing how more waste land could be brought into use and how the output of the existing farms could be further increased. The application by farmers of the knowledge which was being made available during this and the following centuries was slow, perhaps not surprisingly at a time when the old well-tried methods served to produce enough to give the farmer a satisfactory living. But whereas farming was prosperous, the production of food in Great Britain was not keeping pace with the needs of the now rapidly growing population in the industrial towns. So once more the common pattern adopted by a community in search of food was repeated. There seemed no immediate possibility of an increased yield from the acres of existing farm land, so attention was turned to finding new undeveloped land. Transport, already greatly improved and soon to be revolutionized by the steam engine, had made accessible the vast empty lands of the Americas, and of the southern hemisphere. It was to these lands the people of Britain turned for their food. First they began to grow wheat on the rich virgin soils, then to send their livestock to graze the native pasture.

The system of production used, which might be called static nomadism, had a number of characteristics worthy of note. First, no attempt was made to apply science in the utilization of the new lands, partly because the pioneers did not know what questions to ask; partly because the man of science could not have answered the questions which should have been asked without extensive research. Secondly, the food produced was cheap, being subsidized by continuous drawings on the capital reserves stored in the virgin lands and by the use of native labour. Cheap food, combined with intensive industrial specialization, resulted in cheap manufactured goods, which could be advantageously exchanged with other countries. Thirdly, this extremely advantageous economic system was entirely dependent on keeping transport moving freely; if it were interrupted the den population must starve. Fourthly, the nation livin in this way had to be powerful enough to preven others encroaching on its food-supplying areas.

The United Kingdom exploited this way of livin successfully for a hundred years; in the end to successfully. So great became the quantity of chea food that it almost ruined our own farmers, whi the capital assets in the virgin soils on which it dre were being rapidly exhausted.

When war partly blocked our transport lines du ing 1914–18, British agriculture had to try to f the wide gap between our needs and our supplie The farmers, who had changed their methods litt in the past fifty years, set about their task not b trying to increase yields but primarily by bringin back into cultivation land which had been allowe to fall down to indifferent grass during the years depression. For a short time farming was prosperou but once ships began to move freely again the pressu of cheap food from overseas was too great to resi and the products of British farms were no longe wanted.

Science could claim little part in the food pro duction campaign of 1914–18, but the study of agr cultural science was greatly stimulated by the fir danger of famine Great Britain had known for mor than seventy years.

Before the First World War, a number of far sighted men had pointed out that British agricultur if it were to survive, must adopt new methods base on scientific knowledge, and that these could onl be worked out in the laboratory and on the exper mental farm. In 1909, research for the advancemen of agriculture received its first direct State-ai through the Development Commission, and plan were laid for the expansion of the work at Rotham sted, Long Ashton, the universities and the agr cultural colleges, and for the establishment of number of new institutes. Under the stimulu created by the War, rapid progress was made, lab oratories were built and equipped and young me recruited. Within a few years, however, depressio hit not only agriculture but the whole country. Th research institutes carried on with their work, bu growth was halted and recruiting almost ceased fo fifteen years. We are constantly reminded to-day o these blank years by the dearth of men in agricultur research between the ages of forty and fifty-five.

When a Second World War again disrupted ou transport lines, this time more effectively than i 1917 and 1918, the farmers, with the help of th scientific workers, led a revolution in food productio Once more there was a great ploughing up of gras land, but it was accompanied this time by increase in the yield per acre and per beast. The joint effort of farmers and men of science showed clearly tha Britain need no longer depend on the continuou exploitation of virgin lands to meet our needs. W can produce on our farms at home, and in othe lands settled by our own people, the food we want but to do this we must develop research to the fu and apply the findings vigorously in practice.

The value of research was recognized, and betwee 1944 and 1946 the late Sir John Fryer, the the secretary of the Agricultural Research Council, pre ared a plan for the development of research which was expected to be completed in ten years. This ncluded the enlargement of existing institutes and he establishment of new ones in subjects for which facilities were not already provided. The plan has rogressed, not altogether at the scheduled pace, but teadily and without serious omissions. Delays have not been due to lack of money, but to the shortage f trained men and the lack of buildings. We have earnt again that research cannot proceed in jerks, attempting to make up in a few years the neglect of many. If research is to be successfully developed, there must be a steady recruitment of scientific staff. Since it becomes known that men are no longer wanted for any particular type of work, entrants to the universities avoid training leading to it, and when recruitment begins again there are few applicants with suitable training. The flow of entrants to the universities starts afresh with the knowledge of vailable openings, but it is five or six years before hese students are ready to take the most junior esearch posts. Now that the men who entered the universities after the War are available, the supply of man-power has improved and the chief difficulty ests in getting building work completed. There is, however, on every side goodwill towards the agricultural research service and great enthusiasm among he workers. With these assets the difficulties nherent in our present economic troubles can be overcome.

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* Substance of an Evening Discourse delivered at the Belfast meeting of the British Association on September 8.

The need for the vigorous application of the results of research in farming has also been recognized by the setting up of a chain of experimental husbandry farms and horticultural stations, to apply the findings of the research institutes under different conditions of soil and climate, to carry out experiments affected by local conditions and to take the place occupied by the pilot plant in the chemical industry.

This general acceptance of the value of research work and the importance of the application of its results in agricultural practice is part of a great change in our national outlook, in that it is now generally accepted that our hope of survival as a nation depends on greater output from our farms. Not unnaturally, the bulk of the nation, who are neither farmers nor men of science, wish to know what is involved before they commit themselves to a programme designed to give a high output on existing farm-land and to render fertile and bring into full use land of low productivity. They may recognize that it is the only alternative to starvation, but still they rightly wish to know what is the cost.

Sir John Russell made a brilliant summary of the means by which food production can be raised in his presidential address to the British Association at its Newcastle meeting. Anyone hearing or reading that address must be convinced of our technical ability to achieve an enormous increase in food production. Sir John, however, added this warning : "If more food is needed, more work must be done to earn it". It is clear from the context that Sir John was referring not only to work on the land ; he was also speaking of the work involved in producing the equipment and supplies needed for an expanding agriculture.

There is a true parallel between the great war-time projects and a major drive for increased food production. It may be suggested that in war there is the consciousness of immediate danger not present in time of peace acting as a spur to common effort and sacrifice ; but famine, although it may be a less tangible enemy than an advancing army, is even more deadly and more ruthless. Again, it may be argued that war-time projects, often great in conception and large in scale, fire the imagination so that the most humble duty gains an added sense of importance and urgency, whereas agriculture, lacking these qualities, reduces all effort to the common daily round of work. This may have been partly true in times when farming methods were static, when tradition ruled over everything ; it is certainly untrue of an expanding agriculture and of the scientific work which makes the expansion possible.

If we look at the work which is already being done and that which is projected in the British Isles and elsewhere throughout the Commonwealth, we find projects as large and as daring as anything attempted in war. Here are some examples.

The first is a story of land infertile due to lack of water turned into rich farm-lands by the irrigation engineers, and of their titanic scheme to change the course of a river and send part of its waters to double the irrigated area. The Great Dividing Range of mountains follows closely the east coast of the Australian continent, until reaching the extreme south it turns at right-angles to run due west. In the south-east, roughly where the range makes its sharp turn, the land rises to its greatest height in the Snowy Mountains of more than 7,000 ft. Here there is an area of 40 square miles with an altitude of more than 6,000 ft. and an annual rainfall at the highest points of more than 100 inches. From these snow-covered mountains rise the Murray River and its great tributary, the Murrumbidgee, to flow westwards through New South Wales and Victoria, behind and parallel to that part of the Great Divide that runs westward from the Snowy Mountain area. The moist winds from the sea leave most of their water on the slopes of the Great Divide, so that the country through which the Murray and the Murrumbidgee flow, on the landward side of the mountains, has a low rainfall of from 20 inches near the mountains to 10 inches farther inland. The soils of the river valleys are alluvial ; much of the area is covered with good red-brown earths and other fertile soils, but without water they are of little agricultural value. Engineers, by building dams and cutting canals, have carried the water from the river to irrigate each year an area of more than a million acres—about twice the area of the county of Derry—of fertile land. From sparse grazing it is now producing milk, butter, beef, pork, fat lambs, fruit of all kinds, and rice. More dams and canals are under construction, which will irrigate further areas of equal size, making a total of land irrigated each year of more than two million acres. In addition, water for domestic purposes and stock is supplied to a much larger area. These extensions will have absorbed all the available water from these great rivers. No definite estimate has been made of the increased production which will follow the completion of this great network of irrigation, but on the basis of the output figures available for the present irrigation areas in Victoria, where 680,000 acres have yielded £15,000,000 worth of produce, it should be of the order of £40,000,000.

This is a large and ambitious scheme, and the Federal and State Governments might well have been content to rest on their laurels ; but there will still be much good land left unwatered when every available acre/ft. of water has been taken from the Murray and the Murrumbidgee, so the engineers have considered another plan.

Rising in the same area as the Murray and the Murrumbidgee is the Snowy River; but it flows not west into the dry plain, but south through well-watered country to the sea. To the Australian, who is, over a large part of the continent, always fighting drought, this appeared grossly wasteful. If, he argued, this water flowed west into the Murray valley instead of south into the sea, then at least another million acres could be intensively irrigated. But a mountain range lay between the head waters of the Snowy River and those of the Murray and Murrumbidgee, so this seemed no more than an idle dream of what might have been, until the engineers and geologists got together and produced a scheme—now accepted by the Federal and State Governments—by which a large part of the waters of the Snowy River will be taken through two great tunnel systems under the mountain peaks and discharged on the western side into the Murray and the Murrumbidgee. The tunnel to the head waters of the Murrumbidgee will be 15 miles long, with a sectional area of 900 sq. ft. (the Simplon tunnel is 12·3 miles long), that to the Murray is to be in three sections, the first 8 miles long, with a sectional area of 700 sq. ft., the second 9½ miles long, with a sectional area of 1,150 sq. ft., and the third 4½ miles with a sectional area of 1,500 sq. ft. The cross-section of the tunnel is increased as it picks up water from other tributaries through vertical shafts. In addition to these main tunnels the scheme involves many subsidiary tunnels, seven great dams with storage capacity of more than 3,000,000 acre/ft. and more than 400 miles of race lines. Apart from its agricultural importance in making possible increased production of the order of £20,000,000 a year, the scheme provides for the generation by water-power of 2½ million kilowatts of electric power.

This surely is a project to fire the imagination and to call forth a great co-ordinated effort; it is as exciting as the original exploration of the Australian continent and calls for courage equal to that shown by the early explorers.

This, it is true, is only one scheme, large in scale and dramatic in its daring conception, but it illustrates well what the engineer is now doing in many parts of the world, and can do increasingly in the future, to bring water to arid but otherwise fertile land. The cost of irrigation may be high, but so also is the return.

There are deserts which do not lack water, but where the land is barren, due to the absence of one or more of the elements essential for plant or animal growth; the amount of the missing element required is often very small and large areas of land can be made fertile at relatively low cost.

In parts of Scotland and the south-western counties of England a nutritional disease of sheep has been recognized for more than a century. The name 'pine' describes the disease well; the young lambs gradually waste away and die. The only remedies known were to move the lambs to unaffected pasture or to bring soil from other districts and give it, mixed with water, as a drench. The same symptoms were observed in other parts of the world, particularly in Australia and New Zealand. It was thought the disease might be a form of anæmia, and ferrous sulphate was tried as a remedy with varying results. After further experiments, it was shown by Marston that the so-called 'coast disease' of the South Australian littoral, and by Underwood and Filmer that enzootic marasmus in Western Australia, responded dramatically to small doses of cobalt given by mouth. Animals could be kept healthy on the deficient pasture, and those already seriously affected responded rapidly on receiving doses of one milligram of cobalt a day. Other workers soon established tha cobalt deficiency was responsible for pine in th Cheviots and many other parts of Scotland, while i England the same condition was proved to exist in Devon, Cornwall and Worcestershire. Bush sickness, which occurs on large stretches of the pumic soils of New Zealand, was also shown to be due to lack of cobalt. Salt sickness in Florida and nakuruit in Kenya were later added to the list of disease responding to treatment with cobalt. Marston, who has made an extensive study of this subject, ha recently stated that there are probably many othe parts of the world where animals are seriously affected by lack of cobalt and where its administration would produce the same striking results. Cobalt is not the only element having remarkable effects when applied to deficient soils in small quantities or when fed to stock grazing deficient herbage. Low concentration of copper, molybdenum, boron, manganese, magnesium, zinc and sulphur have all been proved to be responsible for failures either in crops or in stock Frequently the trouble arises from the lack of two of these elements, or from the excess or lack of one rendering another unavailable. All areas where the yields of crops and stock fall below those normally to be expected from the soil and climate must be regarded as probably deficient in some nutrient and examined in the hope that the cause of the lack of fertility can be found and set right.

There is often a complex relationship between soil plant and stock which makes the problem difficult of solution. The area of South Australia in which 'coast disease' occurs consists of two soil types, the one composed of calcareous marine shell fragments, the other of siliceous sands. Sheep grazing on both these soil types responded to treatment with 1 mgm. of cobalt a day, but another syndrome then appeared which had been previously masked by the more immediate effects of the cobalt deficiency. This proved to be due to a lack of copper. When both cobalt and copper were administered the sheep grew satisfactorily and remained healthy.

The next problem was to get a sufficient growth of pasture and other crops to feed larger numbers of sheep. Applications of the normal fertilizer mixtures of phosphate, potash and nitrogen failed to produce good yields of cereals or to establish pastures of sown grasses and legumes. It was then found that on the calcareous soils the lack of growth of plants was also limited by the copper deficiency and that a dressing of 7 lb. an acre of copper sulphate enabled cereals, legumes and grasses to respond fully to dressings of the major plant nutrients.

The addition of copper to the siliceous sands did not, however, produce the same results, and it was only after further years of experiment that Marston completed his great work by showing the lack of plant growth on these soils was due to a deficiency of zinc. To drive through the untreated areas and then to come quite suddenly on the improved pasture is to know what the prophet meant when he spoke of the desert being made to "rejoice and blossom as the rose". Nothing could be more rewarding and exciting than the work of the farmers and scientific workers in converting these wastes into fertile lands. The total effect on food production cannot as yet be estimated; all we know is that it must be very arge, as the hundreds of square miles involved are uitably treated and divided into farms supplied with the necessary buildings and fences.

The samples so far given have been of bringing fertile land into use; but an equal, or possibly reater, contribution to our food supplies can be ade by increasing production on existing farm ands. There are two ways of doing this: one by creasing yields, the other by preventing waste. It as often been pointed out that the average yields of rops in the United Kingdom are much below what e best farmers expect as their normal return. There as been since the beginning of the War a steady crease in the average yields of our crops; that of heat, for example, has risen by approximately 0 per cent. This may seem in itself satisfactory, but appears less so when the present average figures f about 20 cwt. per acre are compared with the 0 cwt. on light land and 40 cwt. on strong land btained by many good farmers. The difference here so lies in the full application of scientific knowledge. igh yields depend on the use of a variety bred and lected to suit the conditions of soil and climate, the plication at the right time and in the right way the amounts of the different fertilizers which have een shown by the soil chemists to give optimum ields, the proper cultivation of the soil and the fective control of pests and diseases.

These sound practices are, however, not fully fective if the soil is not at the same time kept at a igh level of fertility. In the United Kingdom we ave never entirely forgotten the teaching of our reat farmers on the need for a sound rotation, including crops to be eaten by stock in the field; but e have found their precepts difficult to follow in e years of depression and of rising working costs. he hurdled flock and the bullock yard on which rtility was based have largely disappeared, and the able land has been used to an increasing extent r cash crops. Increased use of fertilizers and nproved methods of controlling weeds and diseases ave counteracted the loss of yield that would have evitably followed the resultant lowering of fertility.

In the years immediately before the War the gronomists, led by Stapledon, took up the old idea the ley and developed it as a means of maintaining utput under modern conditions, while at the same me building up the fertility of the soil. The replacement of permanent grass by well-grazed short-term ys of three to four years, covering every field on e farm in turn as part of the normal rotation, or here there was no permanent grass the introduction a similar ley to replace the root break and the ne-year ley in the old four-course rotation, is now ell understood and generally accepted.

We do not know yet how great a revolution this odern system of ley farming has brought about; e expected an improvement due to the re-introuction of stock on the arable land, but the men of ience themselves have been surprised at the results hieved and are now busily at work seeking the planation of the unexpected success, in order to fine the conditions under which the ley produces e maximum benefit.

It is known already that the more productive the y and the heavier the stocking, the better the arable ops that follow; we know, too, that a ley should ways be broken while it is highly productive and at the arable land should be re-sown to a ley while fertility is still high. In this way the fertility of e land can be steadily raised and year by year the crop yields increased. We cannot say what the maximum yields will be; the time may come when a yield of two tons of wheat an acre may be regarded as the normal.

Our immediate tasks are to learn all we can about the beneficial effects of the ley on soil structure, and to get the knowledge of how to build up fertility and increase yields of crops widely known and used on British farms.

Ley farming must also find an increasing place throughout world agriculture. Land that has been continuously cropped must be rested under a sward grazed by animals, and the native pastures that carry few animals must be fertilized and sown to new grasses and legumes, if they are to make their full contribution to the world's larder. Each set of environmental conditions into which these methods are to be introduced needs careful scientific examination.

If we grow heavier crops we must protect them from pests and diseases. The loss of food due to the attacks of wild animals, insects and plant diseases is, we know, enormous. In a recently published book, "Untaken Harvest", George Ordish has summarized the existing information about crop losses. He reaches the conclusion for Great Britain that in the year 1947, after spending £10,000,000 on the control of insect pests and diseases, the losses from these sources were equivalent to £78,000,000, and expresses this graphically by saying that it is equivalent to 33,000 of our farms producing no crop, and 51,000 skilled farm workers achieving nothing with their labour. To this must be added the estimates for the damage caused by rabbits and rats. Rabbit damage in Great Britain has been estimated at £50,000,000 per annum, and that by rats at £40,000,000.

All these figures are estimates and the damage must vary from year to year, but it would be safe to assume the total damage to average more than £100,000,000 per annum. The chemists, entomologists and plant physiologists are waging a continuous war against these enemies and have won some remarkable successes since 1947, but there is still much to be done. It seems idle to begin to speak of food shortage while we are losing more than 5,000,000 tons of food each year, and not putting into the battle the effort we should have made to save so large an amount in war-time.

The proportional losses in other countries are as high. Ordish calculates that the losses in South Africa are equivalent to half a million acres, and the loss through fungus attacks on cereals in Australia as equal to the yield of more than 900,000 acres. The same picture can be found in every country, varying in type and extent, but everywhere representing a very considerable fraction, often as high as one-fifth of the potential output.

What has been said of increases in crop production and losses due to pests and diseases can be repeated for the animals on the farm. The output of milk, meat and eggs depends on good stock, the right management, and the control of disease. Figures given for possible improvement in the conversion of crops and grass into animal products are little more than inspired guesses. They all agree, however, in assessing the figures as very high. It would be conservative to estimate a 20 per cent increase in the output of animal products from the same amount of feeding stuffs if the level of production on all the farms in Great Britain could be raised to the level, not of the best, but of the good, by the application of existing scientific knowledge. In few countries would the increase be less and in many countries it would be much higher.

These examples of what could be done to expand agricultural output by the application of science serve to show that the world's food production is far below the maximum.

The rapidly increasing human population presses hard on the heels of available food supplies, and if production remains static, famine is inevitable. The control of population will come with the spread of education, but it will be a slow process; in the meantime the number of people to be fed will continue to rise rapidly. We have in the expansion of production the only means to ward off this danger which threatens the whole world, and particularly dense centres of population such as the United Kingdom.

Increased food production will require great efforts, and for a time sacrifices. Now more than at any other time in the world's history is that increase needed. Have we as a nation, has the world as a whole, the faith and the courage to set aside from our available supplies of trained men and materials those needed for the scientific expansion of agriculture? On the answer to this question may rest the fate of mankind.

X-RAY SHADOW MICROSCOPY

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THE simplest way of making an enlarged picture of an object is to put it close to a point source of illumination and to receive its shadow image on a photographic emulsion at a distance. The magnification obtainable is limited only by practical considerations. The resolution is determined in the first place by the size of the source, and secondarily by Fresnel diffraction in the object and by the grain size of the emulsion. When X-rays are used as illumination, their short wave-length permits higher resolution than with visible light and penetration of objects optically opaque; differential absorption may also enable specific elements to be detected. Shadowgraphy with a point source of X-rays was first proposed by Sievert[1]; later von Ardenne[2] suggested using electron lenses to reduce the electron beam to the required minute spot, but he does not appear to have made any experimental investigations. Recent work has yielded enough evidence to judge the potential value of the method and the limits of its performance.

Microradiography with this method offers higher ultimate resolution than does the contact method, in which the object is placed against an emulsion at some distance from a source of normal size; the resolution is then limited primarily by the grain size of the emulsion and finally by the wave-length of light used in subsequent enlargement. A value of 1 μ has been obtained by Engstrom[3] using Lippmann emulsions, and Ehrenberg and Spear[4] claim rather better results. The shadow projection method, by contrast, is limited in resolution only by the size of electron spot which can be obtained, in the order of 100 A. The shadow method also has the advantage in resolution, and in simplicity, compared with the use of reflecting surfaces to make a true X-ra microscope[5,6], which theoretically can also exceed th optical limit but seems to be restricted by practic difficulties to some 2000 A.[7,8].

The attractions of the shadow method have be obscured by fears that a sufficiently small focal sp could not be obtained or that the available X-r output from it would be so weak that exposure tim would be impracticably long[9,10]. For this reas Marton[11] recently suggested using pulsed co emission from a tungsten cathode. However, expe ments over some years have shown that this limit tion, although real, is not such as to prevent optic resolution being at least equalled; prelimina results of the shadow method were lately publish showing a resolution of a few microns[12]. Attenti to experimental details, and especially to the desi of the magnetic lens used for producing the micr source, has allowed the performance to be broug closer to that of optical techniques. A full accou of the apparatus is in preparation, and a discussi of its application to the study of insect morpholo will shortly appear elsewhere[13]. Here the gene scope of the method and its future possibilities a limitations will be sketched.

The essential need in realizing the shadow princi is to make the utmost use of the X-rays generated the target. This is achieved by using a tungsten f as target, on one side of which is incident the electr beam, while the specimen is placed almost in conta with the far side, with the advantage that it is a in air. By using magnetic electron lenses a po focus less than 1 μ in diameter can be obtained, a the X-ray source will be of similar size if the f itself is not thicker than this; 1-μ tungsten foil h been mostly used, but experiments have been ma also with laminated foils.

The resulting resolution in the shadow image determined by the size of source, so long as the effe of Fresnel diffraction is rendered negligible bringing the object very close to the source. T recording emulsion is placed as near as possible, the interest of short exposure, but must be f enough away for the inherent image detail to larger than the grain size; the camera has usual been a few cm. long. With an object-target distan of less than 1 mm. an initial magnification approac ing 100 × is not difficult to obtain. Fig. 1 shows test micrograph of a silver grid of 1,500 meshes the inch, having bars approximately 2 μ and 3 μ wid

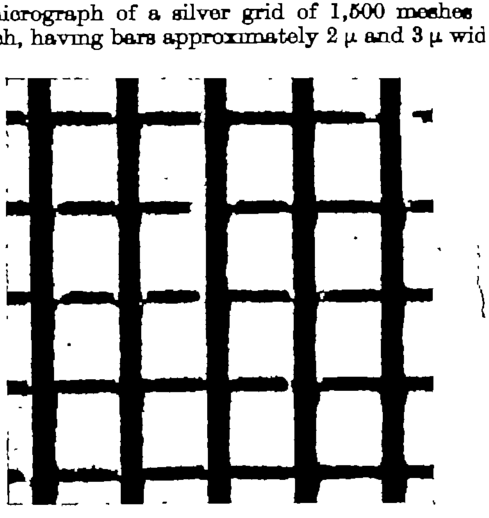

Fig. 1. Silver grid of 1,500 meshes per inch with bars 2 μ and 3 μ wide Initial magnification × 100; total magnification × 70

ne imperfections are rather less clear than in the est obtainable optical picture, and the resolution is timated at about 0·5 μ.

The technique can be applied to any material ntaining inhomogeneities which cause differential bsorption of X-rays, the wave-length being adjusted give maximum contrast in combination with dequate penetration. For biological material, which as so far been the main subject, a long wave-length required and a voltage of 10 kV. was chosen for reliminary studies ; the minimum wave-length is hen 1·2 A. with a peak intensity at about 2·5 A. uch a slow electron beam is readily focused by agnetic lenses, and a focal length of 1 mm. can be btained with an excitation that does not call for ooling of the windings (2,000 amp. turns). A focal pot smaller than 1 μ can thus be obtained by imaging tungsten filament with a single lens ; a condenser ns has been added to control the illumination onveniently.

A typical micrograph obtained in these conditions s shown in Fig. 2, the fruit fly *Drosophila melanoaster*. By bringing the specimen closer to the target higher primary magnification may be obtained at he cost of a reduced field of view ; Fig. 3 shows an solated head of the same insect. In each case the xposure time was 5 min. ; a piece of 1,500 mesh rid serves as magnification and resolution standard. he specimens have been freeze-dried, since the high water content of the living insect obscures detail in he shadowgraph ; some degree of drying is necessary or high resolution and contrast, and freeze-drying as proved to give least distortion of internal tructure. Some work has been done on intermittent bservation of living insects, immobilized for the eriod of exposure by anaesthesia. The poor resolution btained may in some cases be more than comensated by the possibility of following internal rocesses, such as egg formation, in organisms paque to light. The changes induced by high X-ray losage may also be of interest ; rough preliminary neasurements show that the total dose received luring photographic exposure is of the order of 100 r.

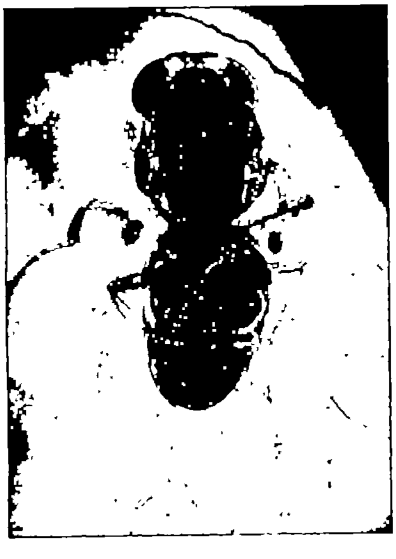

Fig. 2. *Drosophila melanogaster*, freeze-dried, with 1,500 mesh reference grid. Initial magnification × 20; total magnification × 30

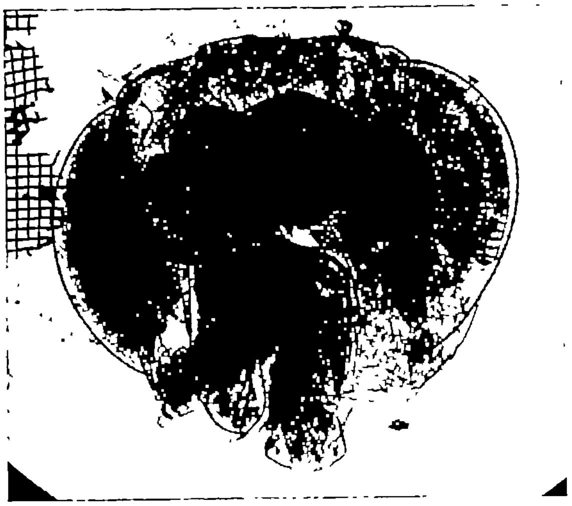

Fig. 3. Head of *Drosophila melanogaster*, freeze-dried, with 1,500 mesh reference grid. Initial magnification × 30 ; total magnification × 90

In its present form, with a resolution somewhat short of that of the optical microscope, the chief value of the method lies in the possibility of examining specimens normally opaque to light. It is also an advantage that stereographs can be obtained of equally high resolution, since the whole depth of specimen is in focus compared with the restricted focal depth of an optical microscope at high resolution. A stereo-view of a head of *Drosophila*, for example, shows the complex structure of the eye and brain in immediate three-dimensional perspective. The prospect appears of examining at high resolution much thicker sections of bulk tissue than can be tolerated in normal microscopy.

The main difficulty in the way of further development threatens to be that of electron intensity. It has long been known that the dissipation of energy from a focal spot becomes relatively more rapid as its diameter is reduced, and conditions are specially favourable in a laminar target where heat flow is almost entirely radial. Detailed investigation[14] shows that with a spot of the order of 1 μ, the temperature can be raised towards the melting point only by over-running the filament considerably compared with normal operating conditions. The limitation on exposure time with still smaller spots then resides in the filament rather than the target. An exposure time between 1 and 10 minutes has been found practicable with a spot of less than 1 μ, without seriously shortening the life of the filament.

The decreased X-ray output resulting from a further reduction in spot size to 0·1 μ could be partly offset by reduction in camera length and by further overrunning the filament, so that the exposure time need not be greatly increased. But the use of an electron spot of the order of 100 A., which can be obtained by two stages of demagnification of the beam, would seem to demand exposure times of the order of one hour. In any event, it is doubtful if many biological problems exist for which such a resolution would be useful, owing to the poor absorption of organic matter for X-rays ; features 100 A. thick would only give sufficient contrast to be observed if very long wave-lengths were used, requiring a vacuum camera. However, loading of the specimen with heavy elements may be practicable, and there are problems of a metallurgical and inorganic nature for which such a high resolution would be useful. Where the absorption of X-rays is much greater, a higher electron voltage could be used, with corresponding improvement in the efficiency of X-ray production. For the present, attention is being paid to refining the existing apparatus and exploring the range of its application.

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NEW EVIDENCE OF COMMUNICATION IN THE HONEYBEE COLONY*

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SCIENTIFIC interest in honeybees centres upon their most striking achievement—the organization of a social life. Social co-operation and coherence presuppose communication between the members. Part of the 'language' of bees has been studied and described by K. von Frisch[4-6], but his investigations were only concerned with recruitment to crops by successful foragers. There must also be other types of communication, concerned with co-ordinating the various activities within the colony, and there might be means by which members of a colony recognize each other.

G. A. Rösch[7] showed that marked workers in an observation hive undertook a sequence of tasks according to their age—brood-rearing, nectar ripening and storage, wax production and comb-building, and finally foraging. However, there is evidence that this succession need not apply in colonies with bees of abnormal age distribution[8,9].

Ribbands[1], who marked groups of workers which had all emerged into a colony on the same day, found that when they commenced their last task—foraging—their ages lay in the range 9–35 days. In addition, the expectation of foraging life of the last group of bees to commence this activity was substantially less than that of their comrades (Fig. 1), so that senility had played some part in their mortalities and they had commenced foraging at a more advanced 'physiological age'. In order to reduce the effects of changing weather conditions, means for three days running were applied to the data concerning the age at which the bees commenced foraging; but despite the smoothing effect of this procedure, the distribution was markedly trimodal (Fig. 2); the peaks indicate that, even in this normal colony, most of the bees had skipped some of the duties in the sequence.

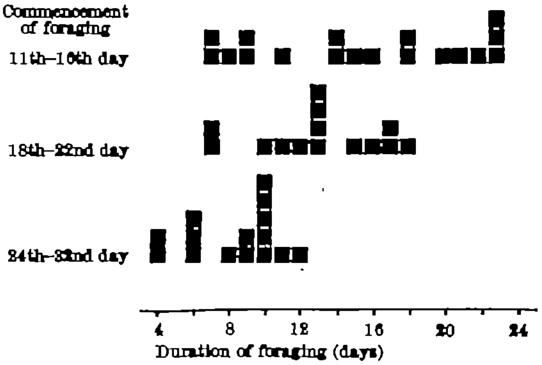

Fig. 1. Duration of foraging for individuals, exp. 1

Thus Ribbands concluded that the age of the individuals was not the over-riding factor in determining the allocation of their duties, but that some other factor was more important. The main tasks o a colony are related to the food supply, which may determine the proportion of bees required for each task. It was thought possible that food supply also affected the metabolism of the individual workers and so led to an appropriate redistribution of their labour to the required proportions; evidence to support this hypothesis is detailed in the full paper[1].

It was supposed that, if food supply determined the allocation of duties, any change in the supply would be quickly appreciated throughout the colony. Investigating this possibility, Nixon and Ribbands showed that there exists a rapid and extensive sharing of food between the members of a colony. In one experiment six foragers from a colony of 24,500 bees were marked and trained to a dish containing sugar syrup. This dish was then replaced by another one which was filled with 20 ml. sugar syrup which contained 100 μC. of phosphorus-32, and in 3¼ hours the six marked foragers carried this solution into their colony. Two hours later, 70 foragers were collected from the hive entrance and 6–12 honey bees from each of the 33 combs in the hive. 62 per cent of these foragers and 19 per cent of the bees from the combs were radioactive. Twenty-four hours later, larger samples were taken; 76 per cent of the foragers and half of the bees on the combs were radioactive. The wings and legs of these bees were

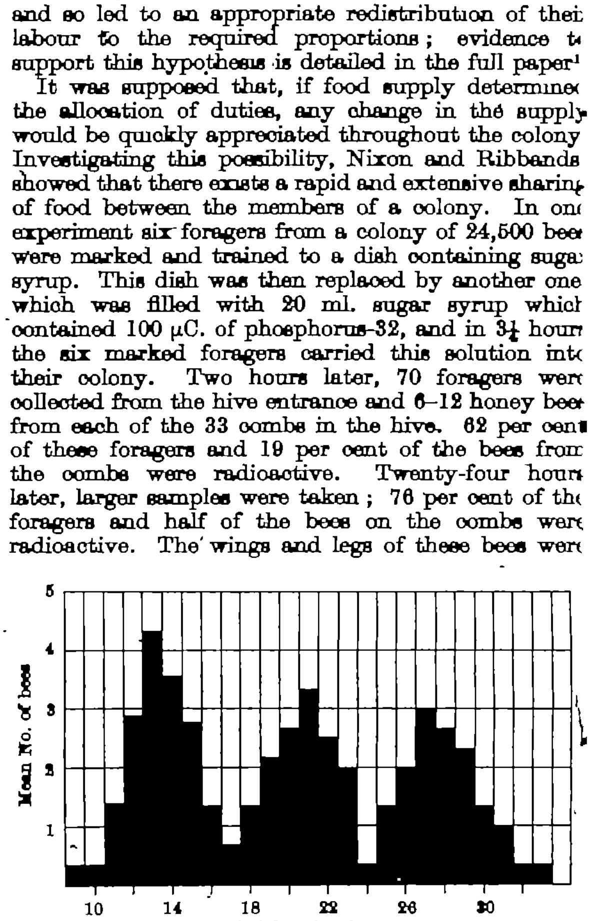

Fig. 2. Age at which foraging commenced, exp. 1. Three-day running means

ot radioactive, so that the transmission had not een caused by external contact, but by food intake. n addition, forty-eight hours after feeding the tracer rup, 100 per cent of a sample of 85 of the older rvæ of the colony were radioactive.

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* Summary of three papers (refs. 1–3) read before the Royal Society on June 19.

This food sharing could provide a material basis for e known division of labour in the honeybee colony. ibbands[1] supposes that at any particular time each sk in the colony is undertaken by a group of bees hich differ slightly in age; the main tasks involve ood manipulation, and any surplus is appreciated by ll members as a consequence of the widespread food ransmission; the oldest bees of the group are then ost likely to leave this activity and turn to which- ver of the subsequent duties is most in need of ecruits.

The results of the food-transmission experiments re complementary to the unexpected results of xperiments concerning the odours by which honey- ees recognize their companions[9]. Von Frisch and Rösch[10], who trained two colonies of honeybees to isit neighbouring dishes of syrup and noted that ewcomers were preferentially attracted towards oragers from their own colony, thought that this reference was caused by a difference in odour. For re-investigation of this problem, Kalmus and ibbands[3] designed the following technique. Two etri dishes, *a* and *b*, were placed about a yard apart bout a hundred yards away from a pair of colonies and *B*. A wooden screen was placed between the etri dishes in order to facilitate the separation of dours emitted in their vicinity. One evening the ntrance of colony *B* was closed, and the next orning dish *a* was filled with sugar syrup and a roup of 50 foragers from colony *A* were trained to . The thoraces of these bees were marked with hite paint and any additional bees were killed. hat evening the entrance of colony *B* was opened nd that of colony *A* closed. Next day dish *a* remained mpty, dish *b* was filled with sugar syrup, and 50 oragers from colony *B* were trained to dish *b*. The horaces of these bees were marked with blue paint, nd additional bees were again killed. The entrance f colony *A* was now opened, and dilute syrup was pplied at both dishes. Soon the marked bees from oth colonies were foraging at their respective dishes. oncentrated syrup was then supplied at both dishes n order to encourage the recruitment of newcomers[11], hich were marked on their abdomens with paint of he same colour as that on the thoraces of the bees rained to the dish which they were visiting. When ufficient recruits had been marked, the dishes were emoved. That evening both hives were opened and ll marked bees found were killed and recorded.

In experiments with different pairs of colonies, it as always found that 70 per cent or more of the ecruits went to the dish being visited by guides from heir own colony. These highly significant preferences onfirmed the result of v. Frisch and Rösch.

Another experiment involved only one colony, rom which a group of 50 bees were trained to one f the two dishes, and marked. New dishes, con- aining concentrated syrup, were then placed at both ites, and all recruits to either dish were killed and ecorded. During the first two hours of observation, 5 recruits went to dish *a* visited by the trained bees, ut only 3 went to the other dish, *b*. The dishes were hen exchanged. During the next 15 minutes only ne recruit arrived at dish *b*, which the trained bees ere now visiting, but seven recruits went to dish *a*. hus the recruits had not been attracted to their trained comrades, but to something pertaining to the dish which had been visited by them. This could only be an odour, presumably emitted from their abdominal scent gland[12]. Other observations indicated that this odour persisted for at least two hours.

Further experiments, using halves of recently split colonies and testing by the basic technique, showed that the distinctive odours could develop quickly and were thus not inherited. Then on September 20, 1951, when little natural forage was available, a colony was dequeened and divided into three nuclei, *D*, *E* and *F*, which were set out in a row ten yards apart. *F* was then fed with half a pound of heather honey and one tablespoonful of treacle, while *D* and *E* were not fed. Foragers were then trained and marked, and on September 29 *D* and *F* were compared. 43 correctly marked and 14 incorrectly marked recruits were found in *F*, and 11 correct and 6 incorrect ones in *D*; thus a highly significant difference ($P = 0{\cdot}006$) had developed between the foragers of these nuclei. On October 5 the two unfed nuclei, *D* and *E*, were compared. 22 correctly and 20 incorrectly marked newcomers were found in *D*, and 16 correct and 13 incorrect ones in *E*; this difference is not significant ($P = 0{\cdot}7$). On October 6 *E* and *F* were compared. In *F* there were 37 correct and 16 incorrect recruits, and in *E* there were 35 correct and 5 incorrect ones. This difference in visiting is highly significant ($P < 0{\cdot}001$). Thus it appeared that no significant difference had arisen between the two unfed nuclei, whereas the fed nucleus had developed a distinctive difference in relation to the other two as a consequence of the differential feeding.

Differences in olfactory attraction do not require absolute differences between the odours emitted; they could also arise from relative differences in the proportions of the same constituents. Thus one would expect that odours from bees of one colony would attract bees from other colonies but to a lesser degree, as the experiments demonstrated. The different mixtures of odours could be derived more or less directly from differences in the crops harvested by the colonies, and a very thorough and extensive food transmission could ensure that the diet of all the foragers of any colony was almost identical, so that at any one time they could all emit similar odorous waste products. Scouts from neighbouring hives may often find different crops, and the readiness with which successful foragers communicate the whereabouts of crops to recruits[13] would maintain this difference so that diets of nearby colonies were not identical; thus the foragers of neighbouring colonies would have different odours.

The foregoing results are relevant to other problems. It has been held[14] that some of the phenomena involved in colony robbing and in queen introduction were explicable in terms of distinctive colony odours; the more recent opinions[15,16] which have rejected this hypothesis may now need revision. An observation of Kalmus[17] concerning fighting between bees of two visibly different strains which were trained to the same dish of syrup can now be explained in terms of distinct colony odours. Food transmission may be an attribute of all social insects, and it would facilitate the rapid dispersal of insecticides[18,19] and drugs.

The results also pose the following new problems, which we are now investigating. Production of the distinctive colony odours suggests that food transmission is even more thorough than has now been recorded, so that a detailed quantitative analysis is desirable. Perception of the distinctive odours suggests that honeybees possess a much more delicate capacity for distinguishing between different mixtures of odours than has been described[20]. It is certain that the most important function of the distinctive odours is facilitation of the social coherence and defence of the community.

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NEWS and VIEWS

British Association: President for 1953

THE president-elect of the British Association for 1953, when the annual meeting will be held in Liverpool, is Sir Edward Appleton, principal and vice-chancellor of the University of Edinburgh since 1949. Sir Edward is well known among men of science both as an original investigator of outstanding ability and also as an administrator of scientific research. His fundamental work on the transmission of radio waves, carried out while he was Wheatstone professor of physics in the University of London (King's College) and later Jacksonian professor of natural philosophy in the University of Cambridge, received just acknowledgment by the award of the Nobel Prize for Physics in 1947. Then in 1939 he gave up the direct pursuit of research to become secretary of the Department of Scientific and Industrial Research, a post which he held for ten years— a period which saw the growth on an enormous scale of the participation of the State in fundamental scientific research and development. In all this activity Sir Edward was one of the leading figures, and his wisdom and characteristically gentle but persuasive drive enabled him to exert widespread influence. In 1949 came another change, when he went to the University of Edinburgh as principal and vice-chancellor, thus in a way completing his change-over to interest in administrative activities. Here he has already made his mark in the University, though he contrives to maintain his interest in his own special field of radio research. The British Association is fortunate in having so many-sided a man to guide it during the coming year.

Psychology at Manchester: Prof. T. H. Pear

PROF. T. H. PEAR, who retired from the chair of psychology at Manchester in 1951, is to be succeeded by Dr. John Cohen, lately of Birkbeck College, London. Prof. Pear's tenure of his appointment has been of notable length, for it began in 1919, when a lectureship of which he had been the first occupan was upgraded. He had previously been a student a King's College, London, and at Würzburg an Giessen; and, like that of many pioneers of psychology, his work was originally developed under th wing of philosophy with strong links with both physic and physiology. He has displayed great variety i his interests. From motion-study in coal-getting t the investigation of the expression of personalit through the voice is a great jump, but Pear has bee equal to it. In recent years he has focused his attention mainly on social psychological problems fallin on the verge of social anthropology, and he has bee particularly active in discussions on the socia responsibilities of psychologists in the internationa field. He has been president of Section J (Psychology of the British Association; and of the British Psychological Society. He has also been Buchanan-Riddell Lecturer in the University of Durham. O his dozen or so books, his first two, "Remembering and Forgetting" and "Skill in Work and Play", hav been perhaps the most influential.

Prof. J. Cohe

DR. JOHN COHEN, who succeeds Prof. Pear, i also a London graduate. He was at Universit College for eight years, under Sir Cyril Burt, an wrote his Ph.D. thesis on the "Statistical Stud of Physical and Mental Types". During the Secon World War he was in the Cabinet Office and spen much of his time as joint secretary of the Wa Cabinet Committee on the Use of Psychologists an Psychiatrists in the Services. Later, as a member o the Working Party on the Recruitment and Trainin of Nurses, he stimulated considerable discussion by an outspoken and cogently expressed minorit report. In 1948 he became lecturer in psychology a Leeds, and in 1949 he was appointed to the chair o psychology in the Hebrew University, Jerusalem Prof. Cohen also is greatly interested in social psychology. He has carried out two investigations fo Unesco, and has been closely associated with th World Federation for Mental Health since its inception. Another of his concerns is the experimental study of higher mental processes. Recently, in addition t lecturing at Birkbeck College, where his scholarlines and integrity have been greatly valued, he has bee engaged on an inquiry for the Acton Society Trus on the effectiveness of working units in relation t their size. He has published papers in the *British Journal of Medical Psychology*, the *Journal of Menta Science*, the *Journal of General Psychology*, th *Eugenics Review*, *Psychiatry*, *Occupational Psycholog* and the *British Medical Journal*.

Proposed British Agricultural History Society

IN the spring of this year, a well-attended meetin was held to consider the formation of a Britis Agricultural History Society. At this meeting small committee was formed to explore the possibi ities. The committee's inquiries were met with promising enthusiasm, and it has now been arrange to hold an inaugural meeting under the chairmanshi of Sir James Scott Watson. The director of th Science Museum, South Kensington, S.W.7, ha allowed this meeting to be held in the Lectur Theatre of the Museum on September 25, at 2.30 p.m The scope of the proposed Society's labours is t cover agriculture in all its phases, human an technical. The social life of all classes of rural societ from the earliest ages is one branch of the subject development of the practice of farming in its hnical and regional aspects is another. The tory of plant and animal breeding, diseases and ir control, and all branches of agricultural science l be included; for example, agricultural chemistry, l science, entomology, mycology, engineering, ilding, land drainage, etc. If sufficient support forthcoming, a periodical containing research pers on all these subjects will be published, nually or more frequently, according to the funds at become available. For the present, Mr. J. W. Y. iggs, Museum of English Rural Life, Shinfield ad, Reading, is acting as honorary secretary, and quiries may be addressed to him. All interested ll be welcome at the meeting at the Science Museum.

The Times Survey of British Aviation"

NOWADAYS there are great expectations for those ho look forward to the annual display and exhibition hich is organized at Farnborough by the Society of itish Aircraft Constructors. The aeroplanes which ave made news in the previous year, month or even eek, are then on show and now, for the first time, ere is *The Times* survey of the whole field published for the occasion (September 1. 1*s*.). This is a served honour since, at least qualitatively, aviation now an important part of our national enterprise. he contributors number some of the most eminent en in the field; and alas, one of them, Mr. John erry, who wrote an article on test-flying, lost his fe through the break-up of a *DH* 110 during the isplay at Farnborough. Some of the photographs of w aeroplanes are spectacular and most are excellent. he survey catches something of the family spirit hich is a part of the equipment of all those engaged British aeronautics—from the industrial apprentice the research scientific worker. From the general ader's point of view, it may be a pity that this irit has here pushed critical analysis into a somehat secondary position so that this issue tends to e a survey only. The problem of the supply of chnical man-power, especially at high level, is arcely considered. Incidentally, there is no mention f the rejuvenating effect of the departments of eronautics in some of the university engineering chools in Britain. Despite the spectacular progress hich has been so strikingly demonstrated, there is s yet insufficient application of scientific technology o some vital problems of design. Can the present rganization of the aeronautical industry adapt itself o life in a peace-time economy?

acao Collecting Expedition in Colombia

A CACAO-COLLECTING expedition to Colombia has een organized by the Imperial College of Tropical griculture, Trinidad, and the Government of olombia, and the advance party, consisting of F. W. ope (plant breeder and expedition leader), R. E. D. aker (plant pathologist) and D. J. Taylor (entomogist), has already commenced work in the forests. urther members are being sent out so that no worker ill spend more than three months in the forest ithout a break. In addition to the British personnel, olombian scientific workers will be participating in he expedition, and also Dr. R. E. Schultes, who has ad much experience in the area collecting *Hevea* pecies for the United States Department of Agriulture. This expedition has been financed by the ritish West Indian and the British West African acao Research Scheme with the full co-operation f the Government of Colombia, and is expected to last for some twelve to fifteen months. The first area to be investigated is the River Apoporis, one of the upper tributaries of the Amazon; and subsequent trips are planned to the Rivers Guaviare, Inirida, Vaupes, Caqueta and to the vicinity of the Casiquiare Bifurcation, the waterway linking the Amazon with the Orinoco. If time permits, short visits will also be made to cacao-growing areas of northern and western Colombia. The expedition plans to follow the main rivers, using aluminium canoes fitted with outboard motors, which can be transported from Bogota, the main base of operations, and from river to river, by Catalina aircraft. It is expected that, in addition to the rivers, it will be possible to use the trails made by the rubber-collectors, and that wild trees of *Theobroma cacao* and of other *Theobroma* and *Herrania* (a genus closely related to *Theobroma*) species will be found scattered or in small groups, but scarcely ever cultivated, throughout the area. The object is to explore the area, which is thought to be one of the homes of Criollo, or high-quality cacao, and thereby to obtain specimens which will widen the existing range of breeding material. Seed and budwood of cacao and of the related wild species will be sent by air to Trinidad and to the Colombian research station at Palmyra.

Progress in French Electronic Instrumentation

ISSUE No. 3, last year, of *Laboratoires*, the quarterly review, in French and English, of French technology, is devoted mainly to electronics and electronic instruments. The opening article is by Prof. P. Grivet who briefly reviews some of the modern applications of electronics. This is followed by a most interesting application of an electron probe and a new method of metallographic spot analysis which has been developed in the laboratories of the Office National d'Études et de Recherches Aéronautiques. If a substance is bombarded by a beam of electrons, X-ray emission is produced and the spectrum of the radiation contains lines which are characteristic of the chemical elements in the bombarded region. By use of electron lenses the beam can be focused and concentrated so that the bombarded region is of very small dimensions, of the order of one micron. An electron microscope has been modified so as to produce the probe, and some of the possibilities of the method and results of experimental tests performed with the apparatus are described. It would appear that the method is rapid and is capable of considerable accuracy. Other articles in the issue are on the mathematical basis of cybernetics, by R. Vallée, vice-president of the French Association of Electronic Engineers, and on the action of short-wave electromagnetic radiations on the maturing of wines, by Prof. M. Lafargue. Finally, there are two articles dealing with medical research: the first deals with electronics in cardiology and describes the various means and apparatus used for observation, analysis, treatment and control; and the second, by Prof. Ch. Oberling, director of the Institut de Recherches sur le Cancer, Villejuif, describes scientific cancer research, its method and tools, with illustrations and details of the particular work carried out at the Institute.

Fluorescent Lighting in Museums

AN article by M. J. Genard, of the University of Liège, originally published in *Museum* (5, No. 1, March 1952) was reprinted, with some additional material introducing the results of more recent research, in the *Museums Journal* of April 1952. A short summary of the latter paper was published in *Nature* of August 23, p. 306. More recently in the *Museums Journal* (June 1952), Messrs. F. I. G. Rawlins (National Gallery) and W. E. Rawson-Bottom (Ministry of Works) have queried some of the statements made in the paper and consider that more specific data should have been obtained in some of the experiments. They have carried out some independent tests and clarified the position as it concerns the museum curator. Their conclusion is that the danger of fading to museum collections exposed to normal fluorescent lighting is negligible.

Rabbit Repellents: a Correction

A review of *Plant Pathology*, a new quarterly journal, appeared in *Nature* of June 21, p. 1050. One of the papers included in this first number concerned the results of trials by H. V. Thompson and C. J. Armour of rabbit repellents for use on fruit trees. The best of these was erroneously given as mixture 96*A*, whereas a mixture of 8 lb. resin in 1 gall. of denatured ethyl alcohol gave the best performance, with only 2 per cent of treated apple stocks showing severe damage.

Present Problems in Nutritional Research: Symposium in Basle

A symposium on "Present Problems in Nutritional Research" will be held in the Kollegienhaus, Petersplatz 1, Basle, during October 1–4 under the auspices of the International Union of Nutritional Sciences. The speakers and their topics will be as follows: Dr. J. Trémolières (Paris), choice of foods; Prof. A. I. Virtanen (Helsinki), natural foodstuffs for nutrition; Dr. D. P. Cuthbertson (Aberdeen), microbiology of digestion, with reference to farm animals; Prof. E. Crasemann (Zurich), energetics of fodder and its metabolism; Prof. E. J. Bigwood (Brussels), free and combined amino-acids in foodstuffs; Prof. K. Lang (Mainz), deterioration of egg-white; Prof. K. Bernhard (Basle), food factors in the prevention of liver-fattening deposits; Prof. K. Thomas (Göttingen), feeding trials with synthetic fatty acids; Prof. O. Högl (Berne), incorporation of additives in food; Prof. E. Abramson (Tomteboda), food additives, including toxic substances; Dr. S. J. Folley (Reading), hormones for nutrition; Prof. A. B. L. Beznák (Birmingham), dietary fat, work and growth; Dr. L. J. Harris (Cambridge), practical significance of vitamins; Prof. H. Dam (Copenhagen), deficiency and mode of action of vitamin E, Prof. H. D. Cremer (Mainz), minerals in foodstuffs; Prof. V. Demole (Lausanne), fluorine and caries; Dr. W. R. Aykroyd (Rome), nutrition work of F.A.O.; Prof. A. G. van Veen (Rome), local foods in supplementary feeding schemes. Participation in the symposium is free. Further information is obtainable until September 30 from *Experientia*, Verlag Birkhäuser AG., Basel, Elisabethenstrasse 15, and after then from the Kollegienhaus, Petersplatz 1, Basel. The secretary of the International Union of Nutritional Sciences is Dr. Leslie J. Harris, Dunn Nutritional Laboratory, Cambridge.

North of England Institute of Mining and Mechanical Engineers

The centenary of the foundation of the North of England Institute of Mining and Mechanical Engineers is to be marked by a meeting during the week beginning September 22 in Newcastle upon Tyne. The meeting opens with a civic reception an luncheon, and includes a centenary dinner, at whic the president of the Institute, Prof. Granville Pool will present the Buddle Medal to Mr. Austin Kirku of the Durham Coal Owners' Association. Pape will be presented during the meeting on the develo ment of the Tyne coal basin (Dr. A. Raistrick), co miners' nystagmus in County Durham (Prof. R. Browne), lighting (Joint Lighting Research Su committee, King's College and the Institute), acc dents from falls of ground (H. F. Wilson and H. Perrins, H.M. inspectors of mines), control of tl strata in mining (Institute's sub-committee on tl subject), pneumoconiosis in Durham and North umberland (Dr. R. I. McCallum, Dr. E. N. Trounson dust suppression (Dr. J. H. Jones), methane emissic (A. B. Dawson), ventilation (Joint Ventilation Su committee, King's College and the Institute), an mechanization of coal mining in the north of Englar (J. S. Raine). Throughout the meeting there w be a mining exhibition in the University School Mines, King's College, Newcastle upon Tyne.

Announcements

Lord Eustace Percy will be president of tl Health Congress to be held at Hastings by the Roy Sanitary Institute during April 28–May 1, 1953.

The fourth post-war annual general meeting an symposium of the Deutsche Gesellschaft fur Fet wissenschaft, Munster, will be held in Dusseldo during October 6–10. The British representativ is Dr. L. Ivanovszky, "Glenbrook", 68 Park Stree Bridgend, Glam.

The Autumn Meeting of the Institution of Nav Architects will be held in Italy during September 25 October 2, in collaboration with the Collegio deg Ingegneri Navali e Meccanici and the Associazion di Tecnica Navale. Meetings for discussion of pape will be held in Genoa (September 26) and Rom (September 29).

An international congress of therapeutics will b held in Madrid during October 16–18 under th presidency of Prof. T. Hernando. The programm will consist of three sections discussing, respectively potassium, massive hormone-therapy and radioactiv isotopes. Further information can be obtained fron the III Congreso Internacional de Teropéutica Instituto de Farmacologia, Ciudad Universitaria Madrid.

An all-day symposium on "Properties of Metall Surfaces", arranged by the Institute of Metals, wi be held in the Lecture Theatre of the Royal Institu tion, Albemarle Street, London, W.1, on Novembe 19 (9.45 a.m.–5.0 p.m.). Attendance at the sym posium is free to all who are interested on applicatio to the Secretary of the Institute, 4 Grosvenor Gar dens, London, S.W.1, from whom further informatio can be obtained.

The University of Padua is offering a Gabriell Zuccari scholarship of 250,000 lire during th academic year 1952–53 for research of at least si months duration at the Zoological Station, Naples The scholarship is open to any person who wishes t undertake research in zoology, comparative anatomy physiology or embryology, and it may be renewed u to a maximum of three years. Application form (to be returned by October 31) and further informa tion can be obtained from the Secretariat of th University of Padua.

SECOND INTERNATIONAL CONGRESS OF BIOCHEMISTRY

THE Second International Congress of Biochemistry was held in Paris at the Sorbonne during July 21-27 and was attended by some two thousand two hundred members from all parts of the world, including about four hundred from Great Britain. Although the large number of adherents proved a surprise and even an embarrassment to the organizers, the arrangements worked with a smoothness which revealed a vast amount of careful preliminary organization by the executive committee under the chairmanship of Prof. C. Fromageot, with Prof. J. E. Courtois as general secretary.

The opening session in the grand amphitheatre of the Sorbonne was attended, in the unavoidable absence of the President of the Republic, by the Minister for National Education, who brought the good wishes of the French Government. The meeting was also addressed by Prof. Gabriel Bertrand, honorary president, by Prof. René Fabre, president of the Congress, and by Prof. C. Fromageot.

Four general lectures were delivered to the congress as a whole: by Prof. J. N. Davidson (Great Britain) on "Nucleoproteins and Tissue Growth" (in English), by Academician A. Oparine (U.S.S.R.) on "Les changements de l'action enzymatique dans les cellules végétales sous l'influence des facteurs exterieurs" (in Russian), by Prof. S. Ochoa (United States) on "Fixation of CO_2 in Animals and Plants" (in English), and by Prof. K. U. Linderstrom-Lang (Denmark) on "Protéines et enzymes" (in French). It is proposed to publish these lectures in the near future.

The main part of the Congress was divided into seven symposia running simultaneously, at which the main papers were moderately comprehensive reviews of recent work given by invitation by recognized authorities on the subjects concerned. These symposia have been published and were available in printed form at the beginning of the Congress. The symposia were supplemented by short communications given by members of the Congress at large.

In symposium No. 1, for example, on the "Biochemistry of Hæmopoiesis", H. G. Wijmenga (Holland) and M. S. Shorb (United States) reviewed recent work on the chemistry and microbiological assay respectively of the cobalamins (the vitamin B_{12} group), while the role of folic acid and the citrovorum factor was dealt with by E. L. R. Stokstad (United States). A most useful review of the metabolism of metals in hæmopoiesis was given by S. Granick (United States), who, as might be expected, dealt chiefly with iron and the importance of ferritin in its absorption and utilization, but who included the parts played by copper, cobalt, molybdenum and zinc. This led naturally to the bone marrow (M. Errera, Belgium) and to the utilization of proteins in blood cell formation (A. Aschkenazy, France). A. Neuberger (Great Britain) surveyed the important recent work on the biogenesis of the hæmin pigments with particular reference to porphyrin formation and the porphyrias, while M. F. Perutz (Great Britain) covered the structure of hæmoglobin.

The complex subject of the "Biogenesis of Proteins" was discussed in symposium No. 2. It opened with a masterly account by J. S. Fruton (United States) of peptide bond synthesis, which was followed by a discussion of the molecular kinetics of proteolytic enzymes by H. Neurath (United States) and of the role of glutamine, asparagine and glutathione in biosynthesis, by H. Waelsch (United States). The general problem of enzymatic peptide synthesis was dealt with in some detail by H. Borsook (United States), while the more specialized aspects of the formation of specific proteins were discussed by other speakers—milk proteins by T. S. Work (Great Britain), serum proteins and antibodies by F. Haurowitz (United States), procollagens by V. N. Oriekhovitch (U.S.S.R.), *iso*hæmagglutinins by R. Wurmser (France), penicillinase by M. R. Pollock (Great Britain) and adaptive enzymes by J. Monod (France). The vexed question of the function of ribonucleic acid in protein synthesis was surveyed by H. Chantrenne (Belgium), and the curious phenomenon of long-range enzymatic action by A. Rothen (United States) and by J. Winter (France).

Perhaps the symposium which aroused the greatest general interest was No. 3, on the "Tricarboxylic Acid Cycle". H. A. Krebs (Great Britain) introduced the subject by discussing the place of the cycle in cell metabolism, and was followed by C. Martius (Germany) and S. Ochoa (United States), who concentrated on certain detailed aspects. In such a discussion as this it was natural that coenzyme A should be dealt with in detail. F. Lipmann (United States) gave a general survey of its importance and discussed in detail recent studies on the synthesis of acetyl-coenzyme A by way of the interaction of adenosine triphosphate, coenzyme A and acetate which has led to the discovery of coenzyme A-pyrophosphate. The importance of the cyclophorase system was fully reviewed by D. E. Green (United States). This paper and the following one by F. Leuthardt (Switzerland) emphasized the importance of the mitochondria in the internal economy of the cell both in relation to the process of oxidation and to the formation of urea by the linking of the arginine cycle with the metabolism of glutamate and malate.

The biochemical dissection of some steps in the tricarboxylic acid cycle by means of inhibitors, and in particular its specific inhibition by toxic fluoro-compounds, was described by Sir Rudolph Peters (Great Britain), while alternative pathways and variations in the cycle were discussed by E. S. Guzman Barron (United States). No discussion of the citric acid cycle would be complete without reference to its role in fatty acid oxidation, which was ably reviewed by F. L. Breusch (Turkey). The final paper in this symposium was by W. A. Engelhardt (U.S.S.R.) on the enzymology of myosin.

Symposium No. 4, on "Hormones related to Proteins", provided a more miscellaneous collection of material. S. J. Folley (Great Britain) discussed the hormonal control of the initiation and maintenance of lactation with special reference to the adrenal cortex and insulin. The opposing actions of these hormones was illustrated by the observation that the potentiating effect of insulin on lipogenesis from small molecules could be diminished or abolished by cortisone. F. Sanger (Great Britain) reviewed his recent important work on the structure of insulin, for which the complete amino-acid sequences of fractions *A* and *B* are now available. *nor*Adrenaline was discussed by U. S. von Euler (Sweden), and the biologically important amines by Z. M. Bacq (Belgium). The recent work of the Cambridge school on the metabolic influence of the pituitary growth hormone was ably surveyed by F. G. Young (Great Britain). R. Michel (France), in a remarkably thorough survey of the thyroid hormone, discussed the biogenesis of thyroxine, the formation and proteolysis of thyroglobulin and the nature of the circulating hormone.

It was not surprising to find that the fifth symposium, on the "Metabolism of Micro-organisms", was also very varied in content. E. Chargaff (United States) discussed the nucleic acids of micro-organisms, a subject which was also touched on by D. D. Woods (Great Britain) in his paper on the formation of folic acid and related growth factors. The surprising versatility of the various active forms of vitamin B_6 in enzymic reactions was clearly brought out by E. E. Snell (United States), while the lipids of the mycobacteria were reviewed in a comprehensive fashion by E. Lederer (France). Three papers dealt with the formation and metabolism of aromatic compounds. B. E. Davis (United States) and G. Ehrensvärd (Sweden) gave stimulating reviews of the biosynthesis of aromatic rings, and R. G. Stanier (United States) dealt with their oxidation.

The metabolism of micro-organisms featured prominently also in symposium No. 6, on the "Mode of Action of Antibiotics". W. W. Umbreit (United States) explained that streptomycin inhibited a reaction between oxalacetate and pyruvate which is lost in resistant cells. Both E. F. Gale (Great Britain) and F. Gros (France) emphasized the profound changes in nucleic acid metabolism and in protein metabolism (particularly the blocking of the uptake of glutamic acid) which take place in micro-organisms treated with penicillin. *Staphylococcus aureus*, for example, grown in presence of penicillin, produces derivatives of uridine-5′-pyrophosphate which were described by J. T. Park (United States). Discussion of the mode of action of antibiotics led naturally to the question of resistance, the genetic aspects of which were dealt with by L. L. Cavalli (Italy). R. D. Hotchkiss (United States) described how penicillin-sensitive rough-strain pneumococci give rise to a proportion of penicillin-resistant variants when grown in the presence of the deoxyribonucleic acid prepared from rough strains selected for spontaneously arising penicillin resistance. Finally, S. Americano-Freire (Brazil) gave an extensive account of the antibiotic properties of *p*-amino salicylic acid and its phenyl ester in experimental tuberculosis.

The seventh and last symposium dealt with "Steroids". The question of the relationship between chemical structure and biological activity was discussed for steroids in general by C. W. Shoppee (Great Britain) and for their 6-hydroxy derivatives by M. R. Ehrenstein (United States). G. Pincus (United States) dealt all too briefly with his recent fascinating work on steroid biosynthesis in the isolated perfused adrenal gland while W. Dirscherl (Germany) surveyed the effects of steroids on enzymatic reactions and metabolic processes. The urinary excretion of steroids and its clinical significance was discussed by E. R. Venning (Canada), G. F. Marrian (Great Britain), L. G. Huis in't Veld (Holland) and M. F. Jayle (France).

It was, of course, clear to the organizers of the Congress that all the original papers submitted by members could not be incorporated into the framework of the seven symposia. Such communications were therefore given in the most appropriate of the thirty-one different sections, which met in the afternoons and covered the following fields of biochemistry (1) mineral elements ; (2) lipids ; (3) amino-acids and proteins ; (4) nucleoproteins ; (5) pigments ; (6) fat-soluble vitamins ; (7) water-soluble vitamins ; (8 enzymes and coenzymes ; (9) carbohydrases ; (10 esterases ; (11) phosphatases and depolymerases (12) proteases ; (3) oxidases and dehydrogenases (14) carbohydrate metabolism ; (15) amino-acid metabolism ; (16) sulphur metabolism ; (17) fermentations ; (18) plant chemistry ; (19) plant metabolism ; (20) photosynthesis ; (21) nutrition (22) biochemistry of ossification ; (23) clinical chemistry ; (24) immunochemistry ; (25) blood clotting ; (26) muscle biochemistry ; (27) physiological chemistry and pharmacodynamics ; (28) chemotherapy ; (29) biochemical effects of ultrasonics ; (30) chemistry of cancer ; (31) apparatus and techniques.

The lighter side of the Congress involved a large number of social functions, including a special performance of ballet at the Théatre National de l'Opéra and a whole-day excursion to Chantilly and Compiègne.

At the closing session of the Congress, with Prof. Fabre presiding, Prof. J. N. Davidson, who was deputizing for Sir Charles Harington as chairman of the International Committee, announced that an invitation had been received to hold the Third International Congress of Biochemistry in Brussels in 1955. Expressions of appreciation of the work of the French organizers were given formally by Prof. A. Tiselius (Sweden), Sir Rudolph Peters (Great Britain), Academician A. Oparine (U.S.S.R.), Prof. S. Ochoa (United States) and Prof. E. J. Bigwood (Belgium).

SOCIETY FOR APPLIED BACTERIOLOGY

SUMMER CONFERENCE IN CAMBRIDGE

THE summer conference of the Society for Applied Bacteriology was held during July 22–24 in Newnham College, Cambridge, and included a symposium, sessions for reading papers and visits to places of interest. At the annual general meeting, Dr. J. G. Davis (London) was elected president for the ensuing two years. The secretary of the Society, from whom further information can be obtained, is G. Sykes, of Boots Pure Drug Co., Ltd., Nottingham.

The symposium, to which contributions were made by H. B. Hawley (Yeovil), M. Ingram (Cambridge), R. S. Hannan (Cambridge), A. Hirsch (Bedford), N. R. Knowles (Belfast), and Miss M. P. Scarr (Bromley), was on "Aspects of Food Preservation". In introducing the subject Mr. Hawley described the origin and some of the earlier methods of food preservation and then, having outlined the principles required, gave some of the modern chemical, physical and biological methods in use. Dr. Ingram discussed the possibility of sterilization by high-frequency voltage fields using a voltage gradient of 1,000 V./cm. Heating during treatment is a major problem, and special precautions and apparatus have to be used to keep the test material cool. He described various types of apparatus and pulsation treatments employed experimentally, and as found that, when temperature effects are elim-ated, there is no evidence of significant lethal ction on yeast cells, *Bacterium coli* or on bacterio-hage. Earlier reports on the apparent success of he treatment must be attributed to heating effects.)r. Hannan described sterilization experiments with igh-energy electrons using an electron accelerator iving 0·1–15 MeV. or using gamma-rays from obalt-60 with energies of 0·7 and 1·2 MeV. By radiation from two sides the electrons can penetrate niformly and effectively up to 10 cm. depth and he gamma-rays rather more deeply. Certain de-terious side-effects can be avoided by pre-freezing. pinions are not in entire agreement on the actual thal doses for micro-organisms, but in general ·2 × 10^6 roentgens kill vegetative bacterial cells, nd 0·5–2 × 10^6 r. bacterial spores; bacteriophage s more resistant than bacterial cells or enzymes. 'he dose required to kill is dependent on a number f factors, including the suspension medium and xygen tension. The system appears to be economic-lly possible and would have wide applications in he pharmaceutical field. In his paper on "Anti-iotics in Food Preservation", Dr. Hirsch said that, n general, antibiotics have been used experimentally)r the preservation of certain non-acid foods, the ain organism to be dealt with being *Cl. botulinum*. ubtilin is of some value with canned peas, but in eneral the method does not appear to be practicable. Jisin has been used in cheese to prevent growth of *lostridium* species (mainly *Cl. butyricum*); this anti-iotic appears to be more effective in inhibiting ermination of spores than development of vegetative ells.

Describing his observations on "The Microbiology f Raw and Heat-treated Liquid Egg", Mr. Knowles aid that fresh-laid eggs are practically sterile intern-lly, but low-grade eggs may contain many millions f bacteria per gram. On hard freezing, the viable acterial population may be reduced by up to 55 per ent. Duck eggs are generally more heavily contam-ated, carrying, in particular, Salmonella bacteria. 3y careful organoleptic control, the quality of raw en eggs used for liquid egg preparation has recently een improved so that bacterial counts have been uch reduced, and a suggested standard of less than × 10^6 viable bacteria per gm. would be meri-orious. Heat treatment is carried out at 149–150° F. 55–65·5° C.) for three minutes in a modified plate asteurizing plant. This reduces the bacterial count o less than 1,000/gm., but careful control is necessary o reduce coagulation deposits on the plates. Miss carr, in her paper on "The Microbiology of Sugar-reserved Foods", dealt particularly with the pro-erties of osmophilic yeasts and moulds, and discussed he types usually found as contaminants and their daptability. Spoilage occurs either through growth f these resistant organisms or from local dilution f syrups brought about by condensation in the sur-ice.

Papers given at other sessions included three on e detection and classification of organisms of the oli-aerogenes group. The first, by N. P. Burman nd C. W. Oliver (London), showed that Folpmer's lutamic acid medium is somewhat superior to lacConkey medium in detecting *Bact. coli* in water; nother by T. Richards and M. T. A. Fouad (Reading) scussed the use of inorganic media containing ucose in the classification of the group, and a ird, by S. B. Thomas and colleagues (National gricultural Advisory Service), reviewed the significance of the coli-aerogenes and *Bact. coli* assessments from more than 2,500 samples of farm waters. W. A. Hoy and L. F. L. Clegg (Shinfield) described a new test for dairy disinfectants using aged milk in soiled churns. Results obtained suggest that they might parallel those from longer-termed field trials. Miss C. Higginbottom and D. W. F. Wheater (Hannah Dairy Research Institute) discussed the occurrence of *Streptococcus bovis* in rumen contents, showing that there is a significant increase during the first hour after feeding; Mrs. A. C. Stirling (Edinburgh) indicated the importance of lactobacilli in silage to ensure a rapid fall in *p*H value and so reduce nutritional losses.

From the public health aspect, A. Clarenburg (Utrecht) discussed the occurrence of Salmonella bacteria in meat. Outbreaks of poisoning from this source are usually traced to meat products rather than raw meats, and carrier animals increase the complications. E. B. Reid and M. Woodbine (Aberdeen) demonstrated the 'Pressfish' process for preparing vacuum-dehydrated foods and discussed the microbiology concerned, and a paper by S. E. Jacobs and Miss M. J. Thornley (Ambleside), on the effect of ultrasonic waves on bacteria suspended in milk, showed that treatment at 20 kW. or at 1 Mw. is only partially lethal to a variety of bacteria, increased protection apparently being afforded by the high protein content. A. M. Paton and T. Gibson (Edinburgh) described an improved technique for assessing microbiological lipase activity, and Miss J. P. Cowne and J. R. Postgate (Teddington) an improved medium for estimating sulphate-reducing bacteria by dilution counts. The normal medium is supplemented with sodium sulphide and cysteine or ascorbic acid, rendering sulphate-reducers easily detectable by the precipitation of black ferrous sulphide.

INSTITUTE OF PHYSICS

ANNUAL GENERAL MEETING

AT the thirty-second annual general meeting of the Institute of Physics, held on June 5 at the Institute's House, 47 Belgrave Square, London, S.W.1, the following were elected to take office on October 1: *President*, Dr. C. Sykes; *Vice-Presidents*, Mr. O. W. Humphreys and Dr. T. L. Ibbs, *Honorary Treasurer*, Dr. S. Whitehead; *Honorary Secretary*, Dr. B. P. Dudding; *New Ordinary Members of the Board*, Mr. H. Barrell, Dr. N. A. De Bruyne, Dr. W. H. Taylor and Mr. R. G. Wood. Prof. W. E. Curtis and Dr. F. C. Toy (past-presidents), Prof. E. G. Cox and Dr. J. Topping (vice-presidents), Mr. T. C. Keeley, Mr. G. R. Noakes, Dr. H. L. Penman and Prof. S. H. Piper continue to serve on the Board. Sir Owen W. Richardson was elected to honorary fellowship of the Institute.

The thirty-second annual report of the Board, covering the work of the Institute during 1951, was adopted at the meeting. It records that the Board met six times, and its various standing committees nineteen times, during the year. The membership increased by 222 to 4,080. Applications for election or transfer to the various grades of membership of the Institute received during 1951 numbered 524, compared with 627 in the previous year. There was a slight decrease in the number of subscribers and students, but substantial increases in the numbers in the other grades, particularly in the recently established grade of graduateship. The regulations and syllabuses for the graduateship examination which were published during the year aroused wide interest, and the number of candidates for the first graduateship examination, held recently, was greater than was anticipated. The regulations governing election to the associateship grade were modified to permit the admission of candidates whose training in physics is adequate but who may have graduated in subjects other than physics.

The number of candidates who presented themselves for the 1951 examination for National Certificates in Applied Physics was substantially greater than in the previous year; twelve colleges entered candidates at the ordinary level and five at the higher stage. Nine technical colleges which have applied for recognition, or for an extension of recognition, as institutions approved by the Institute for the education and training of physicists, were inspected.

In 1949 the Board decided that the Institute should rapidly increase the volume of its publications, and although this development has been somewhat restricted by printing and other delays and the substantial rise in the cost of printing and paper, it has largely been implemented. In addition to its two journals, the *Journal of Scientific Instruments* and the *British Journal of Applied Physics*, and its monthly *Bulletin* to members, two further monographs in the "Physics in Industry" series were published. Other books published for the Institute (issued by Edward Arnold and Co.) were "Some Aspects of Fluid Flow" containing the papers presented at a conference organized by the Institute in October 1950; "Bibliography on Electron Microscopy", edited by Dr. V. E. Cosslett for the Institute's Electron Microscopy Group; and a further selection of laboratory and workshop notes from the *Journal of Scientific Instruments*, prepared and edited by Dr. Ruth Lang. A new development is the Board's decision to sponsor a series of small books suitable for university students and those studying for Higher National Certificates in Applied Physics, each of which will cover some branch of applied physics and be written by an authority in that field. It is hoped to launch the series shortly.

In addition to individual inquiries from members concerning professional matters, the Board has considered the Ministry of Labour's report on the supply of and demand for physicists, the right of travel for men of science and the part-time employment of retired members; and it has issued an informative report on the second survey of salaries and emoluments paid to fellows and associates of the Institute resident in Great Britain and Ireland. The Institute is represented on the Parliamentary and Scientific Committee and the Joint Council of Professional Scientists, and thus keeps in close touch with science in the government service and ensures that proper regard is given to the scientific point of view in the political sphere.

The fifteen local branches and specialist subject groups of the Institute held more than a hundred meetings during the year. Details of the various activities of the branches and groups are listed in the report. A new event was the very successful exhibition of scientific instruments and apparatus arranged by the Australian Branch in Melbourne, which attracted some four thousand visitors during the four days it was open to the public. The Branch committee ha given consideration to a proposal that an independen Australian Institute of Physics be established, an the Board of the Institute has intimated that, if th proposal should receive the support of the Australia members, it would welcome the development. Th London and Home Counties Branch, under the chai manship of Dr. A. J. Maddock, held a summer meetin at the Cavendish Laboratory, Cambridge, and an 'a home' at the Institute's House in October. Th Education Group held meetings in Birmingham (i conjunction with the Midland Branch) and Mar chester (with the Manchester and District Branch together with a joint meeting at Cambridge with th Electronics Group, and a three-day conference i London; it also visited the Royal Naval Colleg Greenwich. The X-Ray Analysis Group held its usu two conferences, has continued its work on th extension of data for the card index of diffractio data published by the American Society for Testin Materials, and has published a memorandum on th preparation and mounting of polycrystalline spec mens for X-ray analysis. It is interesting to note th the National Committee of Crystallography, on whic the Board is represented, has directed the attentic of the X-Ray Analysis Group to the fact that th fortieth anniversary of the discovery of X-ra diffraction falls in 1952. It has since been announce that a commemorative meeting will be held durin October 24–25 at the Royal Institution (see *Natur* June 7, p. 949).

COST OF GERMAN MEDICAL AND SCIENTIFIC PERIODICALS

By DR. W. BONSER
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AND
MARGARET P. RUSSELL
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THE exorbitant cost of German medical an scientific periodicals has once again become th concern of those who budget for university and oth learned libraries. The cost of English periodicals h continued to rise, although slightly, owing to i creased cost of publication; still more has the cost American periodicals risen, not only on account devaluation but also on account of similar productio increases in the United States as well. But the co of German periodicals has exceeded those to a alarming extent, and appears to be settling down at figure which will make it impossible for many Britis libraries to continue their subscriptions.

A parallel situation arose after the First Wor War, and a united effort by those affected—conduct in the pages of *Nature*—succeeded in achieving reduction of 20 per cent in 1933 and a further redu tion of 25 per cent in 1935, conceded after a fall value of the pound sterling. The pre-war complain were not only of the excessive cost compared w that of British periodicals of a similar nature a size, but also of the impossibility of computing t annual cost, owing to irregularity in the number volumes per year. This same state of affairs regre tably still obtains.

An analysis of costs of a selection of representati medical journals in similar subjects from Gre

Britain, the United States, other European countries, and Germany (for example, *Journal of Physiology*, *American Journal of Physiology*, *Archives internationales de Physiologie*, *Pflügers Archiv*) has been made for the years 1938–39, 1950 and 1951, and shows that in these last two years the cost of German journals exceeded the combined sum expended on the others, although the increase on account of devaluation of sterling amounted to 45 per cent for American, and 26 per cent only for German periodicals. Compared with 1933, the totalled prices of the sets of journals in the four categories, taking the average of 1950 and 1951 in each case, may be presented in simple ratio as follows :

	British	American	Other countries	Germany
1933	1·0	1·06	0·875	3·8
1950–51 (averaged)	1·0	1·69	0·96	4·15

showing that the case for a reduction in price of German periodicals holds again.

A further table has been compiled showing that of these German periodicals from different publishing houses, those emanating from the Springer Verlag are three (3·2) times the cost of the others, and although the 1951 figures for Springer publications show a reduction on 1950 prices, the fall would appear to be due not to a reduction in price but to one in output.

We are told by experts that the post-war value of German scientific and medical periodicals is scarcely yet up to pre-war standard, but is still of high enough quality to justify their purchase by those who can afford them. It is obvious that German scientists will do their utmost to achieve the highest standard, and we are assured that they are prepared to co-operate in this effort to reduce the excessive price of their journals. We are sure it will be agreed that their output is as essential to research as that of other countries, and curtailment of its circulation owing to prohibitive costs is to be deplored. American librarians are equally anxious to find a solution to this problem, as has been evidenced in our correspondence with them.

It is impossible to print here the full text of this nvestigation, done in 1950 and revised for 1951 ; but a copy will be sent on request to those interested.

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FUNDAMENTAL PARTICLES

SCIENCE PROGRESS of April (40, No. 158, 193 ; 1952) contains an interesting and informative article by Prof. H. S. W. Massey entitled "Fundamental Particles", the term which is applied usually to such entities as electrons, protons, etc. Prof. Massey points out, however, that the quantum theoretical description of the physical world is a dualistic one in which mechanical phenomena are viewed from both a particle and a wave aspect and that classical physics is the limiting case when h, Planck's constant, tends to zero. It is better, therefore, when describing the fundamental nature of matter and radiation to begin with the purely wave description and then, by imposing quantization, to lead to the particle aspect.

It is Prof. Massey's contention that the general features and consequences of the application of quantum theory to wave fields can be made clear without the use of elaborate mathematics and can be appreciated without a detailed knowledge of physics, and after reading his admirable article the reader will doubtless agree with Prof. Massey. The quantized electromagnetic field and its associated particles, the photons, are dealt with first, then the electron field and finally the interaction between the two fields. It is shown that at no stage is it necessary to postulate action at a distance, but that the necessary interaction between particles can be transmitted through the electromagnetic field vacuum photons.

Turning next to the subject of the classification of the fundamental wave particles, Prof. Massey shows that the particles can be loosely separated into three categories, which he aptly terms "building stones" (electron, proton and neutron), "cements" (photon and pi-meson) and "bric-a-brac" (neutrino, mu-, V-, tau- and kappa-mesons). The first two categories, as their names imply, are involved in the structure of matter, but the third, apparently, does not fulfil any important role in that respect. The properties of the various particles and the relations between them are briefly and clearly described, and it is evident that their number (now some twenty-four) is far too large for them all to be fundamental. Nevertheless, as Prof. Massey states, the discovery of new particles is still a prominent feature of modern physics, and thus, until some new fundamental advance or simplification is made on the theoretical side, not only to provide a basis for the "bric-a-brac" but possibly also to account for the more complete range of particles yet to be explored, the fundamental scheme of Nature must remain obscure.

S. WEINTROUB

DATING THE LIBYAN DESERT SILICA-GLASS

By DR. KENNETH P. OAKLEY

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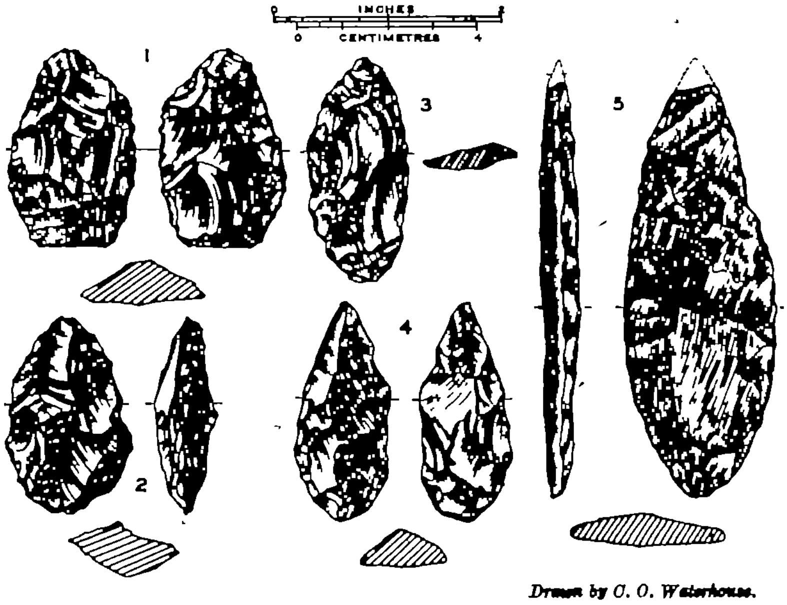
PIECES of natural silica-glass up to 16 lb. in weight occur scattered sparsely in an oval area measuring 130 km. north to south and 53 km. from east to west, in the Sand Sea of the Libyan Desert. This remarkable material, which is almost pure (97 per cent SiO_2), relatively light (sp. gr. 2·21), clear and yellowish-green in colour, has the qualities of a gemstone. It was discovered by the Egyptian Survey Expedition under Mr. P. A. Clayton in 1932, and was thoroughly investigated by Dr. L. J. Spencer, who joined a special expedition of the Survey for this purpose in 1934.

The pieces are found in sand-free corridors between north–south dune ridges, about 100 m. high and 2–5 km. apart. These corridors or 'streets' have a rubbly surface, rather like that of a 'speedway' track, formed by angular gravel and red loamy weathering debris overlying Nubian Sandstone. The pieces of glass lie on this surface or partly embedded in it. Only a few small fragments were found below the surface, and none deeper than about 1 metre. All the pieces on the surface have been pitted or smoothed by sand-blast. The distribution of the glass is patchy



Drawn by C. O. Waterhouse.

PROBABLE ATERIAN ARTEFACTS FROM LIBYAN SAND SEA

(1) Miniature foliate 'hand-axe' in silica-glass; plano-convex; probably made from thick flake. The straight basal margin is a natural surface pitted by sand-blast. The *arêtes* of the flake-scars are slightly smoothed. Brit. Mus. (Nat. Hist.) Geol. Dept. *E.* 1454

(2) Miniature foliate 'hand-axe' in silica-glass. The narrow area on one face which shows shallow pitting is a remnant of a surface which was sand-blasted before the material was worked. The flaked surfaces are slightly smoothed by sand-blast. *E.* 1453

(3) Thin, twisted, bifaced foliate point in silica-glass. Slightly smoothed by sand-blast Perforated by meandering tubular cavity, 0·6–1·5 mm. in diameter, which is blocked at the narrower end by a particle of loam. *E.* 1455

(4) Bifaced foliate point in silica-glass; plano-convex; probably made from a flake All the edges are smoothed by sand-blast, the convex surface considerably so. *E.* 1456

(5) Bifaced foliate point in quartzite. Tip broken. Slightly worn by sand-blast. *E.* 1452

(ref. 1, see map, p. 434). It was found to lie most thickly around the expedition's Camp 7 (lat. 25° 17′ 54″ N., long. 25° 34′ 0″ E.). At several places there were groups of flakings, evidently where large lumps had been broken up by man. Only two small fragments were found upon the dune ridges. They occurred in company with an implement of quartzite and had evidently been carried there. One piece of silica-glass was found 240 km. south by east of the main area of distribution, and another piece 225 km. to the east-south-east. These, too, had probably been transported by man.

While undoubtedly natural, the origin of the Libyan silica-glass is uncertain. In its constitution it resembles the tektites of supposed cosmic origin, but these are much smaller. Tektites are usually black, although one variety found in Bohemia and Moravia and known as moldavite is clear deep green. The Libyan silica-glass has also been compared with the glass formed by the fusion of sand in the heat generated by the fall of a great meteorite, for example, at Wabar in Arabia and at Henbury in Central Australia. Reporting the findings of his expedition, Dr. Spencer (ref. 2, p. 506) said that he had not been able to trace the Libyan glass to any source; no fragments of meteorites or indications of meteorite craters could be found in the area of its distribution. He said: "It seemed easier to assume that it had simply fallen from the sky".

It would be of considerable interest if the time of origin or arrival of the silica-glass in the Sand Sea could be determined geologically or archæologically. Its restriction to the surface or top layer of a superficial deposit suggests that it is not of great antiquity from the geological point of view. On the other hand, it has clearly been there since prehistoric times. Some of the flakes were submitted to Egyptologists in Cairo, who regarded them as "late Neolithic or pre-dynastic" (ref. 3, p. 504). In spite of a careful search by Dr. Spencer and the late Mr. A. Lucas, no objects of silica-glass could be found in the collections from Tut-ankh-Amun's tomb or from any of the other dynastic tombs. No pot-sherds were encountered in the silica-glass area, but in the neighbourhood of the flakings some "crude spear-points of glass" were found, also some quartzite implements, "quern stones" and ostrich-shell fragments (ref. 1, pp. 433, 435).

In the hope of throwing more light on the date of origin o silica-glass in the Sand Sea, al the artefacts of this materia which Dr. Spencer deposited in the British Museum (Natura History) have been re-examined together with those of other materials from the same area which he brought to England.

The artefacts collected were mainly from workshop sites in the region of Camp 7 in Street *B* and in the neighbouring parts of Street *A* to the west (19 km north of Camp 9) and of Street *C* to the east (west of Camp 10). The material preserved in the Departments of Mineralogy and Geology in the British Museum (Natural History) comprises: two bifaced foliate points, two small bifacial tools (miniature 'hand-axes'), one atypical core and more than 22 flakes and flake-blades of silica-glass; one bifaced foliate point and nine flakes and flake-blades o quartzite (silicified Nubian sandstone); two pieces of hæmatite. (These pieces of hæmatite were presumably brought into the area by man. The so-called quernstones, found, for example, in Street *C* in proximity to quartzite flakes, were probably for grinding hæmatite into red ochre (ref. 4, p. 71). A typical pair comprised a large flat lower stone o partly silicified Nubian sandstone, and a smaller bun-shaped upper stone (an oval boulder of the same sandstone, but of much coarser grain).)

All the flaked artefacts are of palæolithic facies The flakes of silica-glass include a few large Clactonoid forms (that is, struck by the elementary *bloc-on-bloc* technique), while several are Levalloisoid (that is struck from prepared cores). Many of the quartzite flakes and flake-blades are Levalloisoid. Indeed, since they show faceted striking-platforms in addition to evidence of preparation of the face of the core, they may be described with little hesitation as Levalloisian. In comparing the typology of the artefacts of the two materials, it has to be remembered that whereas any flake of silica-glass would have been kept by the investigators, the rougher flakes of quartzite would probably have been neglected. Moreover, the flaking qualities of quartzite and silica-glass are very different A high percentage of the flakes of silica-glass are o e narrow form now called 'flake-blades' (ref. 5, 91), and include curving spalls up to 9 cm. long ef. 3, p. 504). It is noteworthy that the collection cludes no true blades (that is, made by the punch-chnique); nor does it include any microliths.

The *bloc-en-bloc* and prepared-core techniques were ed in Africa by various cultural groups extending er a long range of time, so that the Clactonoid and evalloisoid flakes are not closely diagnostic of the e or cultural status of the silica-glass workshops. owever, there are five artefacts in the collection ted above, all from Camp 7, and four of them in lica-glass, which indicate the Late Palæolithic lture known as Aterian—that is, the bifaced liate points and the miniature 'hand-axes' (see lustration). The bifoliate points are the "crude ear-points of glass" noted by Dr. Spencer (ref. 1, . 433). These figured specimens are now in the epartment of Geology of the British Museum Natural History).

These artefacts can be closely matched in the terian industries which occur in Morocco, Algeria d sparingly farther east, for example, in the harga Oasis (ref. 6). The Aterian is based on a evalloiso-Mousterian ('Middle' Palæolithic) tradition, d is akin to the Still-Bay industries of the southern alf of Africa. It is distinguished by the absence of e true blade elements which characterize the suc-eeding Capsian group of industries. Commonly per cent or more of the artefacts in an Aterian dustry are flake-blades (ref. 5, p. 121). The associa-on of bifaced foliate points with certain types of and-axes', including miniature forms, is one of the atures of the Aterian industries noted by Miss aton-Thompson (ref. 5, pp. 91, 97). The type-artefact f Aterian culture is the tanged-point, or arrow-head. t is regrettable that none is represented in the ollection of silica-glass artefacts which has been xamined (but it is perhaps worth recording that one f the pointed flake-blades from Camp 7 is accident-lly pedunculate and most deceptively simulates the orm of a blunted Aterian arrow-head).

While the only well-defined artefacts in silica-glass rom the Sand Sea are almost certainly Aterian, one not justified in concluding that all the flakings in his material are of the same age. Some may well be ounger; for example, any which are contemporary ith the ostrich-shell fragments and grinding stones re probably not older than Upper Sebilian (Meso-thic). But more important from the point of view f the present inquiry is the question of whether any re *older* than Aterian.

Some of the larger flakes of silica-glass might well e Early Palæolithic (Acheulean) waste-flakes; but hey could equally well be the primary or 'quartering' akes of an Aterian industry. Similarly, although heir proximity to bifaced foliate points strongly uggests that they are Aterian, the miniature 'hand-xes' described above might be exceptionally small cheulean hand-axes. However, it is true to say that o undoubtedly pre-Aterian artefact in silica-glass as been found.

At a point 24 km. south of Camp 8 in Street *D*, ixty large quartzite hand-axes of Upper Acheulean ype were discovered lying on the surface with lossy sand-worn faces uppermost (ref. 1, p. 435). A ew were deposited in the Cairo Museum; others vere left *in situ* for further investigation. I have xamined one specimen, regarded as typical of the roup. It is a symmetrical biface with Gothic-arch ip, true-edged, 21 cm. long, 10·5 cm. wide, and with maximum thickness of slightly less than 5 cm. Associated with these large hand-axes there were quartzite waste-flakes. At the same site there were scattered pieces of silica-glass, but none appeared to have been worked. If Acheulean hunters had encountered silica-glass in pieces as large as those occurring, for example, in Street *C* about 10 km. to the west-north-west, it seems probable that they would have attempted to use it as raw material for hand-axes, just as they used the volcanic glass (obsidian) at Kariandusi in the Kenya Rift Valley (ref. 7, p. 36). The fact that no undoubted Acheulean artefacts in silica-glass have been found cannot be regarded as proving that this material was absent from the region during the period of that culture; for it is possible that such artefacts occur, but have not yet been found or recognized. Another possibility is that attempts by the Acheuleans to work the material into large hand-axes were unsuccessful owing to its brittleness and the consequent wastage. It must be remembered that large pieces of silica-glass may have been rare even at the time of its origin, whereas the supplies of obsidian at Kariandusi were probably large enough to allow considerable wastage in the manufacture of hand-axes.

Thus the archæological evidence allows us to go no further at present than to conclude that silica-glass was present in the Libyan Sand Sea in Late Palæolithic (Aterian) times. But it is important to bear in mind that the glass was already corroded by sand-blast before it was worked into the bifaced points. It should be noted here that the Acheulean and Aterian cultures may have been separated by a considerable interval, corresponding to the time when the basic Levalloiso-Mousterian culture flourished. The Aterian was technologically a derivative of the Levalloiso-Mousterian, and is now considered to have been broadly contemporary with the 'Aurignacian' and Solutrean cultures of Europe—that is to say, it has a probable antiquity of between 10,000 and 20,000 years.

Several artefacts of natural green glass (moldavite) were found in the 'Upper Aurignacian' (Gravettian) levels in the loess at Willendorf in Lower Austria (ref. 8), and one example, apparently from a Mousterian horizon, in the Gudenus Cave in the same region (ref. 9). It is also interesting to note that tektites have been found in the Trinil beds of Java, which are considered to be of about the same age as deposits containing remains of Acheulean culture in the west, that is, Middle Pleistocene (ref. 10). Thus the suggestion that Libyan silica-glass, moldavite, and other tektites represent 'glass-meteorites' which reached the earth within a limited period of time (ref. 11) at least appears consistent with the rather meagre archæological and geological evidence.

In conclusion, I should like to express my thanks to Dr. L. J. Spencer for the help he has given me in the preparation of this article.

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MISCIBILITY OF LIQUIDS INFLUENCED BY RATE OF SHEAR

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WHETHER or not phase separation will occur in a liquid system is a question of the mutual solubilities of its components. It is usually assumed that, if pressure and relative composition are held constant, the temperature alone determines these solubilities and thereby decides the question of demixtion, that is, the general phase state of the system. From experiments which we have performed it appears, however, that the assumption of complete determination of solubility by temperature at constant pressure and relative composition requires considerable amendment. Our results show that in the case of certain demixed liquid–liquid systems the maintenance of a field of flow (stirring) can affect the solubility and thereby the miscibility of the phases as profoundly as a change of temperature of, say, 10° C., or a 1·15-fold dilution. It was found that even relatively mild flow conditions suffice to bring about complete reversal of phase separation in these systems.

The systems referred to are formed when two macromolecular solutes, for example, polystyrene and ethyl cellulose, are dissolved in the same solvent, for example, benzene. In such cases phase separation sets in at very low solute concentrations and the two phases formed contain disproportionate amounts of the two solutes. A comprehensive study of such systems has been made in particular by Dobry and Boyer-Kawenoki[1]. Taking as example the system polystyrene – ethyl cellulose – benzene used in our experiments, it is found that a solution containing only 2–3 per cent total polymer (degree of polymerization about 1,000) is separated into two phases at room temperature. These phases again each contain 97–98 per cent benzene, but one is largely a solution of polystyrene with only a little ethyl cellulose, and the other is an ethyl cellulose solution with relatively little polystyrene.

The two phases obtained in this manner are similar in their behaviour to the phases obtained when two partially miscible liquids, for example, water and amyl alcohol, are mixed together.

The systems are dependent on temperature and, in the particular case of the system polystyrene – ethyl cellulose – benzene considered here, the mutual solubility of the phases is increased as the temperature is raised. More ethyl cellulose is dissolved by the phase rich in polystyrene and more polystyrene by the phase rich in ethyl cellulose. The compositions of the two phases of the unstirred system therefore approach each other as the temperature is increased, and for each given overall composition there exists a well-defined 'critical' solution temperature T_c at which phase separation just ceases and above which the system is homogeneous.

Overall concentration (% w/w)			T_c (°C.)	Relative volume of phases at 21·7° C. i.e., T_c–10° C. (vol. %)	
Benzene	Polystyrene	Ethyl cellulose		I	II
97·1	1 14	1·80	31·7	47	53

At 22° C. the above system is obviously 10° C. below its critical temperature and is separated into two phases. If, however, a velocity gradient of $q = 200$ sec.$^{-1}$ is maintained in this system (at 22° C.) a homogeneous one-phase solution results. Ther exists, in fact, a quantitative relationship betwee the number of degrees, ΔT (°C.), by which the syste is below its critical solution temperature, and th rate of shear q (sec.$^{-1}$) which can completely rever the phase separation at the temperature $T_c - \Delta T$. I the case of the particular system investigated by u this is:

$$q = 20\ \Delta T. \qquad (1$$

In order to illustrate the rates of shear necessar according to (1) to produce a noticeable shift in th critical solution temperature, consider a Couett apparatus, that is, a cylindrical drum (say, 5 cm. i diameter), rotating in a concentric cup (say 7 cm. i internal diameter), the interspace being filled wit solution, and assume that the angular speed of rotatio of the drum is 1 revolution per second. (These pa ticular dimensions apply to the apparatus used by u It is worth noting, by the way, that, as the viscosit of the solution is 0·11 poise, laminar flow condition prevail up to about $q = 270$ sec.$^{-1}$.) Such a spee which could easily be maintained by hand, would i this case correspond to a rate of shear $q = 27$ sec. and would, according to (1), suffice to change th critical solution temperature by 1·3° C.

The changes observed in this manner are completely reversible, that is, the system separates aga (becomes turbid) as soon as the rate of shear drop below the values given by (1). The effect of the fiel of flow is thus to make the homogeneous syste stable at temperatures at which the homogeneou system of the same composition, but at rest, is metastable. This means that the free energy of the stirre homogeneous system, and with it also the free energ of certain of its components, must be larger than th corresponding quantities of the resting, separate system at the same temperature.

The reversal of phase separation in a field of flo is intimately connected with the large interfacial are which is created when the separated system is gentl stirred. An immediate break-up into fine drops take place, their final size being determined by the hydrodynamics of flow. By simple dimensional analys the mean linear dimension r of the largest dro which can exist in a laminar field of flow of velocit gradient q can be related to the interfacial tension and the viscosity η of the surrounding medium. W find:

$$r = \text{const.}\ \frac{\sigma}{\eta q}, \qquad (2$$

where the constant of proportionality is dimensionless and of the order of 0·15 in cases where th difference between the viscosity of the drop and th viscosity η of the surrounding medium is small[2].

If it is assumed that the interfacial tension is lef unaffected by the decrease in drop radius, equatio (2) represents the effect of the field of flow on dro size for all values of q. Our experiments have show that this is true only initially, that is, at low rate of shear, and only up to drop sizes of about 10^{-4} cm Further decrease in drop size is found to result in rapid decrease of interfacial tension and a complet reversal of the phase separation.

Experimentally, we infer the disappearance of th second phase from the disappearance of turbidity that is, of optical inhomogeneity in the system. I this optical homogeneity had been produced accordin to (2), that is, by a mere reduction in size of drop the necessary rate of shear would, obviously, hav had to be 1,000 times greater than that required fo

= 10^{-2} cm. Experimentally, however, we find a ctor of only about 10, clearly showing, as stated, at a breakdown of σ must have occurred at some termediate size of drop.

Theoretically, we can explain this phenomenon as llows. The interface between two phases is not finitely thin, but represents a transition zone of homogeneous composition, of finite thickness and lume. If this thickness is ε cm. and if there are sq. cm. of interfacial area per 1 c.c. of the system, en the interface occupies a fraction $f\varepsilon$ of the tal volume. The interfacial tension may be defined the free energy necessary to form ε c.c. of 'interce' out of the non-interfacial region of the system. he existence of f sq. cm. of interface therefore aplies a free energy increase of $f\sigma$ ergs/c.c. relative the state of the system in which $f = 0$. An isoermal approach in composition of the two phases ould reduce σ, and therefore $f\sigma$, but would at the me time increase the free energy in the $(1 - f\varepsilon)$ c.c. ot occupied by the interface. So long as f is small $\varepsilon \ll 1$), the change in composition, which must company a reduction in $f\sigma$, will therefore severely strict this effect. In our case, ε is determined by e dimensions of the coiled polymer in solution and , thus, of the order 10^{-6} cm. When the size of drop is therefore smaller than about 10^{-6} cm., the intercial volume, $f\varepsilon$, becomes comparable with 1, and an pproach in composition leading to a reduction in tal free energy, as well as in $f\sigma$, becomes possible. t constant rate of shear, q, this decrease in σ brings ith it, as secondary effect, a further reduction in ze of drop (see (2)), and, due to the increased value f f, a renewed change in composition. Equilibrium reached between these tendencies at lower rates of ear, but there exists a critical value of q at which ese effects so reinforce each other that there is a mplete resolution of all differences in composition nd a complete reversal of the phase separation.

In the above, we have given a somewhat simplified escription. Thus, at constant q and σ, there can be reduction in f, and therefore of $f\sigma$, by a solution of me of the dispersed phase in the surrounding edium (analogous to the increase of vapour pressure f small droplets by capillarity). This reduction in f , however, in our case, where dispersed phase and rrounding medium are of roughly equal volume, ccompanied by a correspondingly large change in mposition. The two effects, the one mentioned ow and that discussed in the preceding paragraph, re therefore on closer inspection seen to be nonseparable phenomena.

It is clear that, as the size of drop, r, becomes mparable with ε, the definition of r, and with the concept of capillarity, rapidly lose precision. he homogenization process at this stage may e pictured as a gradual replacement of the nonterfacial $(1-f\varepsilon)$-regions by the interfacial $(f\varepsilon)$-gions of the system (the interface will, in general, onsume' one phase faster than the other). As $\to 1$, the concentration gradient in the interface, r energetic reasons, tends to decrease, leading ventually to the homogeneous solution as the most able state. The use of f and σ has here only a ymbolic significance.

We have emphasized the fact that the homogeneous ystem has a larger free energy than the separated, nstirred system at the same temperature (as revealed y spontaneous demixing as soon as stirring is topped[2]). The otherwise unstable homogeneous tate is thus maintained at the expense of a continuous degradation of mechanical into thermal energy in the field of flow. The rate at which thermal energy is produced under the conditions described by equation (1) in a medium of viscosity $\eta = 0{\cdot}11$ poise is obviously $\eta q^2 = 44(\Delta T)^2$ erg/c.c. sec. On the other hand, the time during which a noticeable demixtion would take place in the solution is roughly equivalent to the time, t, taken by the coiled polymer to diffuse a distance, of the order of its end-to-end distance ($\sim 5 \times 10^{-6}$ cm.). Remembering that the diffusion constant of the polymer in a medium of this viscosity is about 10^{-8} cm.^{2}/sec., $t = \frac{1}{2}(5 \times 10^{-6})^2/10^{-8} = 1{\cdot}25 \times 10^{-3}$ sec. and the thermal energy produced in this time equals $5 \times 10^{-2}(\Delta T)^2$ erg/c.c. This we compare with the free energy required to homogenize 1 c.c. of the demixed system when it is ΔT° below T_c. Using the theory of Scott[1], it is easily shown that this energy is of the same magnitude, being in the present case about $6{\cdot}2 \times 10^{-2}(\Delta T)^2$ erg/c.c. The rate at which thermal energy is produced from mechanical energy in the field of flow is thus, indeed, sufficient to prevent the homogeneous system from demixing.

From the above it becomes clear that the effects observed (shift in solubility and critical solution temperature) need not be specific to systems with macromolecular components, although it can be seen why they are particularly large in such cases. Fundamentally the same situation arises in all liquid–liquid equilibria as well as in the case of liquid–vapour transitions and the corresponding critical phenomena. [Dec. 6.

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INFLUENCE OF SUBSTITUENTS ON THE MESOMORPHISM OF *p*-*n*-ALKOXYBENZOIC AND 6-*n*-ALKOXY-2-NAPHTHOIC ACIDS

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SINCE Reinhitzer's discovery of mesomorphism in 1888, a large number of organic compounds which show this phenomenon have been prepared. Their physical appearance and the texture of their mesophases have been extensively studied by Friedel and others; but there is at present little or no information concerning the molecular dimensions which determine whether a system will show mesomorphism, or of the effect of substituents on the range and character of the mesophases. Vorländer[1] discussed the significance of certain structural features, and Bernal and Crowfoot[2] attempted to indicate the types of structure which would lead to the formation of nematic and smectic phases. Weygand *et al.*[3] made a systematic study of certain homologous series of alkoxyanils, azo- and azoxy-compounds. Nevertheless, all that can be said is that to show mesomorphism an organic molecule must either be predominantly one-dimensional or rod-shaped, as in *p*-azoxyanisole, or saucer-shaped, as in the cholesteryl esters, thus allowing the close packing in both the crystalline and mesomorphic states. In no series, hitherto, has the influence of substituents been systematically studied.

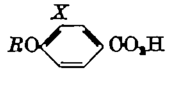
Table 1

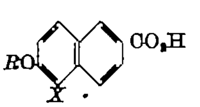
	First appearance of: (a) nematic phase	(b) smectic phase	Smectic phase only	Maximum phase-length
X = H	$R = C_3H_7$	C_7H_{15}	$R = C_{18}H_{37}$	57° ($R = C_{10}H_{21}$)
F	C_8H_{17}	C_9H_{19}	$C_{16}H_{33}$	16° ($R = C_{16}H_{33}$)
Cl	C_8H_{17}	C_8H_{17}		4 5° ($R = C_{16}H_{33}$)

Table 2

	First appearance of: (a) nematic phase	(b) smectic phase	Smectic phase only	Maximum phase $R < C_{16}H_{33}$
X = Cl	$R = C_3H_7$	$R = C_6H_{13}$	$R = C_{16}H_{33}$ and $C_{18}H_{37}$	42° ($R = C_6H_{13}$)
Br	C_3H_7	C_7H_{15}	$C_{16}H_{33}$ and $C_{18}H_{37}$	40° ($R = C_7H_{15}$)
I	C_4H_9	C_8H_{17}	$C_{16}H_{33}$ and $C_{18}H_{37}$	25° ($R = C_8H_{17}$)
NO_2	C_9H_{19}	$C_{12}H_{25}$		1·5° ($R = C_{10}H_{21}$)

In an attempt to enlarge existing knowledge regarding the molecular dimensions which would appear to be necessary for mesomorphism to occur, an examination was recently made of the relative importance of length to breadth, or flat-area, in such molecules as the 4 : 1-, 5 : 1-, 6 : 2- and 7 : 2-*n*-alkoxynaphthoic acids[4]. Here, only the 6-*n*-alkoxy-2-naphthoic acids are mesomorphic. This investigation has now been followed by a study of the influence of substituents, particularly of the halogens, in the 3-position of *p*-*n*-alkoxybenzoic acids and in the 5-position of 6-*n*-alkoxy-2-naphthoic acids.


(I)


(II)

In the benzoic acids the effect of substituents is very marked. Introduction of the large bromine atom eliminates the mesomorphism completely. With chlorine and fluorine the mesophases persist, but their length is reduced, and their appearance in the series delayed. Thus, even with a fluorine atom, the nematic phase, which first appears in the unsubstituted acids in *p*-*n*-propoxybenzoic acid, is not found until the hydrocarbon chain is lengthened to octyl, in 3-fluoro-4-*n*-octyloxybenzoic acid. Moreover, in the unsubstituted acids a maximum phase-length of 57° is found in *p*-*n*-decyloxybenzoic acid[5,6]. In the fluoro-substituted acid the maximum phase-length is reduced to 16°, and in the chloro-acids it is only 4·5°. Both maxima are found in the *n*-cetyloxybenzoic acids. Some of the data are summarized in Table 1; the alkyl groups used were CH_3 to $C_{10}H_{21}$, $C_{12}H_{25}$, $C_{16}H_{33}$ and $C_{18}H_{37}$.

In view of these results, the absence of mesomorphism in 3 : 5-dichloro-4-*n*-alkoxy- and in 3-nitro-4-*n*-alkoxy- benzoic acids is not surprising.

A substituent in the alkoxynaphthoic acid (type II) affects its breadth (looked at along the line of axis of the O*R* and COOH groups) less than it does in the benzoic acid; even with a chlorine atom in the 5-position, the molecule is only a little broader than the parent acid. As a result, the decrease in the mesomorphism is far less marked than in the benzoic acids and, in all but the first members, mesomorphism persists throughout the chloro-, bromo- and iodo-alkoxynaphthoic acids. The influence of a nitro-group is much more striking, since its size and its polar character will probably affect orientation in the melt. The first eight acids in this series show no mesomorphism, but a short nematic phase appears in 5-nitro-6-*n*-nonyloxy-2-naphthoic acid. By contrast, a nematic phase is found in the unsubstitute 6-alkoxy-2-naphthoic acids in the 6-methoxy-aci and the maximum phase-length in the first twel members is 49° in 6-*n*-hexyloxy-2-naphthoic aci The influence of increasing group size on the mesomorphism is shown in Table 2.

A particularly interesting feature of these resul is the appearance of the smectic phase. In t chloro-acids, it emerges when *R* is hexyl, wi bromine as substituent when *R* is heptyl, and wi iodine when *R* is octyl. Thus, as the size of t halogen atom increases, this phase appears pr gressively later in the series.

It might have been expected that the appearan of the nematic phase would be affected similarl That is, since a nematic phase is found with iodi and bromine as substituents in the butoxy- an propoxy- acids respectively, it might be found in t chloro-series in the ethoxy-acid. Actually, t lengths of the phases in 5-bromo-6-*n*-propoxy- naphthoic acid and in 5-iodo-6-*n*-butoxy-2-naphtho acid are so short that they cannot be measured b normal methods (they persist for less than 0·1° Moreover, the melting points of the ethoxynaphtho acids are much higher than those of the propox acids, and it is therefore not surprising that so sho a phase is not found in 5-chloro-6-ethoxy-2-naphtho acid with its high melting point of 264°.

When the alkyl group contains twelve or mo carbon atoms, the effect of an increase in the size the substituent, particularly of the halogen, is not marked, and the halogeno-stearyloxynaphthoic aci become identical in their mesomorphic behaviour.

Table 3

	Phase-length			
	X = Cl	Br	I	NO_2
$R = C_{12}H_{25}$	35°	31°	24°	4°
$C_{16}H_{33}$	35°	34°	31°	4·5°
$C_{18}H_{37}$	35°	35°	35°	8°

These compounds are the first extended series substituted mesomorphic substances to be examin in detail. The gradual decrease in mesomorphism the naphthoic acids as the size of the substituent increased, together with its elimination in the benz acids, are noteworthy.

A fuller account of this work will be publish later. [Feb. 21.

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[1] Vorländer, *Trans. Farad. Soc.*, 899 (1933).

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[3] Weygand and Gabler, *J. prakt. Chem.*, 151, 215 (1938), *Ber.*, 2 (1938).

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

E Region during the Solar Eclipse of February 25, 1952

During an eclipse of the sun, changes in the electron density (N) in an ionospheric layer of Chapman type may be represented by the relation:

$$\frac{dN}{dt} = q - \alpha' N^2, \qquad (1)$$

in which q is rate of production of electrons and α' is effective recombination coefficient. If the ionizing radiation were emitted uniformly from all parts of the disk, q would be proportional to the fraction (A_s) of the disk unobscured by the moon. Observations made at optical frequencies show that the disk radiation is not uniformly distributed. Consequently, if we assume that the ionizing radiation has a similar distribution, it is necessary to represent q during an eclipse by two terms denoting the intensity of the radiation coming from the uniform ($A_s I_0$) and non-uniform (I_s) components respectively. Thus:

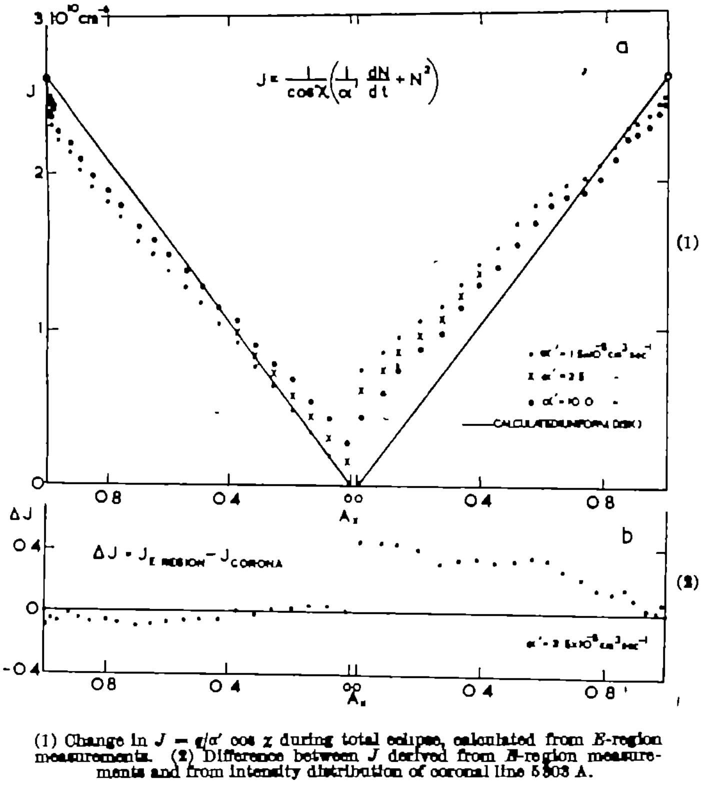
$$q = K \cos\chi \, (A_s I_0 + I_s), \qquad (2)$$

where K is a constant and χ is zenith angle of sun. Substituting this in equation (1), we can write:

$$\frac{K}{\alpha'}\,[A_s I_0 + I_s] = \frac{1}{\cos\chi}\left[\frac{1}{\alpha'}\frac{dN}{dt} + N^2\right] \; (= J). \qquad (3)$$

On the right, $\cos\chi$ is known, and N and dN/dt can be deduced from the changes in E-region critical frequency (foE) during the eclipse. Hence the values of J calculated from ionospheric measurements can be compared with those obtained by inserting different values of I_0 and I_s in the left of equation (3).

Measurements of foE were made at intervals of four minutes at Khartoum during the total solar eclipse of February 25, 1952. The standard deviation of the error in measuring foE was about 0·01 Mc./s. and, since special precautions were taken to ensure accurate timing, the maximum error in calculating dN/dt is probably about ± 10 per cent. J has been computed for several values of α', and the experimental points are shown in Fig. 1 with the computed values for a uniformly radiating disk. J has been plotted as a function of A_s since the slope of the line through the points is then proportional to I_0 (equation 3).



(1) Change in $J = q/\alpha' \cos\chi$ during total eclipse, calculated from E-region measurements. (2) Difference between J derived from E-region measurements and from intensity distribution of coronal line 5303 A.

The observations imply that the uniform (J_0) and non-uniform (J_s) components have magnitudes: $J_0 = 200 \times 10^8$ cm.$^{-3}$; $J_s = 60 \times 10^8$ cm.$^{-3}$. Part of the non-uniform component is divided about equally between the east and west limbs of the sun, since a sharp fall in J occurred just after first contact and a similar rise preceded fourth contact. It also seems probable that J did not fall to zero during totality.

These conclusions are consistent with the distribution of intensity over the disk of the green coronal line, information on which has been obtained through the courtesy of M. L. d'Azambuja, of the Paris Observatory at Meudon. The difference between the value of J calculated from the coronal data, assuming an extension to 1·04 solar diameters, and from the E-region measurements, assuming $\alpha' = 2·5 \times 10^{-8}$ cm.^{3} sec.$^{-1}$, is shown in Fig. 2. The main discrepancy appears abruptly just after totality, and suggests the existence of an intense source of ionizing radiation near the west limb of the sun which cannot be accounted for in terms of the solar data available at present. If J is not allowed to become negative just before totality, the minimum possible value of α' is $1·5 \times 10^{-8}$ cm.^{3} sec.$^{-1}$. This would imply that J rose from 0 just before, to 73 ± 10^8 cm.$^{-3}$ just after, totality, and also that 28 per cent of all the ionizing radiation was emitted from 0·4 per cent of the disk area. On these grounds a somewhat higher value of α' may be required, at least near totality.

A fuller account of these and other ionospheric measurements made during the eclipse will appear elsewhere. The work described above was carried out as part of the programme of the Radio Research Board and this note is published by permission of the Department of Scientific and Industrial Research.

C. M. Minnis

Radio Research Station,
Ditton Park,
Slough, Bucks.
July 19.

Observation of a τ-Meson

ANOTHER example[1-4] of a τ-meson has been found, on an Ilford *G5* plate, 1,200 microns thick, exposed on Mount Rosa (4,550 m. above sea-level) surrounded by an aluminium absorber 5 cm. thick.

The τ-particle enters the emulsion from the glass almost horizontally, and, after travelling for about 8,000 microns, decays at rest into three particles, with tracks *a*, *b* and *c* (see photograph). The first two of these go into the glass after 2,600 and 2,000 microns in the emulsion respectively; the third, *c*, is much shorter and goes into the air after 100 microns.

The three tracks, *a*, *b*, *c*, are sufficiently long to allow accurate measurements of the projected angles between them and of their dips. We find the following: dip of *a* = − 29°; dip of *b* = − 36°; dip of *c* = + 49°; angle *ab* = 115° 30′; angle *ac* = 114° 30′. With these values one can verify that the three tracks are coplanar within ± 1° and lie in a plane inclined about 51° to the plane of the emulsion. The true angles are: angle *ab* = 91½°; angle *ac* = 127°.

Accurate measurements by grain counting have been carried out on the first two tracks, *a* and *b*, and less accurate ones on the third, *c*. The values obtained are: 68·5 ± 1·9, 49 ± 1·8, and 37 ± 4·3 grains per 100 microns respectively. These values have been referred to the ionization versus range relation experimentally determined for μ-mesons of the same part of the plate. In this way, we have found that the number of grains of the three tracks, *a*, *b*, *c*, are the same as those of μ-mesons at distances of 4·8 mm., 10·3 mm. and 17·5 mm. from the end of their range. If we suppose that the three tracks are due to π-mesons, we obtain in this way for their energies the following values: for *a*, 17·4 ± 0·7 MeV.; for *b*, 27·3 ± 1·2 MeV.; and for *c*, 37 ± 5 MeV. The independent measurements of the mean angle of scattering for the first two tracks *a* and *b*, which give $\bar{\alpha}_a$ = 0·98° ± 0·16° and $\bar{\alpha}_b$ = 0·47° ± 0·18°, are fairly consistent with the previous assumption.

Assuming that the total momentum of the three particles is zero, and that all three of them are π-mesons, one can easily calculate with the preceding data the mass of the τ-meson. Giving most weight to the grain-counting measurements, and assuming alternatively as exact the determinations relating to track *a* or to track *b*, we obtain the following results:

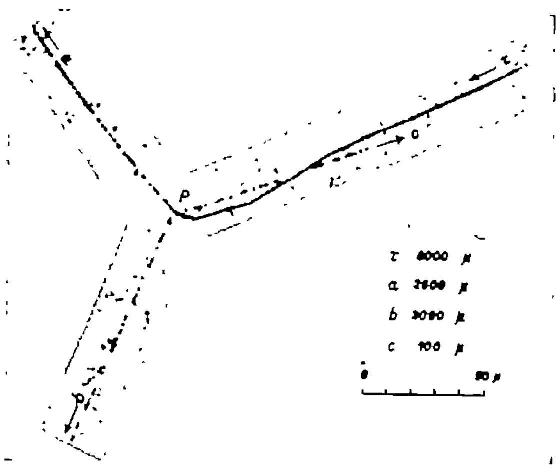
KINETIC ENERGY IN MEV

	Track *a*	Track *b*	Track *c*	Total	Mass of the τ-particle
Based on *a*	17·4 ± 0·7	28 2	43·3	87·9 ± 6·8	994·1 m_e
Based on *b*	16·8	27·3 ± 1·2	41	85·1 ± 7·2	968·6 m_e
Mean	17·1	27·8	41·6	86·5 ± 5	991 ± 15 m_e

In estimating the probable error, we have taken into account not only the errors in the grain counting and the measurement of the angles but also the lack of precision on the value of the thickness of the emulsion and the errors in the mass of the π-meson (274 ± 2 m_e).

The great length of the track of the τ-meson itself in the emulsion allows us to make two direct and independent measurements of its mass, based on the angle of scattering and range and on the ionization and range relations.

For the first, we have divided the track in parts of 1 mm. and have measured the angle of scattering for each of them, and hence the energy (for a low-energy



track one can obtain directly the energy from the *p* value without knowing the mass). The energ versus range relation is found to be:

Range	500	1,500	2,500	3,500	4,500	5,500	6,500	micron
Energy	7·8	13 1	16·3	21	24 2	27·6	32	MeV.

The corresponding mass of the particle is 946 ± 140 m_e

For the second, the gap/range relation for th τ-particle has been plotted and compared with gap range relations for protons and μ-mesons; in thi way a value for the mass of 995 ± 150 m_e has been found. As a mean value from the two direct measure ments we can take 970 ± 100 m_e, in fair agreemen with the preceding determination.

The accuracy in the determination of the data o two of the disintegration tracks, *a* and *b*, enable us to test, by means of the conservation of momen tum, whether the event considered can be inter preted satisfactorily only by assuming that the three disintegration tracks are due to π-mesons, or whethe alternative modes of decay, including one or more μ-mesons, are possible. We have therefore calculated assuming as exact the experimental values of th energy relating to track *a*, the values of the energy for the other two tracks in accordance with th conservation of momentum, in all the possibl cases. We obtain in this way the following eight possibilities:

KINETIC ENERGY IN MEV.

a	*b*		E_a	E_b theoretical	E_c theoretical	E_b experimental	E_c experimental
π	π	π	17 1	27 8	41·6	27·3	37
π	π	μ	17·1	27 8	49·7	27·3	28·9
π	μ	π	17·1	33·7	41 6	21·3	37
π	μ	μ	17 1	33·7	49·7	21·3	28 9
μ	π	π	13 6	17·8	27·0	27·3	37
μ	π	μ	13 6	17·8	33 5	27·3	28 9
μ	μ	π	13·6	22·5	27 0	21·3	37
μ	μ	μ	13 6	22·5	33·5	21·3	28·9

We see that the only cases in which there is complete agreement for the three tracks between theoretical and experimental values within the experimental errors are the first and the last; that is, either if the three tracks are all π-mesons, or if they are all μ-mesons. But in this last case the total energy of the three tracks would be 63·8 MeV., and that would give for the mass of the τ-meson the value 766 m_e, which is well outside the probable error of the direct determination of mass of 970 ± 100 m_e. We think, therefore, that our analysis gives direct evidence that the three decay products of the τ-meson are all π-mesons, even without reference to preceding similar events, in which the nuclear interaction[1] or the direct measurement[4] of the mass of one of the condaries has already given evidence that at least ne of them was a π-meson.

It is interesting to observe that our detailed analysis f the event was made possible by the fact that it ok place in a very thick emulsion; for the great clination of the plane of the π-mesons to the plane f the emulsion would not otherwise have allowed e tracks to be sufficiently long for that purpose.

We wish to acknowledge the help of the Brussels roup and especially of Prof. G. Occhialini in developg the plate. The event was discovered by Mr. M. reco.

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Detection of *S* Waves in the Earth's Inner Core

A theoretical calculation by one of us[1] shows at, if the earth's inner core has a rigidity comparable ith its incompressibility, then the seismic phase KJKP would, on present available knowledge, be ost likely to be detected over a range of epicentral stance Δ given by 130° $\leqslant$ Δ $\leqslant$ 155°, the expected ergy and amplitude in this phase being about 0·04 d 0·2, respectively, of that in the companion phase KIKP. The phase *PKJKP* appears, therefore, to on the border of observability and, if the solidity the inner core is to be established, it becomes portant to investigate the practical question of tecting a phase of such low amplitude.

The difficulty of the process of detection has been arply focused by work of one of us (T. N. B.-G.), ho has searched for the phase *PKJKP* over the ries of seismograms recorded at the Riverview ollege Observatory from 1909 to the present day. he work, details of which are to be published elsehere, shows that, of the whole series, there were ly seventeen shocks for which Δ was in the above nge and for which the amplitude of *P′* was greater an or equal to 4 μ. Of these seventeen shocks, Δ was proximately in the range 142°–145° in ten cases, and ere was a fair probability that the observed *P′* reted to a branch other than *PKIKP*. Of the remaing seven shocks, one had *P′* amplitudes of 6 μ, two of μ and four of 4 μ. In the case of *P′* amplitude 6 μ Δ = 133°), there were microseisms of amplitude near the theoretical arrival-time of *PKJKP* and impulse was observed. In one of the cases of *P′* plitude 5 μ, microseisms were significant, and in the her the seismogram was changed at the expected KJKP arrival-time. In the cases of *P′* amplitude , there were movements near the expected arrivale of *PKJKP* of amplitudes greater than or equal those of *P′*; the size of these amplitudes means at they must be attributed to other causes.

The "International Seismological Summary" is of nited value in the search for *PKJKP* as it does not cord amplitudes. A search was made over a section the "Summary", and, while a limited number of recorded impulses were found to agree with the travel-time of *PKJKP*, it was not possible statistically to make any inference.

The main point which emerges from this investigation is the relatively small number of records from which the existence of the phase *PKJKP* is likely to be substantiated. It appears that, unless a record is traced far inland where microseisms are negligible, a prerequisite for observation of *PKJKP* is that the *PKIKP* amplitude should be at least about 20 μ. Not one of the Riverview seismograms over a period of more than forty years both conforms to this criterion and has the value of Δ in the correct range. The important question as to whether the earth's inner core is solid can therefore not be decided in this way, unless many routine observatory workers would be willing to record significant onsets (preferably on vertical component seismograms) within 20–30 sec. (say) on either side of the expected arrival-time[2] of *PKJKP*, whenever the *PKIKP* amplitude reaches 20 μ. The first of the signatories to this letter would appreciate it if details of such recordings could be transmitted to him. It appears that the best ranges to consider are 130° $\leqslant$ Δ < 142°, 145° < Δ $\leqslant$ 155° (for 142° $\leqslant$ Δ $\leqslant$ 145°, it is difficult to estimate the amplitude of *PKIKP*).

It may be remarked that in the large earthquake of November 25, 1941 (φ = 37·5° N., λ = 18·5° W.), the *P′* amplitude at Riverview was 74 μ, while amplitudes of 11 μ and 15 μ were recorded on the vertical component, respectively 2 sec. before and 11 sec. after the expected arrival-time of *PKJKP*. The value of Δ for this earthquake is 171°, for which the calculated amplitude of *PKJKP* is only 0·03 times that of *PKIKP*. The theoretical amplitude calculations could be in appreciable error if the region *F* of the earth[3] differs seriously from the simple model assumed in the calculations, so that the onsets recorded at Riverview in the case of this earthquake could just possibly be significant in relation to *PKJKP*. It is suggested that the records of this earthquake might well be examined at observatories within the ranges of distance mentioned in the previous paragraph.

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Silver Films and Dielectric Multiple Films in Interferometry

The work on multi-layer dielectric films as described recently by A. H. Jarrett and H. v. Klüber[1] is of interest in two respects: the reflectivities reported are rather higher than those found by other workers, and the successful use with étalons shows that these films must have a considerable degree of uniformity. But the comparison of the relative merits of these films and silver films for use with Fabry–Perot interferometers is very misleading. Jarrett and v. Kluber do not mention recent publications on the resolving power of silvered étalons and the reflectivity of evaporated silver layers[2]. If the measurements published in these papers are taken into account, it is apparent that multilayer coatings are not superior, in the range of wave-lengths over which they have been investigated, to evaporated silver films of good quality.

The value $R = 0{\cdot}90$ does not represent the "useful upper limit" of the reflectivity of silver layers (as is stated by Jarrett). The direct measurements made with new layers by Kuhn and Wilson show that, for a transmissivity of 0·02, the reflectivity varies from 0·97 to 0·96, and the absorption from 0·01 to 0·02 over the range of wave-lengths from 6800 to 5200 A. The performance of these silver layers is thus slightly superior to that of Jarrett's multilayer coating, which was found to have a reflectivity of 0·97 and an absorption of 0·02 in this region. The reflectivity and absorption of silver films three weeks old are about the same as for multilayer films. Towards shorter wave-lengths the efficiency of both silver and dielectric films decreases, but not enough quantitative data for the latter are available to allow comparison.

In practice, very high reflectivities are not used with étalons, since the limiting factor to the resolving power is the accuracy of working of the surfaces of the plates. With plates of good quality, the errors are not substantially smaller than 1/50 fringe; and since a reflectivity of 0·95 produces fringes with a width of 1/60 of an order, there is little to be gained by using layers denser than that required to produce this reflectivity. The width of the fringes of the line 5436 is estimated by v. Kluber to be 1/34 order, equivalent to a reflectivity of 0·91. The measured width of fringes produced with silver layers was 1/39 order, for films with a transmissivity of 0·04. These fringes were thus narrower than those produced by the multilayer coating, but in both instances the fringe-width was probably substantially increased by imperfection in the surfacing of the plates.

Judged on the basis of existing experimental data, multilayer films offer the advantage of a very slight gain in intensity in the range of lower reflectivities, below about 0·9. This should make them useful as étalon coatings for special purposes; if they could be made to operate for violet and ultra-violet light, they might gain considerable importance in spectroscopic interferometry.

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The silver films reported by D. A. Jackson and K. Kuhn are very efficient; considerably more so than those quoted by previous workers[1].

In this connexion, I wish to state that I have recently produced silver films possessing a reflectivity of 94 per cent and an absorption coefficient as low as 0·03 for $\lambda = 5461$ A., so giving an efficiency similar to that recorded by Kuhn and Wilson[2] for an aged silver film at 5200 A. Extreme care was exercised with regard to the cleanliness of all the surfaces in the vacuum vessel.

From a graph in the same paper, for an aged silve film at 5200 A., one concludes that $R = 0{\cdot}97$ fo $T = 0{\cdot}005$, that is, $A = 0{\cdot}025$. These values ma be compared with those for the multilayer coating which were the subject of a previous communication[3]

Coating	R (per cent)	A (per cent)	T (per cent)	$\tau = \left(\frac{T}{T+A}\right)'$
Silver (fresh)	97	2·0	1·0	0·11
Silver (aged)	97	2·5	0·5	0·08
9-Layer dielectric	97	2·0	1·0	0·11
Silver (fresh)	94	2·0	4·0	0·44
Silver (aged)	94	3·0	3·0	0·25
7-Layer dielectric	94	1·0	5·0	0·69

(The figures for silver are from Kuhn and Wilson's results for 5200 A ref. 2.)

The multilayer coatings were measured during th two days following their production.

Since the underlying motive for pursuing the mult layer investigations was to obtain as large a tran parency (τ in the table) as possible for the étalo compatible with a small fringe half-width—a featu of supreme importance for phenomena, such as sol flares, etc., of limited duration—the conclusion fro the above is that the multilayer coatings possess th greater transparency for the lower reflectivity cited but for the higher value the freshly prepared silv films of Kuhn and Wilson appear their equal. must be stressed, however, that the multilayer cha acteristics were not obtained immediately aft deposition.

The comments in the foregoing corresponden appertaining to the possibilities of multilayer coatin for the blue end of the spectrum would depend suitable dielectrics being obtained exhibiting litt absorption in this region; zinc sulphide, for exampl has an absorption band[4] at 3650 A.

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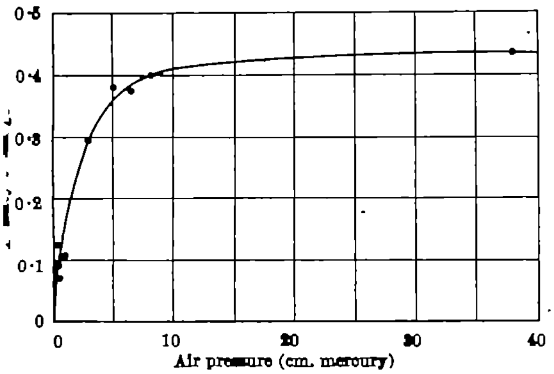
Russell Effect on Evaporated Metal Films

In 1897, Russell[1] discovered that freshly abrad metal surfaces produce an image on photograph plates and suggested that hydrogen peroxide responsible for this action. Although a conside able amount of work was done on this subject the first decade of this century, the only more rece publication is a paper by Churchill[2]. Work in t Mechanical Engineering Research Laboratories Thorntonhall confirms that hydrogen peroxide produced whenever fresh surfaces of certain met are exposed to the action of water and oxygen. Wh for example, aluminium, magnesium, nickel or zi is cut under water, measurable quantities of hydr gen peroxide are produced[3].

Recently, we have found that evaporated films metals, when exposed to the action of oxygen a water vapour, are capable of producing an image photographic plates. Before briefly describing t



xperimental procedure used, it is necessary to state at no satisfactory explanation of the cause of the ussell effect has so far been advanced. In our view, is caused by the availability of free electrons on eshly exposed metal surfaces, as recently described y Kramer[4]. The following reactions then lead to e formation of hydrogen peroxide :

$$e + H^+ \,{}^-OH \rightarrow H^\cdot \,{}^-OH \rightarrow H^\cdot + (:OH)^- \quad (1)$$

$$H^\cdot + O_2 \rightarrow HO^\cdot_2 \quad (2)$$

$$IO^\cdot_2 + H_2O \rightarrow H_2O_2 + {}^\cdot OH. \quad (3)$$

he hydroxyl radicals disappear either through

$$+ {}^\cdot OH \rightarrow (:OH)^- \;(4)\text{ or } 2.OH \xrightarrow{\text{third body}} H_2O_2. \;(5)$$

The experimental investigation of the Russell ffect with evaporated metal films was carried out the following manner. Using a conventional vaporator, metal was evaporated *in vacuo* on to a lass slide fixed on a small carriage. After evapora- on, and without breaking the vacuum, the carriage as allowed to slide into a light-tight box holding a oroughly outgassed Ilford 'half-tone' plate. Air ontaining a certain quantity of water vapour was dmitted to the evaporator. After 24 hr. the plate as removed and developed by a standard procedure. he optical density of the plate was measured by eans of a photometer.

The experimental results show that, at a given tio of water vapour to oxygen, the optical density creases at first with the increase in air pressure. t higher air pressures the density becomes independ- nt of the pressure. This is illustrated in the accom- anying graph, which shows the results obtained ith an evaporated film of aluminium, using air ntaining 1·8 per cent by volume water vapour. Complete results of the investigation will be blished elsewhere.

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Adaptive Mechanisms of Buffaloes to Ambient Temperature

Animals of diverse origin vary widely in their capacity to withstand severe climatic conditions. Breed differences in the response to high external temperatures and humidity were demonstrated by Rhoad[1]. Buffaloes have a lower level of respiration-rate, body-temperature and pulse-rate than cattle[2]. Under shade, they have a better cooling mechanism than cows, as has been shown in India[3]. The black-pigmented skin assists the absorption of infra-red rays with a subsequent rise in body-temperature[4], while in thin-skinned animals heat penetrates easily, resulting in over-heating of the body and interference with efficient elimination of heat[5]. Shedding of hair in cattle is a seasonal phenomenon[6].

Six non-pregnant buffalo cows (eight years old) were kept in open stable during 7–10 a.m., exposed to direct sunlight for two hours starting at 10 a.m., and then removed to shade until 2 p.m. Respiration-rate, body-temperature and pulse-rate were recorded every ten minutes at intervals from 7 to 8 a.m. and from 10 a.m. to 2 p.m. The fluctuation in the three items were measured and expressed as deviations from the normal deviation[7]. Atmospheric temperature (which ranged from 23·5° to 43·0° C.) and relative humidity (which ranged from 40 to 79 per cent) were recorded throughout the experiment. Shedding of hair, colour of hide, and thickness of skin (measured at shoulder) were carried out on fifty buffaloes.

No noticeable variations were observed in respiration-rate, body-temperature and pulse-rate between 7 and 8 a.m. in the shade. Soon after exposure to sunlight, both respiration-rate and body-temperature began to rise. The increase in pulse-rate during the first hour of exposure fluctuated. During the second hour of exposure, the respiration-rate increased to a smaller extent than during the first hour. The increase in both body-temperature and pulse-rate was nearly double the increase occurring during the first hour. When the animals were removed to shade, there was a sudden decline in respiration-rate. This decline occurred after a latent period, of ten minutes for body-temperature and forty minutes for pulse-rate. The percentage of increase in respiration-rate, body-temperature and pulse-rate during the two hours of exposure to sun was followed by a similar decrease at the end of the first hour of shade. The relative decrease in body-temperature was greater than in respiration-rate and pulse-rate during the second hour of shade.

Newly born buffalo calves have long dense hair of brownish steel-grey colour. As the animals grow older, the density of the hair becomes less. Shedding usually takes place at the age of three years. Pregnancy and lactation hasten shedding of hair. Shedding of hair occurs at the end of spring and at the beginning of summer months. The pigmentation of the buffalo skin varies from black to steel-grey. When the animals are kept in close confinement, the skin loses its pigmentation and becomes reddish-white. The pigmentation is regained after removal to direct sunlight. The skin of the buffalo is flexible and its thickness varies with age (see accompanying table). The brisket skin in the buffaloes is well developed,

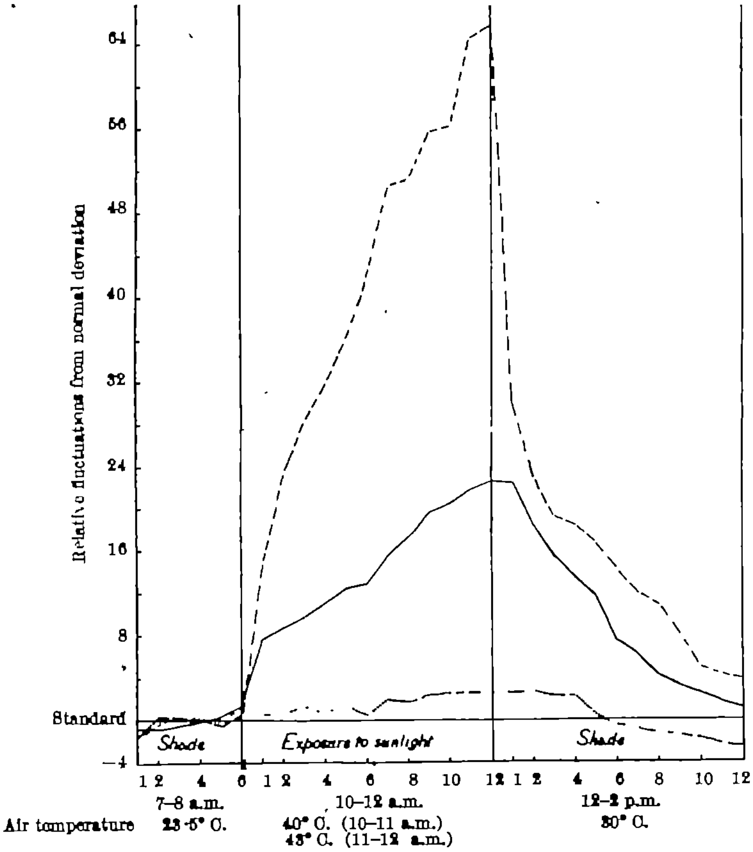
Thickness of buffalo skin (mm.)

Age	Calves	1–2 yr.	2–3 yr.	Mature
Skin thickness	4·47±0·4994	5·40±0·7849	5 48±0 1094	6 01 ± 1·447

and on exposure skin secretions are usually noticed between the fore-limbs as well as between the hind-limbs around the udder.

Respiration-rate in the buffalo increases on exposure to hot conditions whereas the rise in body-temperature is delayed. When removed from sunlight to shade, the respiration-rate was also first affected. It would seem that the respiratory tract is the first means of dissipating heat accumulated in the animals. As the respiratory movements cannot cope with the extra elimination of heat from the body, the pulse-rate is increased reflexly, but after a latent period. The increase in pulse-rate may be regarded as an attempt to stimulate the peripheral circulation and so helps heat loss through increasing salivation and skin secretions. Further investigation is needed to clear up the mechanism of peripheral circulation as affected by ambient heat. After one hour of shade, the buffaloes were able to lose almost all the heat gained at the time of exposure. The time required for eliminating extra heat through exposure needs investigation also.

The adaptive mechanism of the buffalo to hot humid climates is characteristic to the breed. The black-pigmented hide absorbs the infra-red rays of solar radiation and thus limits the animal's adaptability to exposure to sunlight. Such exposure does not occur under either wild or domesticated conditions. In the shade, however, the black coloration aids heat dissipation. The thick skin of the buffalo may prevent heating of the body from hot air and by radiation from the sun or hot ground. Hence we believe that although the buffalo is surviving in ho zones, where humidity is high, shade and coolin systems are needed for the animal's comfort.



----, Respiration-rate; ———, body temperature; . . . ., pulse-rate

Relative fluctuations of body-temperature, respiration-rate and pulse-rate of buffaloes in sun and shade, under normal (7–8 a.m.) and experimental (10 a.m.–2 p.m.) periods

This work, which is still in progress, has bee carried out at the Animal Breeding Research Station Cairo. Thanks are due to Mr. M. Ibrahim for statistical advice.

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Photoperiodic Behaviour of *Hibiscus sabdariffa*, L.N.P.5

Hibiscus sabdariffa, L., is one of the most importan fibre plants of India, commonly known as rosell fibre. There are several well-known varieties[1]. Th plants can be grown on all types of soils, and henc the economic possibilities are considerable. study of photoperiodic effects was undertaken in Ma 1951, since the strain was found to grow best whe sown during May–June.

For a study of the photoperiod effects of the plant, seeds obtaine through the courtesy of the India Agricultural Research Institut New Delhi, were sown in earthen ware pots of 13-in. diameter in circle equidistant from the rim an the centre of the pot on May 2 By May 25, the cotyledons wer unfolded and the plants were read for treatment. There were fou plants per pot and three pots p treatment, so that twelve plan were taken for each treatmen Light periods ranged from eigh hours to sixteen hours; for ligh periods longer than normal, add itional illumination was provide from an electric bulb (100 candl power) at a distance of 1 m., whi for the shorter light periods th plants were taken inside a venti ated dark chamber for the required period before dusk and we brought back to the field aft nightfall.

The results are given in t accompanying table as the mean the readings for twelve plants p treatment. Flowering time denot the time taken for the initiation the first visible flower-bud, an fruiting time, the appearance of th first visible fruit. In addition, th total height of the plant an the circumference at the base the stem on the flowering day wer noted separately for each plant.

eatment	Mean height at flowering in cm.	Mean basal circumference of stem at flowering in cm.	Mean flowering time in days	Mean fruiting time in days
8 hr.	93·8	2 984	87·5	92
0 hr.	71·36	2 125	69 25	75
2 hr.	210·7	4 1	126	131
4 hr.	240 783	4 6	141	150
6 hr.	235·066	5 28	154	162
ontrol	236·7	5 0	122	127

he daily light period of the normal plants rose dually from 13 hr. 20 min. on May 25 to 13 hr. min. on June 22 and again fell gradually to 12 hr. nin. at the time of flowering.

t is evident that *H. sabdariffa*, *L.N.P.*5, has a y definite photoperiodic response and is a short- plant flowering fifty-three days earlier than the ntrol under the short-light period of 10 hr. At r., however, there is an average delay of nineteen ys from those at 10 hr. At longer photoperiods wering is delayed. The earliness of flowering is y marked at 10 hr. while a conspicuous delay urs among the 14- and 16-hr. groups. Bolhuis[2] ted and Ergle *et al.*[3] confirmed the fact that flower- in *H. sabdariffa* var. *altissima* is strongly influenced the length of day. The behaviour of *H. sabdariffa*, *N.P.*5, appears to be similar.

My thanks are due to Dr. J. C. Sen Gupta for his erest in the work.

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Effects of Preliminary Treatment on the ubsequent Variation in the Resistance of *Lemna minor* to the Phytotoxic Action of 2 : 4 Dichlorophenoxyacetic Acid

DURING a study of the inter-relationships between ht intensity, temperature and the biological effects 2 : 4 dichlorophenoxyacetic acid, it was found in e case of *Lemna minor* (duckweed) that when the ncentration of the growth regulator in the external ater culture solution was sufficiently high to kill me of the fronds at the end of three days exposure, en the mortality increased with decreasing light tensity over the range of continuous illumination 0–180 ft. candles. It was further observed that, hereas the degree of toxicity was markedly depend- t on the light intensity received by the fronds prior treatment with the dichlorophenoxyacetic acid re-treatment period'), yet similar variations in the tensity during the following short 'treatment riod' of three days had no effect.

Since the ratio of area to weight was increased low levels of light, it was at first thought that this ger proportion of surface was associated with a eater uptake of the toxicant. However, as the oduct of the area–weight ratio and the concentra- on required to produce a 50 per cent mortality (the .D. 50' determined by probit analysis) was not onstant this explanation seems unlikely. Further- ore, when fronds in the pre-treatment period were eated with low and non-lethal concentrations of dichlorophenoxyacetic acid, although the area to weight ratio was little affected, the concentrations required to give a 50 per cent kill in the following treatment period were greatly increased. Thus, while without initial pre-treatment the required concentration of the acid was 81 p.p.m., it rose to 91, 116 and 193 p.p.m. after the fronds had been exposed respectively to 2·5, 10 and 40 p.p.m. in the previous twenty-four hours.

The next step was to determine whether this increased resistance induced by the pre-treatment was a specific effect. Accordingly, experiments were carried out in which fronds in the initial period were placed for twenty-four hours in low concentrations of a number of other compounds—for example, 2-methyl-4-chlorophenoxyacetic acid, 2 : 4 dinitro-*o*-cresol and cupric sulphate. In each case, such an initial treatment increased the resistance to dichlorophenoxyacetic acid in the treatment period. For example, pre-treatment with dinitro-*o*-cresol at 0·5 p.p.m. demanded a rise from 83 to 148 p.p.m. in the concentration of the phenoxyacetic acid needed to bring about the standard 50 per cent mortality.

When in the pre-treatment period the time of exposure to 40 p.p.m. dichlorophenoxyacetic acid was varied from 0·75 to 48 hours it was found that the induced increase in resistance to the *same* compound reached a maximum and steady value at the end of 3 hr., but that treatment for as little as 0·75 hr. had a significant effect. It is not possible to rule out enzyme adaptation as an explanation for the results of this experiment, since even within the short periods recorded many 'generations' of an enzyme may have taken place. However, on this basis, it is difficult to account for the common effect of different compounds on the subsequent response of *L. minor* to dichlorophenoxyacetic acid.

The results will be reported more fully and discussed in greater detail elsewhere. The techniques of the *Lemna* culture and the methods of probit analysis have been previously described[1-3].

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Neurospora following a Volcanic Eruption

EARLY in 1951, Mount Lamington in New Guinea erupted violently, and the resulting shower of hot ashes which followed the explosion devastated many miles of the countryside, causing severe damage and loss of life. Very soon after the eruption, Mr. G. A. Taylor, volcanologist stationed in New Guinea, visited the area, and in the course of his investigations found large patches of a pink fungus which he collected and sent for identification. The fungus was readily isolated and proved to be a heterothallic species of *Neurospora*, which has been provisionally identified as *N. crassa* (Shear and Dodge). The genus *Neurospora* is well known as a troublesome pest of bakeries and similar high-temperature situations. The ascospores of this genus do not germinate readily unless subjected for a brief period to high temperatures (for example, 1 hr. at 60° C.). Its occurrence, therefore, in the Mount Lamington area, while not at all surprising to mycologists, is an interesting example of the invasion of an unusual ecological niche.

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Occurrence of Putrescine in Potassium-deficient Barley

THE identification of primary effects of potassium in plant cells has proved to be one of the most elusive problems in mineral nutrition. Many widespread physiological disturbances accompanying potassium deficiency are well known, especially in the fields of nitrogen and carbohydrate metabolism; but the immediate causes of the characteristic (yet variable) leaf symptoms and the premature death of foliage have been almost entirely a matter for speculation. This communication is intended to direct attention to the fact that in barley, at least, putrescine is produced and accumulated under certain conditions of potassium deficiency, and that some of the observed symptoms may well be directly attributable to its presence.

A qualitative investigation, by means of paper chromatography, into the free ninhydrin-reacting compounds in barley leaves (F. J. Richards and E. Berner, in the press) revealed the frequent occurrence there of an unidentified basic substance. It was found in more than trace amounts only in potassium-deficient plants, and only in such of those as had not been supplied with either sodium or rubidium. Any of these alkali metals appeared to suppress its accumulation. Where it did occur it was present from an early age, increasing in quantity as the external symptoms of deficiency became acute.

In order to isolate and identify the substance, a large quantity of potassium-deficient barley was grown in 1951. Green laminæ, moribund leaves and stems from this material all contained the compound; indeed, on chromatograms from the moribund leaves it provided the most intense of all the ninhydrin spots. The substance was first isolated from the other ninhydrin-reacting compounds present in 75 per cent alcoholic extracts by elution on columns of 'Permutit' special sulphonated polystyrene resin; after passing hydrochloric acid and ammonium hydroxide through the charged columns the substance was removed by means of 0·2 *M* ammonium carbonate. The eluate was partially evaporated to remove the ammonia, acidified with hydrochloric acid and evaporated to dryness. The residue was then steam-distilled from a soda solution, acidified and evaporated nearly to dryness; a little ethanol was added and the substance thrown down with acetone. It was finally re-distilled and re-precipitated.

The isolated substance was indistinguishable from putrescine, whether in the form of hydrochloride, platinichloride or picrate; chromatographically, too, it behaved exactly like putrescine. The identification was confirmed by the production of identical X-ray powder photographs from the isolated substance and from putrescine hydrochloride; thanks are due to the Pedology Department of Rothamsted Experimental Station for taking these photographs.

The concentration of putrescine in the moribund potassium-deficient leaves is quite high, the yield indicating that the content of the free base mu have been at least 0·15–0·2 per cent dry weigh No estimate of the content in green leaves has y been made, but is, of course, lower than this.

Preliminary work involving feeding putresci through the partially cut leaves of high-potassiu plants has revealed toxic effects which bear clo resemblances to some of the symptoms found potassium-deficient barley. Chlorophyll disappea in patches and death soon follows. This may occ even on tillers remote from the one receiving t putrescine directly, distal parts of the leaves th being especially affected. The toxic sympton induced by the free base, however, differ somewh from those developed when the hydrochloride supplied.

It is hoped that experiments in progress may thr some light on the origin of the amine (ornithine wou seem to be the most likely precursor, but is n normally detectable in barley leaf extracts), a whether or not it is also produced, but metaboliz immediately, in the presence of alkali metals.

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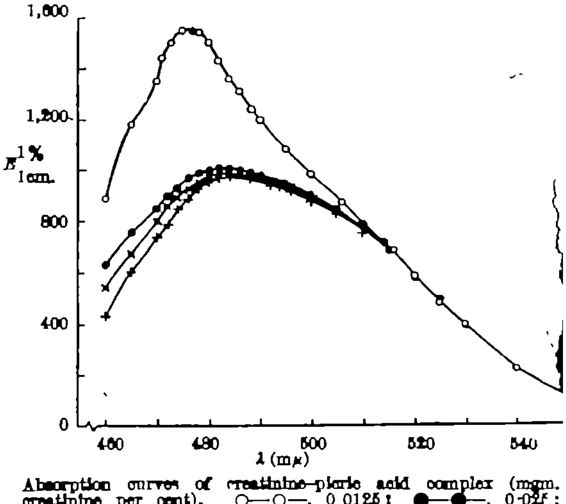
Determination of Creatinine

CREATININE is commonly determined in biologic fluids by various modifications of the Jaffe reactio The method is recognized as being non-specific an must be applied with caution unless there is a lar excess of creatinine present over interfering su stances. The specificity of the method has bee greatly improved by Miller and Dubos[1].

Peters[2] has pointed out that a significant deviatio from Beer's law becomes apparent at conce trations of creatinine greater than 5 mgm. p cent. This may be due to the bicolorimetric natu of the determination; the orange-red colour being mixture of the red of the coloured creatinine comple and the yellow of unchanged picric acid. So far as known, it has not been made clear that anomalie may also occur at low concentrations of creatinin

As the accompanying graph shows, it has bee found that if the absorption spectrum of the creatinir



Absorption curves of creatinine–picric acid complex (mgm. creatinine per cent). ○—○—, 0·0125; ●—●—, 0·025; ×—×—, 0·05; +—+—, 0·1 ıplex (against a picric acid compensator) is plotted lifferent concentrations of creatinine, not only does x vary, but so also does E(1 per cent, 1 cm.).

Iost clinical methods recommend that the colour duced in this reaction should be read using a -mμ filter. An explicit reason for this can now be en, for the absorption curves become closely vergent at a wave-length of about 515 mμ.

'he findings indicate that the reaction postulated Greenwald[3], in which one molecule of picric acid said to react with one molecule of creatinine to duce a tautomeric (enolic) form of creatinine rate, cannot be as simple as considered hitherto.

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iversity, Liverpool 3. April 2.

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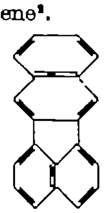
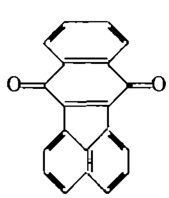
olation of 11 : 12-Benzfluoranthene from a Coal Tar Fraction

A RECENT description by Kruber and Oberkobusch[1] the isolation from a coal tar pitch fraction of an dentified hydrocarbon $C_{20}H_{12}$ (m.p. 216° C.) mpts me to record the isolation from a correspond- coal tar fraction of a hydrocarbon which possesses ilar properties and which has been identified as : 12-benzfluoranthene (I). The substance was ained from a fraction (b.p. 269–279° C./5 mm.) duced by high-efficiency fractionation of the tral portion of a distillate obtained during the duction of pitch coke. By crystallizing the soft nous fraction from ether, a yellow solid was ained which was purified by the crystallization l subsequent decomposition of its 1 : 3 : 5-tri- obenzene derivative. The pure hydrocarbon stallized from benzene as very pale yellow needles,). 216–217° C. It had a molecular formula of H_{12}, and its ultra-violet absorption spectrum was ntical with that published for 11 : 12-benzfluor- hene[2].



(I)



(II)

'he identity of the hydrocarbon was confirmed comparison with a synthetic specimen of 11 : 12- zfluoranthene prepared according to the method cribed by Orchin and Reggel[2]. The following vatives of the coal tar hydrocarbon were also ntical with the corresponding complexes formed n the synthetic hydrocarbon: unstable picrate d needles, m.p. 167–168° C.), 1 : 3 : 5-trinitro- nzene derivative (golden-yellow needles, m.p. –182° C.), 2 : 4 : 7-trinitrofluorenone derivative ange-red microcrystals, m.p. 253–254° C.).

xidation of both the synthetic and coal tar lrocarbons with potassium dichromate in acetic l yielded a quinone which, after purification by omatography on activated alumina, crystallized bright red needles, m.p. 236–237° C. Analytical ıres were in agreement with the formula $C_{20}H_{10}O_2$. rther oxidation produced naphthalic anhydride, indicating that the quinone has the structure (II), assigned to it by Moureu, Chovin and Rivoal[3].

A complete account of the investigation of the pitch-coking distillate will be published at a later date.

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Coal Tar Research Association,
Gomersal, Nr. Leeds.
July 22.

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Sugar Components of Blood and Urinary Glycoproteins: Confirmation of the Presence of Fucose by a New Reaction

DURING the course of a systematic study of the carbohydrate constituents of some glycoproteins of human and animal origin, a number of unexpected component sugars have been separated by paper chromatography. In particular, the presence of fucose has been definitely demonstrated in human serum mucoprotein and in normal human urinary proteins.

Serum mucoprotein was prepared by the method of Weumer *et al.*[1]. To prepare the urinary protein, normal urine was dialysed and concentrated to one-fifth of its original volume at room temperature and reduced pressure. Six volumes of alcohol were added to precipitate the proteins. An examination of this material by paper strip electrophoresis showed the presence of albumin, α_1, α_2 and β globulins, these latter in rather low concentration.

The glycoproteins were hydrolysed with 2 *N* sulphuric acid for 8 hr. at 100° C. in sealed tubes. The hydrolysates were neutralized to *p*H 4·5 with barium hydroxide and the clear filtrate concentrated to a suitable volume. Aliquots were then chromatographed using pyridine/amyl alcohol/water, phenol/water for 3 per cent ammonia, or butanol/ethanol/water as solvent systems. The chromatograms were sprayed with *p*-anisidine hydrochloride in butanol[2]. Mannose, galactose, and a hexosamine were found, corresponding to the results obtained by Werner and Odin[3] for ox seromucoid. The hexosamine was identified as glucosamine[4] and some of it is present in the native protein as the N-acetylated derivative. A faster moving component was invariably present on the chromatograms, however. It was found to have an R_F value corresponding to that of fucose in all the solvent systems used. The intensity of the spot relative to the other sugar components was greater in the urinary material than in the serum mucoprotein.

In order to confirm the identity of this sugar, advantage was taken of the fact that periodate oxidizes methylpentoses to formic acid and acetaldehyde, whereas simple aldoses and ketoses are oxidized to formic acid and formaldehyde[5]. Acetaldehyde can be readily detected by the Rimini reaction[6] with piperazine and nitroprusside, the full scope and limitations of which will be described elsewhere[7]. This test can be applied to paper chromatograms, which are sprayed with 2·5 per cent aqueous sodium metaperiodate. The oxidation is allowed to proceed for ten minutes and then the Rimini reagent is applied. This reagent must be prepared immediately before use by mixing 7 per cent aqueous sodium nitroprusside (1 vol.) with a saturated ethanolic solution of piperazine (3 vol.) and methanolic 1 per cent ethylene glycol (4 vol.). An intense blue spot slowly develops, in the presence of not less than 10 μgm. methyl pentose. The component in the hydrolysate believed to be fucose gave a strongly positive reaction in this test.

2-Deoxy sugars and the amino-acid threonine also give a blue colour under these conditions, but they can be distinguished from the methylpentose by comparison of R_F values and other reactions.

The presence of fucose in human blood-group substances has been shown by Bray and Stacey[8] and in human cervical mucus by Werner and Bergman[9]. Whether serum and urinary glycoproteins have any direct relationship with the blood-group substances, or whether fucose will be found together with other neutral sugars in other body tissues, is now being investigated.

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Birmingham 15.
March 31.

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Slow Combustion of Cyclopropane

We have investigated the slow thermal oxidation of cyclopropane by the static method between 380° and 430° C. and at partial pressures of the reactants between 50 and 400 mm. The products are mainly carbon monoxide and water, with small amounts of carbon dioxide and formaldehyde, and the course of the reaction can readily be followed by pressure measurements. There is a period of negligible pressure change followed by rapid acceleration to a maximum rate, during which $\Delta p \propto \exp(\varphi t)$, where t is the time from the beginning of the reaction and φ a constant. Thus, as is the case for nearly all other hydrocarbons and their simple derivatives, the oxidation can be explained in a general fashion as a chain reaction with degenerate branching[1].

The temperature-range over which the rate is measurable overlaps the lower limit of the so-called 'high-temperature' region for slow hydrocarbon combustion, which is given[2] as approximately 400° C. It has been suggested[3] that the kinetics of the 'high-temperature' oxidation (for example, of methane, ethane, ethylene and propane above 390° C.) closely follow that of methane, for which the maximum rate of the reaction is represented by the expression $\rho(\max) \propto [CH_4]^2.[O_2]P$, where P is the total pressure of the mixture[4]. Using cyclopropane, however, while Day and Pease[5] found that, as with methane, no cool flames are observed, the dependence of ρ(max) on the partial pressures of the reactants resembles more closely that exhibited by oxidations in the 'low-temperature' region (200°–300° C.), characterized by a very marked variation of ρ(max) with hydrocarbon concentration but little or no variation with oxygen or total pressure[6]. Thus, at any temperature th is a range of 'low' oxygen partial pressure wit which $\rho(\max) \propto p(C_3H_6).p(O_2)$, and a range of 'hi oxygen partial pressure where $\rho(\max) \propto p^2(C_3$ and independent of $p(O_2)$. The latter dependence in qualitative agreement with the results of th experiments reported by Day and Pease[5] for oxidation at 370° C. The change of dependence usua takes place over a fairly small pressure range, a this 'critical partial pressure of oxygen' increa greatly on increasing $p(C_3H_6)$ or the temperatu In other words, at 'high' $p(O_2)$, 'low' $p(C_3H_6)$ and lower temperatures, the latter dependence is served, whereas at 'low' $p(O_2)$, 'high' $p(C_3H_6)$ and higher temperatures the former dependence observed. However, in no circumstances does addition of nitrogen affect ρ(max) or the induct period.

In the 'low-temperature' region a change fr dependence to independence of ρ(max) on $p(O_2)$, this is increased at a constant value of the hyd carbon pressure, has been reported for the oxidat of several hydrocarbons[6,7]. But it has hitherto be generally agreed that in the 'high-temperatu region ρ(max) is always strongly dependent on oxygen concentration.

The variation of ρ(max) with temperature has be investigated at high and low oxygen pressures. both cases the Arrhenius plots are straight lines w some curvature at the high- or low-temperature e respectively. The overall activation energies for two regions of different dependence of ρ(max) concentration, as calculated from the slopes of straight portions, are the same (∼ 35 kgm.cal./mol and the curvatures appear to be due to alteration dependence with the temperature. It is possible th some of the curved Arrhenius plots which have be reported by other workers[2] for gaseous oxidati are due to this cause.

It may be suggested that the kinetic results ported here are due to the structure of the cyc propane molecule, which has been the subject some controversy[8]. However, the molecule mu presumably contain CH_2 groups, irrespective of type of bond between the carbon atoms. Thus work may be considered to cast some doubt on view that hydrocarbon oxidations in the two te perature-ranges are kinetically very distinct; a in fact, it is possible that ρ(max) would be in pendent of oxygen concentration at any temperat at which slow combustion can occur, if a high enou partial pressure of oxygen were used.

Further work is in progress and it is hoped publish fuller details of the investigation in due cour

We wish to thank the Anglo-I. .nian Oil Compa for a grant.

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March 4.

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, September 15—Friday, September 19

Institute of Metals (at Oxford).—Annual Autumn Meeting.

Monday, September 15—Saturday, September 20

Cement and Concrete Association in conjunction with the uilding Research Station (at the Royal Society of Arts, John dam Street, Adelphi, London, W.C.2; Monday only, September 15, t the Royal Institution, 21 Albemarle Street, London, W.1).—Third nternational Symposium on "The Chemistry of Cement".

Wednesday, September 17

Oil and Colour Chemists' Association, London Section (at anson House, 26 Portland Place, London, W.1), at 7 p.m.—Mr. J. Curtis: "Cadmium Pigments".*

Wednesday, September 17—Friday, September 19

British Ecological Society (in the Department of Zoology, The niversity, Liverpool).—Autumn Meeting.

Thursday, September 18—Saturday, September 20

Society for Water Treatment and Examination (at Sheffield) —Autumn Meeting.

Friday, September 19—Saturday, September 20

Biochemical Society (in the Department of Biochemistry, The niversity, Glasgow), at 11 a.m.—Scientific Papers.

Society of Leather Trades' Chemists (in the Large Chemistry ecture Theatre, The University, Leeds).—Annual Conference.

riday, September 19

At 2 p.m.—Prof. J. B. Speakman: "The Reactivity of Protein ibres; some Analogies between Keratin and Collagen" (Fifth Procter emorial Lecture).

Friday, September 19—Monday, September 22

Aslib (at The Hayes, Swanwick, Derbyshire).—Twenty-seventh Annual Conference.

Friday, September 19

Prof T U. Matthew: "The Significance of Information in Present-lay Industrial Society".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned.

Assistant (with an honours degree in biochemistry, or its equivalent) in the Biochemistry Department—The Secretary, The University, Aberdeen (September 18).

Lecturer (with high academic and research qualifications) in Chemistry—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W 3 (September 19).

Demonstrator in Electrical Engineering and Physics—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (September 20).

Scientist, Grade III (with a first- or second-class honours degree in physics, preferably with a knowledge of electronics, workshop practice, and general physics) at the Central Laboratory, Shade House, Bolton Road, Pendlebury—The Divisional Establishment Officer, National Coal Board, North-Western Division, 40 Portland Street, Manchester 1 (September 20).

Electronic Engineer for the construction and servicing of high gain amplifiers for physiological recordings at different frequencies—The Secretary, Maida Vale Hospital for Nervous Diseases, London, W.9 (September 21).

Lecturer in Biology, to teach mainly zoology up to B Sc. general degree standard—The Principal, Acton Technical College, High Street, Acton, London, W.3 (September 21).

Non-Medical Biochemist (university graduate holding the B.Sc. in chemistry or biochemistry, or associate of the R I C.)—The Superintendent, Royal Hospital, West Street, Sheffield 1 (September 24).

Statistician (Scientific Officer grade)—The Secretary, National Vegetable Research Station, Wellesbourne, Warwick (September 24).

Engineers to the Ministry of Supply in Lancashire, for inspection of wide variety of plant and equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.456/52A (September 27).

Crop Physiologist to work on effect of climatic factors prevailing in Scotland on growth and cropping of horticultural crops, an Applied Geneticist for genetical studies, to develop varieties of horticultural plants for special use in Scotland, a Mycologist to work on problems connected with red core in strawberries, particularly those arising from development of physiological strains of this fungus, an Entomologist to work on incidence, life histories, pest range, etc., of insects which are known or may possibly act as vectors of virus diseases to horticultural crops in Scotland, a Horticultural Botanist to work on problem of vegetable culture in Scotland, and an Entomologist to act as field and laboratory assistant in the Plant Pathology Section —The Secretary, Scottish Horticultural Research Institute, Vernonholme, Riverside Drive, Dundee (September 30).

Lecturer in Physiology—The Registrar, King's College, Newcastle-upon-Tyne (September 30).

Lecturer (Grade II) in Chemical Pathology, and an Assistant Lecturer (Grade III) in Veterinary Pathology, at the Veterinary Field Station, Langford, Somerset—The Registrar and Secretary, The University, Bristol (September 30).

Veterinary Research Officer in the Sudan Veterinary Service—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1 (September 30).

Junior Lecturer in Bacteriology—The Secretary, London Hospital Medical College, Turner Street, London, E.1 (October 4).

Head of the Department of Natural Sciences, a Senior Lecturer or Lecturer in Botany, a Senior Lecturer or Lecturer in Engineering, and a Lecturer in Geography, in the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W 1 (October 6).

Lecturer in Bacteriology, a Lecturer in Geology, and a Lecturer in Philosophy, at the University of Adelaide—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Adelaide, October 15).

Chief Sewage Chemist—The Town Clerk, Town Hall, Bradford, endorsed 'Chief Sewage Chemist' (October 17)

Research Officers in the Soil Survey and Pedology Section, Division of Soils (initially at Adelaide and Canberra), for soil surveying and pedological investigations requiring approximately six to seven months each year in the field—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3968 (October 18).

Lecturers and Senior Lecturers in Primary and Non-Ferrous Metallurgy, and a Teacher in Coal Mining, at the New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (October 27).

Lecturer in Physics (with special qualifications in theoretical physics)—The Secretary, Queen's University, Belfast (November 30).

Lecturer in Experimental Pharmacology—The Secretary of the University Court, The University, Glasgow, W.2 (December 31).

Arrowroot Processing Chemist (with a degree in chemistry and experience in starch technology) in St. Vincent—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27106/62/52.

Assistant Director of Botanical Gardens, Singapore—The Director of Recruitment (Colonial Office), Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/261.

Assistants (Grade A) to teach Mathematics up to degree standard —The Clerk to the Governors, South-East Essex Technical College, Longbridge Road, Dagenham, Essex.

Biochemist in the East African Tsetse and Trypanosomiasis Research and Reclamation Organization, to carry out research on animal and insect physiology in connexion with trypanosomiasis investigations in East Africa—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27106/63/52.

Engineer (Design) in the Department of Rural Water Development, Gold Coast—The Gold Coast Office, Melbourne House, Aldwych, London, W.C.2.

Inspector of Mines (with a degree or diploma of a recognized school of metalliferous mining and at least three years practical experience including underground mining) in Uganda—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting C.S.D.63/9/01.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Bulletin of the British Museum (Natural History). Geology, Vol. 1, No. 8: Cretaceous and Tertiary Foraminifera from the Middle East By T. F. Grimsdale. Pp. 221–248+plates 20–25. (London: British Museum (Natural History), 1952.) 10*s*. [263

Selected Papers from the Royal Cancer Hospital and the Chester Beatty Research Institute, 1948–1949. Vol. 6. Pp. x+616. (London: Royal Cancer Hospital, 1952.) [265

Statistical Method in Industrial Production: being Papers given at a Conference held by the Industrial Applications Section of the Society in Sheffield, September 29th to October 1st, 1950. Pp. v+89. (London: Royal Statistical Society, 1951.) 7*s*. 6*d*. [265

Forestry Commission. Thirty-second Annual Report of the Forestry Commissioners for the Year ending September 30th, 1951. Pp. 82. (London: H.M. Stationery Office, 1952.) 3*s*. net. [275

Forestry Commission. Leaflet No. 1: The Large Pine Weevil (*Hylobius abietis*). Revised edition. Pp 10. 6*d*. net Leaflet No. 29: Pissodes Weevils. Pp. 12. 6*d*. net. (London: H.M. Stationery Office, 1952.) [273

London School of Hygiene and Tropical Medicine. Report on the Work of the School for the Year 1950–1951. Pp. 112. (London: London School of Hygiene and Tropical Medicine, 1952.) [273

Fifth Annual Report of the Advisory Council on Scientific Policy, 1951–1952. (Cmd. 8561.) Pp. iv+12. (London: H.M Stationery Office, 1952.) 6*d*. net. [285

Department of Scientific and Industrial Research: Road Research Laboratory. Road Note No. 1. Recommendations for Tar Surface Dressings. Second edition. Pp. 10. (London: H.M. Stationery Office, 1952.) 9*d*. net. [285

War on Want: a Plan for World Development. Pp. 96. (London: Association for World Peace, 1952.) 1*s* [295

Mushroom Research Association. Report for the Year 1951. Pp. 58. (Yaxley, Peterborough: Mushroom Research Association 1952.) 5*s*. [56

Scottish Home Department. Freshwater and Salmon Fisheries Research. 2: Second Annual Report of the Supervisory Committee for Brown Trout Research, 1949–1950. Pp. 12+4 plates. 2*s*. 6*d*. net. 3: Third Annual Report of the Supervisory Committee for Brown Trout Research, 1950–1951 Pp. 14. 2*s*. net. (Edinburgh and London: H.M. Stationery Office, 1951–1952.) [56

Carnegie United Kingdom Trust. Thirty-eighth Annual Report 1951. Pp. viii+48. (Dunfermline. Carnegie United Kingdom Trust, 1952.) [56

British Standard 1751 : 1952, General Purpose Glass Stopcocks. Pp. 10. 2s. net. British Standard 1792 : 1952, One-mark Graduated Flasks. Pp. 12. 2s. net (London : British Standards Institution, 1952.) [56

Dollar Savings through Standards. Report of Survey to obtain Data on Savings derived from the use of Standards by American Industry. Pp. 32. (London. Mutual Security Agency, American Embassy, 1952.) [56

British Drug Houses, Ltd. Report and Accounts, 1951. Pp. 15. (London : British Drug Houses, Ltd., 1952.) [56

British Society for the Promotion of Vegetable Research. Second Annual Report, 1951. Pp. viii+83. (Warwick : National Vegetable Research Station, 1952.) [96

Depopulation and Rural Life in the Solway Counties. By Bertram Hutchinson. (N.S. 120.) Pp. iv+110+25 plates. Depopulation and Rural Life in the Tweed Valley. By Bertram Hutchinson. (N.S. 120b.) Pp. ii+60. Depopulation and Rural Life in Aberdeen and Banff. By Bertram Hutchinson. (N.S. 120c.) Pp. 63. Depopulation and Rural Life in Scotland. By Bertram Hutchinson. (N.S. 120d.) Pp. ii+36. (London : Social Survey, 1949.) [96

Bulletin of the British Museum (Natural History). Mineralogy, Vol. 1, No. 3 : Oriented Rutile in a High-Temperature Andesine from Nigeria, by P. M. Game ; Note on Anorthoclase from Nigeria, by J. R. F. Joyce and P. M. Game. Pp. 73–93+plates 5–6. (London : British Museum (Natural History), 1952.) 6s. [96

Department of Scientific and Industrial Research : National Physical Laboratory. Report for the Year 1951. Pp. viii+77. (London : H.M. Stationery Office, 1952.) 3s. net. [96

The Framework of Joint Consultation. By J. H. Smith and Miss R. J. Carey. (Nationalized Industry Series, 10.) Pp. iii+85. (Claygate : Acton Society Trust, 1952.) 2s. [116

Other Countries

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DISTRIBUTION OF RESEARCH EFFORT IN BRITAIN

FIVE years ago, the Federation of British Industries published a statistical survey of scientific and technical research in British industry, based on an inquiry conducted during 1945–46 by its Industrial Research Committee. That survey was of particular interest as providing a forecast of the demands of British industry for research workers and technologists. Since then, we have had the reports from sub-committees of the Technical Personnel Committee of the Ministry of Labour and National Service, and a comprehensive report on chemical industry from the Association of British Chemical Manufacturers, as well as relevant reports from 'productivity teams', such as that on industry and the universities, of the Anglo-American Council on Productivity, and a report on scientific man-power from the Advisory Council on Scientific Policy.

The second survey of the Industrial Research Committee of the Federation, based on the year ended on or before March 31, 1951, which has now been published*, is thus of interest, less in relation to the man-power situation than from the point of view of the balance of the national research effort in general, and particularly in relation to development and industrial efficiency and productivity, on which such stress has been laid since the first survey appeared. Although a further five hundred copies of the questionnaire were circulated to industrial firms, a much smaller proportion of replies was received; and the 301 replies which were sufficiently detailed for analysis obviously represent too small a sample for sound or really authoritative deductions. These 301 firms were spending during 1950–51 the sum of £23,779,000 on research and development. If they are as representative a sample as the 420 firms of the earlier survey, the expenditure of which was £21,815,000, it might be inferred that expenditure has increased by about 50 per cent. On the other hand, an analysis of the expenditure of 107 firms common to both surveys suggests an increase of 100 per cent, and allowing for the difficulties in making an accurate estimate, the increase over 1946, on an expenditure basis, is probably somewhere between 50 and 100 per cent. On the assumption that the latest survey is as representative as the first, the total annual expenditure by industry on research and development within its own establishments could be put as between £45 millions and £60 millions.

This cannot, however, be assumed to represent a proportionate increase in research effort. Inflation in the past five years has reduced the value of the pound by a fifth, and the cost of equipment and salary-levels have both increased. From the point of view of research effort, this expenditure should be assessed first against corresponding expenditure in other fields, and secondly, against the numbers of qualified staff employed in research and development.

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* Research and Development in the British Industry: a Survey of Expenditure on Industrial Research and Development in the Year 1950–51 made by the F.B.I. Industrial Research Committee. Pp. 19. (London: Federation of British Industries, 1952.) 1s. 3d.

On the first criterion, it should be noted that the survey excluded firms which reported a research and development expenditure of less than £2,000 per annum. The smaller firms, however, still represent the bulk of the industrial units of Great Britain: less than one per cent of our industrial units employ more than 500 people each; some 92 per cent employ less than 50, and it is these smaller firms that constitute the major problem in securing the more widespread and effective utilization of scientific knowledge in production. To some extent their research needs are met by the research associations, which like the nationalized industries are excluded from the survey. The expenditure of the forty-two research associations during 1950–51 was £3·4 millions, of which £2·15 millions was contributed by industry, as against £1 million by the twenty-six research associations of 1945–46, in which was included £570,000 from industry.

It is not easy to get a clear picture of the distribution of the research effort of Great Britain as between industry, government establishments and the universities. In the House of Lords debate on June 11, the Lord President of the Council put State expenditure on civil research at £16 millions a year, apart from that included in the £18 millions provided for the universities. Besides £5·5 millions on the Department of Scientific and Industrial Research and the research associations, this £16 millions includes £1·5 millions on medical research and £3 millions on agricultural research; and in the same debate Lord Waverley put the total expenditure on industrial research in the great firms and in the Department of Scientific and Industrial Research at not less than £50 millions a year. Excluding research on nuclear physics, current expenditure on fundamental research in the United Kingdom was put by the 'productivity team' on the universities and industry at not more than £1·5 millions, compared with some £30 millions expended in the same way in the United States.

These estimates are presumably based in part on the £141 millions for research and development in the Civil Estimates for 1951–52; for 1952–53 the corresponding figure is £161,433,349. But it is difficult to obtain an adequate breakdown of this figure or of the £650 millions for production and research in the defence estimates for 1952–53 (an increase of £250 millions on 1951–52). The 1952–53 Civil Estimates includes the sum of £13,893,500 on research and development in the Navy estimates and £1,350,000 for Colonial Development and Welfare Research Schemes, but not that part of the £25 millions for universities and colleges which goes on research. It includes nearly £2 millions for the Medical Research Council, £1 million for the Agricultural Research Council and a further £1·9 millions for research and development work under the Ministry of Agriculture and Fisheries, as well as some £650,000 for the Department of Agriculture for Scotland. Just over £1 million goes to the Ministry of Works. The major item, however, is £128,308,000 for the Ministry of Supply—an increase of £18 millions on the corresponding vote last year. Of this, £52,750,000 is for research and development work carried out by industry or extra-mural work by t universities, while £7,896,380 is accounted for by t civilian staff of the Research and Developme Division and £483,484 by that of the Directorate Scientific Research and Technical Division.

Although details of the staff employed in t various directorates and divisions of this Minist are included in the Civil Estimates, it is not easy gain a clear picture of the research effort for whi it is responsible in terms either of money or staff. I complicated character is apparent from what h already been said, and in his highly critical comme on June 12 Lord Falmouth stated that the Minist employed a staff of 1,051 scientific officers, 1,0 assistant scientific officers and 1,444 technic assistants. The civilian staff of its Research a Development Division alone numbers 14,449, with further 2,300 in the Directorates of Atomic Energ of Guided Weapons and Electronics, of Scienti Research and Technical Development, the Ch Scientist and the Chemical Inspectorate.

With all allowance for the value to industry work done in this Department, the government sta employed on research and development in this w look considerable when placed alongside the 3,7 employed by the Department of Scientific a Industrial Research, or even the 31,000 perso estimated by the Federation of British Industries engaged full time by the 301 firms on research a development work. Of these, about 8,500 possess university degree or equivalent qualification. B the survey attempts no estimate of the number persons employed full-time in industry as a whole research and development. The earlier survey p this at roughly 45,000, of whom about 10,000 we qualified scientific men or technologists. An analy of the qualified staff of some 254 firms as at 1946 a 1950 indicates an increase of about 50 per cent, a while there is evidence of a slight general increase the ratio of unqualified to qualified staff, it wou appear from this survey that the number of qualifi scientific men and technologists employed by industr on research and development is unlikely to exce 15,000 in a staff of perhaps 65,000 to 70,000.

Among this qualified staff, chemists are still t most numerous; but their 38 per cent is now fo lowed closely by engineers (35 per cent), physicis coming third with 11 per cent, compared with 4 33 and 10 per cent, respectively, in 1946. In the 254 firms the number of chemists employed increase from 2,357 to 2,945, of engineers from 1,455 to 2,6 and of physicists from 844 to 2,357. The number biologists was 182 in place of 92, of mathematici 115 compared with 61, and metallurgists 416 in pla of 293. Expenditure per unit of qualified staff vari from a little more than £2,000 in heavy electric engineering to more than £4,000 for glass and f textiles, compared with £1,600 to £2,300 in 194 The ratio of unqualified to qualified staff a fluctuates considerably, varying from about 2 i glass and in the scientific instruments and heav electrical engineering groups to 5 2 in light electric engineering, but generally shows a slight upwa trend.

The total floor space of the research and development departments of 249 firms has increased by 4 per cent since 1946 and is approximately 1,000 q. ft. per qualified member of staff. Research and development expenditure expressed as a percentage f turnover varied considerably in the industrial groups analysed, being as little as a half per cent in extiles, the ferrous metals, and the food, drink and obacco group and as much as five per cent for light lectrical engineering and scientific instruments. The gure of 2·4 per cent for the chemicals group compares with that of 3 per cent for Imperial Chemical Industries, Ltd., in 1950 given by Sir Wallace Akers o the International Symposium on the Organization f Scientific and Industrial Research.

On the evidence of this survey, the research and evelopment effort of British industry is unlikely to ave increased by more than 50 per cent since 1946, nd the upper estimate of about £60 millions contrasts with Dr. Vagtborg's estimate of an expenditure n research of 600 million dollars by American ndustry, or 2,000 million dollars if development work s included; Lord Hall, in the debate on June 11, quoted a figure for 1951 of £900 millions. This omparison, moreover, ignores the question whether he research effort is wisely directed at the right argets, and whether the best use is made of technological and scientific man-power, so that it is not wasted on tasks that could be equally well performed y clerical, administrative or less highly trained echnical staff.

Such questions, however, are all-important in considering the distribution of the research effort of Britain, and particularly the proportion that is arried out directly or indirectly under the auspices of the State, a point Lord Falmouth was inclined to overlook in his criticism of the Ministry of Supply. By and large, however, the expansion of research and development in British industry lags behind that of other countries, and as Sir Henry Tizard maintained n his Messel Memorial Lecture at Aberdeen on July 9, its dependence on the State is increasing.

The survey made by the Federation of British Industries is purely factual: no attempt is made to discover or discuss the causes of the trends revealed. It is the more useful, therefore, to examine the survey n the light of some of the replies received to questionnaires sent out by the Parliamentary and Scientific Committee to various affiliated scientific institutions and research organizations, as well as to the directors of research of some major industrial firms, in connexion with the debate in the House of Lords on June 11 and 12. A number of the replies confirmed the view expressed in that debate and elsewhere that the lack of a sufficient number of trained scientific men and technologists, particularly on boards of directors, is an important factor in delaying the application of research results in industry. This deficiency is being gradually remedied, and the discussions on higher echnological education have focused a fair amount of attention on it; though in this connexion and particularly while the shortage of certain categories of scientific men persists, more attention could well be given to the most effective use of the time of such men. The ratios of qualified to non-qualified staff quoted in the Federation of British Industries survey appear to justify one comment by the Parliamentary and Scientific Committee that more use could be made of less highly qualified staff on duties which do not really demand the expert knowledge, for example, of a trained chemist.

Much emphasis was laid in the replies to the Parliamentary and Scientific Committee's inquiry on the obstacles to development presented by the present fiscal policy in regard to plant obsolescence, and by the long delays experienced in obtaining delivery of plant or equipment, licences for plant extensions and other capital projects, as well as to the danger that rapidly mounting costs of re-equipment and plant alteration are tending to involve capital expenditure beyond the resources of a small company. Such factors, which are a direct result of Government policy, tend to overshadow the conservatism of the British manufacturer and consumer. Sir Henry Tizard was right to appeal for a greater spirit of adventure on the part of industry; but British industry will also be grateful for his outspoken reference to the way in which taxation policy discourages industrial adventure. The point is one which the Parliamentary and Scientific Committee might take up strongly.

Apart from the shortage of qualified scientific men and technologists, particularly of engineers, chemists, physicists, metallurgists, chemical engineers and physical chemists, replies to the Parliamentary and Scientific Committee's inquiry suggested that the rapid application of scientific knowledge in industry is being hindered not only by the absence of sufficient numbers of those able to assimilate and apply such knowledge, but also to some extent by defective means of dissemination. Both presentation and interpretation require improvement, and Sir Wallace Akers, who in commenting on the staff position had stressed the importance of quality rather than quantity, and the serious effect on the teaching of science in schools of the scarcity of really good scientific staff, urged Government assistance in the publication of original scientific papers and abstract journals.

Generally speaking, the replies to the Parliamentary and Scientific Committee's inquiry contributed little that is new, and the general trend of opinion was faithfully reflected in the House of Lords debate. Strong support was forthcoming for more generous support for the research associations and the government research stations, and there was no suggestion that the distribution of research effort as between industry, government establishments and the universities is unbalanced; nor was concern expressed that there is excessive reliance upon the State. Sir Wallace Akers, indeed, referred to a suggestion that the Department of Scientific and Industrial Research's grant system should be extended to encourage the appointment of effective field-teams, particularly in those research associations serving industries which are not remarkable for their technical progress. He also commended a suggestion that the research associations might be used as recruiting agencies for the corresponding industries by establishing training schools within the associations themselves to provide courses for production and research staff for these industries.

The educational potentialities of the research associations deserve more attention than they have yet received, both in regard to the expansion of technological education and from the point of view of industrial recruitment and the movement or interchange of staff both with industries and with the colleges of technology or even the universities. This is a further reason for viewing with concern the recruiting difficulties to which the Advisory Council for Scientific and Industrial Research directs attention in its recent report, and for probing further the reasons for the reluctance of many of the best science graduates to enter the government scientific service.

That, of course, is independent of the question whether or not, in fact, an undue proportion of the nation's scientific effort is being made under government auspices. The question of quality, however, scarcely enters into the strictly factual survey of research conducted by the Industrial Research Committee of the Federation of British Industries, though it was clearly in the minds of some at least of those who replied to the questions of the Parliamentary and Scientific Committee. None the less, the survey, like the memorandum of the Parliamentary and Scientific Committee, gives a picture of the present position and an indication of some of the trends and the close relation of industrial research and development to such matters as technical and technological education and the effective dissemination of the results of research, in which circumstances to-day have increasingly thrown large responsibilities on the government. The observations and suggestions will no doubt be carefully considered by Lord Woolton and by Lord Cherwell on behalf of the Government, and it is to be hoped that they will bring the necessary note of urgency to the formulation and execution of an adequate policy, both in regard to industrial research and development and such ancillary matters as technological education.

SCIENCE AND SOCIETY

The Impact of Science on Society

By Bertrand Russell. Pp. 140. (London: George Allen and Unwin, Ltd., 1952.) 7*s*. 6*d*. net.

THIS book, which appeared appropriately as Lord Russell celebrated his eightieth birthday, has more unity than might be expected from the prefatory statement that it is based upon lectures originally given at Ruskin College, Oxford, and that the last chapter, which discusses the stability of a scientific society, was given as the Lloyd Roberts Lecture at the Royal Society of Medicine, London, on November 29, 1949. For some readers the book's main interest may derive from its revelation of Russell himself, but it is something more than the musings or reflexions of one of the most brilliant intellects of our times. Here is no octogenarian living in the past. Once again the gifts that have stimulated two generations play over the problems that scientific advance in the last three centuries have created 1 mankind—the clash between science and traditi the general and the specific effects of scienti technique in an oligarchy or totalitarian regime a in a democracy, the relations of science and war a of science and values, and the stability of a scienti society, whether dictatorship or democracy. he is sometimes more subtle than in some earl books and the gentleness of age leaves it for t reflective reader to discover how penetrating a stimulating some of his comments and observatic really are, we have still in good measure the impi almost Puck-like wit that we have long been acc tomed to from one whose intellectual eminence linked with the freshness of youth.

Save where in his first chapter he touches science and tradition and stresses three factors in t scientific outlook of the eighteenth century that we specially important in developing the mechanis outlook, and again when he discusses the philosopl of human power, the philosophical element in tl book is slender. This, however, is what gives t book its distinctiveness, as may well be seen if it set beside the study, similarly entitled, and of li length, to which fifteen years ago Lord Stan expanded his presidential address to the Briti Association. On the general effects of scienti technique on society, the problems of science ai war and even the question of science and value both Russell and Stamp have much to say that similar. Both were convinced that one of the ma consequences of scientific development is to increa the interdependence of peoples, and that scien offers possibilities of far greater well-being for tl human race subject to the fulfilment of certa conditions. Even on those conditions they wou seem to be broadly in agreement. As defined b Russell these are: the abolition of war; even di tribution of ultimate power; and limitation of tl growth of population. Stamp was largely concerne with the devising of practical measures to preve the stresses arising from social or industrial di equilibrium due to excessive rate of change, and h agreement with the second condition is implicit rath than explicit. On the first and third, Russell is r more emphatic than Stamp, for all the experience the intervening years, which has shown the necessit for finding some means of averting recourse to w and of limiting the growth of population if the worl is to avoid either destruction of civilization starvation.

The difference in emphasis and in outlook betwee the two studies lies in the quickened appreciation the importance of the problem of power which mark that of Lord Russell. Not all the aspects of th problem are indeed illuminated by him: at some the darker problems, such as that of the control mind and personality, Russell only hints. He concerned above all with the problem of officialdo in the scientific society which may confront us, a if to the question how the government itself is to controlled by the governed he gives no clear answe much in his book should stimulate the scientist deep thought, whether he is concerned primarily w the future of science or that of society.

When he touches on the practical problems of ho world government is to be achieved, the growth population controlled, or the abuse of power pr vented so that freedom of initiative and expressio are ensured in the new context, Lord Russell disappointing. He closes, indeed, on a note timism rather than pessimism ; but he is hopeful ther than confident. His firm condemnation of the aticism of our times is not matched by the same surance in giving his reasons for thinking that ankind may avoid the disaster which such fanatic- n and refusal to adjust its activities in the light of ason threaten to bring. He discounts unduly the rt played by emotions in human affairs, seems to gard emotion as necessarily or essentially evil, and discard religion with the fanaticism he denounces. rhaps for this reason—whereas Stamp, calling for advance in the science of man commensurate with e advance in the science of matter during the past ree centuries, leaves us facing the future with some nfidence that we can regain control over events— ssell, declining to believe that the world war and rld disaster are inevitable, for all the factors which delineates as tending to bring them, leaves us shing that wisdom and reason may prevail rather an with the serene confidence of those who have en and believe in the greatness of man and who are in the appreciation of what is noble, beautiful, ntle and wise, and in the vision of a society, where dividuals grow freely and where hate and greed and vy die, of which he spoke in his broadcast reflexions his eightieth birthday. R. BRIGHTMAN

MOLECULAR SPECTRA AND MOLECULAR DYNAMICS

olecular Spectra and Molecular Structure

: Spectra of Diatomic Molecules. By Gerhard erzberg. Second edition. Pp. xv+658. (New ork : D. Van Nostrand Co., Inc. ; London : Mac- llan and Co., Ltd., 1950.) 9.75 dollars ; 73*s*. 6*d*. net.

ROM time to time a landmark appears along the hard road towards the complete understanding molecular dynamics, serving not only to please d encourage, but also to stimulate us to further fort. Such is this book, a work of authority, of lendour and polish, and—in spite of its encyclo- edic content—of absorbing interest. The first ition was published twelve years ago at the outset the Second World War, and few copies were avail- le outside the United States, so few indeed that y own copy was almost continuously on loan. This w volume is the most thorough treatment and ference work on the spectra of diatomic molecules t published. It covers ground which is equally portant in physics and chemistry, and in revising e book the author has added new sections on icrowave spectra, Zeeman and Stark effects, hyper- e structure, and many aspects of photodissociation, well as giving us some promising new data on rophysical phenomena.

Dr. G. Herzberg's clarity as a lecturer is well own, and this is reflected in his books. He has sembled here all the salient theory of molecular namics required for the interpretation of rotational, brational and electronic band spectra, amply illus- ted by numerical results and photographs, and ectly applied to a variety of typical cases. All this presented in a logical readable form. There is too ten a tendency by some workers in this field to othe the subject-matter in a shroud of forbidding athematical formulation, which leaves the ordinary ader or the student both exhausted and in despair. r. Herzberg deals properly and adequately with such mathematical theory as is needed for the problems involved and, incidentally, provides a clear exposition of the wave-mechanical principles ; he never fails, however, in illuminating asides, to seek some attractive physical picture or visualizable analogy, as, for example, his model to illustrate the meaning and mode of action of the Franck–Condon principle. The somewhat puzzling topics of vector coupling of momenta, of the symmetry properties of different energy-levels, and of ortho- and para-modifications are also clearly discussed, and all the ramifications of the rotational fine structure associated with electronic-vibrational transitions are set out.

The later parts of the book deal with the dissociation processes associated with different kinds of continuous and diffuse spectra, and with the electronic structure of molecules in relation to stability and interatomic forces. The derivation of molecular data such as heats of dissociation and potential energy diagrams is explained fully, and in a critical manner.

Finally, an up-to-date table is given of the energy-levels, vibrational frequencies, anharmonicity co-efficients, rotational constants and other desirable data, which will long remain a place of reference for all those working in this field and for many others less directly concerned. More data are now becoming available about the higher vibrational levels of molecules in the electronic ground-state, studied with high-dispersion grating spectrometers and very long absorption paths, and the greater precision which is now possible may well lead to a revision of some of the molecular constants listed in this table. Yet this does not in the least detract from the enormous value of Herzberg's compilation. This is, in fact, an admirable book. H. W. THOMPSON

SUGAR BEET DISEASES IN IRELAND

Sugar Beet Diseases in Ireland

By Prof. Robert McKay. Pp. ix+78+37 plates. (Dublin : At the Sign of the Three Candles, 1952.) 21*s*.

TO his illustrated guides for the recognition and control of flax and tomato diseases Prof. Robert McKay now adds this third volume, and like its predecessors it is attractively produced, beautifully illustrated, and reveals first-hand knowledge of the subject. Sugar beet has been grown commercially in Ireland for a quarter of a century, and the crop is subject there to much the same diseases as occur in England, though not always in the same degree. Black leg, for example, causes considerable loss every year and is not controlled by seed treatment with organo-mercury dusts, whereas in England, where seed treatment is a routine operation, this disease, though common, is rarely destructive.

The very heavy loss in sugar yield (about £6,000,000) experienced in England in 1949 as a result of the worst epidemic of virus yellows known there, has not been paralleled in Ireland, and both mosaic and downy mildew are evidently also of less significance. This may well be due in no small measure to the action of the Irish Sugar Company, which, following moderate epidemics of virus-yellows and downy mildew in 1946, insisted on stecklings being grown in complete isolation from seed and root crops, and on seed and root crops being grown in separate fields and as far apart as possible.

Until 1940, all supplies of mangold and beet seed had been imported into Ireland from the Continent; then it became necessary to produce home-grown seed, and for convenience the seed crop was raised in the same fields as the roots. As a result the major diseases increased rapidly during the next six years. No severe epidemics have occurred since compulsory isolation was introduced in 1947; but recent partial failures clearly indicate that it is not sufficient merely to raise stecklings in isolation. The steckling areas must be chosen carefully, and build-up of virus in them must be prevented by keeping down groundkeepers under a proper rotation.

Prof. McKay describes about two dozen diseases. His main conclusion is that their control is a matter of prevention rather than cure, of good husbandry rather than protective spraying. His story is an interesting one, and should be readily understood by anyone interested in sugar beet production. Ten of the thirty-seven plates are in colour; there is a glossary of the fifty or so technical terms used; and an author as well as a subject index.

W. C. Moore

TRANSCENDENTAL PHENOMENOLOGY

Ideen zu einer reinen Phänomenologie und phänomenologischen Philosophie

Von Edmund Husserl. Buch 1 (Husserliana, Band 3): Allgemeine Einführung in die reine Phänomenologie. Neue, auf grund der Handschriftlichen Zusätze des verfassers erweiterte Auflage. Herausgegeben von Walter Biemel. Pp. xvi+483. 20 guilders. Buch 2 (Husserliana, Band 4): Phänomenologische Untersuchungen zur Konstitution. Herausgegeben von Marly Biemel. Pp. xx+426. 19 guilders. Buch 3 (Husserliana, Band 5): Die Phänomenologie und die Fundamente der Wissenschaften. Herausgegeben von Marly Biemel. Pp. vi+167. 6.75 guilders. (Haag: Martinus Nijhoff, 1950–52.)

With these three stately volumes, the scholars of the Husserl-Archiv at Louvain bring their immediate task to an end. It would, however, be incorrect to write "Husserliana concluded", because there is some reason to suppose that further material of outstanding consequence to philosophers is still being worked over, and that, ahead again, we may be presented one day with an authentic biography of the master himself. In a recent discussion with Husserl's daughter, I gained the impression that the treasure-house has not yet been exhausted, which only underlines the debt which all serious students of the subject owe to Prof. H. L. Van Breda and his colleagues for their long labour of love. The present editions are the work of Dr. Walter Biemel and of Marly Biemel, and between them account completely for Husserl's researches and their development during the period 1913–25. Much of importance is to be found in a series of supplements to the main text, embodying somewhat copious rescripts. It is clear that publishers and printers have given of their best.

The first book contains the complete theory of phenomenological reduction, including the derivate factor of pure consciousness and its essence-correlate. An attempt follows to obtain a clear-cut approach to the former, with its influence upon recent scientifi trends. In the second book the relation of phenomenology to the physical sciences, psychology an aesthetics is discussed. Here, the establishment o suitable pre-conditions is recognized as the firs essential, and permits a deepening of previou knowledge.

The purpose of the third book is to probe the 'idea of philosophy, in the light of the possibility o developing a norm of absolute knowing. Cognitio at this level is seen as the pre-condition for an system of metaphysics (and former philosophies, too) which are in principle capable of appearing a sciences. It may be remarked that, in this context some concordat is to be expected with an extende *philosophia perennis*, a point brought out some yea ago from another angle. This may, of course, prov to be but a minor matter; what is more significan is that, by reflecting upon the ontological basis of th sciences, Husserl is gradually leading up to th feasibility of science offering—and in the even accepting—fundamental criticism of itself, and tha at its own level. A recent author, in discussing th "Theodicy" of Leibniz (1710), has given reasons fo thinking that a re-birth of metaphysics will assuredly come about one day: that this should be said jus now, coupled with the prophetic insight of phenomenology, raises hopes that metaphysics may ye assume the role of a progressive discipline, and thu qualify to be regarded as a necessary outcome—among others—of Husserl's "Ideen". It is only too manifest that this is not the part which metaphysics is traditionally credited with playing, if the history of thought is widely analysed. Sometimes, fo example, we find it neatly sliced away from contac with all experimental techniques, and left to justify itself, if it can, as a convenient mental short-cut when observational work had become tedious, o mathematics too hard. At other times, when a mos valuable time-saving science—witness the rise o chemistry, which by its own efforts reached a empirical summit, unscaled by physics for ages—i discovered and pressed home, nobody would dream that, in a sense, a species of metaphysics was being evolved without ontological regard.

These are not exactly questions which can b settled by yea or nay; what matters is that a philosophical climate should be provided, such that in it, they may be recognized as specific problems even if insoluble for the general case. The structure underlying the doctrines of the present volumes i one at least capable, in theory, of embracing these situations.

Of these three contributions, therefore, it may b said that they represent the fullest development o Husserl's transcendental phenomenology, and that in a form embodying the most polished finish of whic his system is capable. But there must be a tool, *Methodik*, especially one deliberately fashioned to c through to a philosophy which can lay claim to prior to all (other) knowledge and scientific ratiocination. This weapon, the general character o which has been sketched on previous occasions, i the principle of phenomenological reduction. It purpose is to attain to a pre-suppositionless regio with its emphasis upon pure consciousness (th individual ego), and in such a way as to be free from pre-judgment. The residue, after reduction, is the 'stuff', so to speak, of phenomenology, and the facto upon which it operates. A crude image of what thi means would be the suspense account with which w more or less familiar in administrative affairs. rein something is laid by for the time being, and judgments passed upon it; for Husserl this comses the world, and all 'posited' things. The German *geschaltet*, often translated 'eliminated', does not olly satisfy British minds; it inclines too heavily wards finality. To borrow an expression from ctrical engineering, 'switched-out' is probably arer the true connotation. There is then nothing prevent us from throwing in the 'breaker' again enever circumstances permit.

In bringing to a close this series of essays on sserl's phenomenology which have appeared in *ture*[1], it may be legitimate to take a final glance the panorama spread out before us, now that the ours of the archivists have been so well implented. Husserl was convinced to the end that his earches had indeed disclosed the existence of a *ena* of thought, free from vestiges of prepposition, and endowed with perfect rigour. If pact upon the world of learning is any criterion of rth, then, as the original memorial volume to the ster's memory illustrated, his influence is already et. More particularly is this so in the *Geistessenschaften* (psychology, psychiatry and so forth), ich are the most difficult to discipline, just because ey are youthful and full of promise. There perhaps, re than anywhere else, is the value of suspense of dgment (reduction) most in evidence. The relative rits—or limitations—of *Gestalten* and association e still not fully resolved: as one example among ny.

Finally, this may be the place to record the death Prof. Husserl's widow, on November 21, 1950, at e age of ninety. It seems almost incredible that en she was nearly eighty she contrived to get her sband's papers out of Germany, and into the nerous care of the authorities at Louvain. Surely, t feat alone is her fitting memorial.

And now the little band of scholars, some dozen ars after the event, can lift up their eyes and look on the fields, for they are white already to harvest.

F. I. G. RAWLINS

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[1] *ature*, **154**, 504 (1944); **156**, 516 (1945), **166** 919 (1950).

A PROSPECT FOR ESTATE WOODLANDS

tate Forestry

y Sir William Ling Taylor. Pp. xi+200+12 plates. ondon: Crosby Lockwood and Son, Ltd., 1951.) s. net.

IR WILLIAM TAYLOR, who was for many years a member of the Forestry Commission of Great itain, ultimately becoming director-general, adesses this book to "the owners, agents and foresters o are concerned with the management of private tate woods". As this is one of the few books of any se to be published about estate forestry since the cond World War, it will certainly provide food for ought among those to whom it is addressed.

It comprises twenty-two chapters, of which the st three deal with forestry in general: its background, its problems and its national aspects. The xt five chapters are concerned with sylvicultural oblems and notes on broad-leaved and coniferous ecies. These are followed by five chapters on rseries, planting, tending and maintenance, and coppice. After this, two chapters on damage and protection are included, and four chapters on the business side of forestry, including marketing, taxation, co-operative groups, with a chapter entitled "Forestry and the Farm". The last two chapters deal with the forest year and forestry books.

It is a very good thing to see that a chapter on the farmer's trees has been included, for in the past too little importance has been attached to farms as potential sources of timber. Since 1940 hedgerow trees have made a very useful contribution towards the timber needs of Britain. If it were only possible to persuade farmers that trees are worthy of better treatment than as fence posts, it would indeed be a step forward.

The question as to whether forestry pays or not is a problem which must be present in the minds of many who are concerned with woodland management at the present time. In answering this question, however, it is to be regretted that the author did not provide figures relating to the actual cost of the usual forest operations. Forestry is a business and, as in all businesses which are to remain solvent, one must know what the costs of production are.

The views which the author expresses on some points will not be accepted without question by some of his readers. His statement that "workers new to the woods, if well supervised, speedily acquire skill and soon become able to notch-plant up to a thousand transplants in a day's work" needs some qualification.

On the subject of the best tool to use for pruning, he says "there is little doubt that the best work is done with a sharp well-set hand pruning saw used in conjunction with a light ladder". This may be the experience of the author, but those who have seen the excellent results obtained with such chisel pruners as the 'Whitmore Pruner' may feel that Sir William is somewhat dogmatic.

The book is well produced and has a number of very good photographs, together with a synopsis of the Forestry Act, 1951, included as an appendix.

N. D. G. JAMES

STUDY OF THE WOOD RAT

The Dusky-footed Wood Rat

A Record of Observations made on the Hastings Natural History Reservation. By Jean M. Linsdale and Lloyd P. Tevis, Jr. Pp. x+664. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1951.) 56s. 6d. net.

THE dusky-footed wood rat (*Neotoma fuscipes* Baird.) is a medium-sized rodent native to North America. It and other species of the genus *Neotoma* are also called pack rats, trade rats, brush rats and cave rats. It rarely leaves its normal living-quarters in the wilds, though it sometimes comes to isolated habitations of man. Wood rats are nocturnal and are seldom seen without special search, but the conspicuous houses in which they live, built of sticks above ground, readily show their presence. The subspecies dealt with in this book is *N. f. luciana* Hooper of coastal central California.

The authors have investigated all the aspects of the biology and ecology of this animal for ten years on the Hastings Natural History Reservation in Monterey County, California. They have made an intensive study of this comparatively small area and of the individual rats that lived there during successive generations. Their trapping methods made possible the repeated handling and examination of the rats, which were often kept under observation for the whole of their life-spans.

The population studied was more stable than that of most rodents, the stability reflecting a continuous and precise adjustment to the brushland and woodland where the animals live. A wood rat's ability to survive is affected by the conditions that enable it to leave its home and those that affect it away from shelter. A rat that lives in a house providing protection from the weather and predators is exposed to these dangers when away from home. It leaves its house mainly to get food and housebuilding material, to escape from dangerous intruders or intolerant members of its own family, and to find other rats.

Many rats contribute to the maintenance of few houses, which last much longer than any single occupant, but the character of each house is dictated by its situation and the available materials; it remains constant in type through successive tenancies. After a period of vacancy a house falls to pieces because it loses its 'sign', such as odour, deposits of fæces and urine, and gnawings; it is then no longer recognized by the rats as a house.

The wood rat is polyœstrous, and breeding occurs throughout the year although there is a peak in early summer. The number of young in a litter averages about two, and females produce from one to five litters a season; the survival-rate is low, nearly half the litters of 1946 disappearing before any members of them were trapped. An important character of the population, however, is that the number of adults remains fairly constant. Every month sufficient new rats appear to replace the old ones that vanish. There must always be some homeless rats seeking suitable houses, probably young ones that have never had homes of their own and old ones driven out by aggressive newcomers. A rat driven from a bad house by weather or other factors may be able to oust the owner of a better one.

These are but samples of the topics covered by this book, which deals with every facet of the life of the wood rat from the cradle to the grave. The researches recorded here are not only an important contribution to the study of mammals, but also a most interesting and intimate account of the life of a charming creature. Few species of wild mammal have been so closely studied or so thoroughly portrayed.

L. HARRISON MATTHEWS

MENTAL EPIDEMIOLOGY

On the Objective Study of Crowd Behaviour

By Dr. L. S. Penrose. Pp. vi+74. (London: H. K. Lewis and Co., Ltd., 1952.) 10s. net.

THE study of crowd behaviour has long been hampered by the lack of suitable quantitative methods of treating the data. The analytical approach of writers like le Bon and Freud, profound and illuminating as it has often proved to be, is not enough to establish a systematic science of social behaviour. Prof. L. S. Penrose's monograph represents an important advance towards this goal. His contribution to methodology is twofold: first, in suggesting new techniques of measuring the effects of the size of a group on changes of opinion among its members; and second, in quantifying the conceptic of a 'mental epidemic'. Let us consider these briefl in turn. Prof. Penrose takes as his fundamental un of measurement "a person characterised by possessir a given idea or potential reaction pattern". He mak the assumption that, in the type of group he is considering, the making of decisions and changes opinion among the group members may be looke upon as random fluctuations which are a functic only of group size. A comparatively small minorit of members who know their own minds can the control the decisions of the indifferent majority. I general, the power of a bloc vote diminishes only the square root of the number of indifferent membe The degree of control which a bloc of 5 exercises ov an indifferent 25 is the same as that exercised by bloc of 100 over 10,000. Given the size of the resolu minority and of the indifferent majority, an index the power of the minority can be obtained b reference to tables of the normal curve.

Prof. Penrose's second main contribution al involves the same fundamental unit of measureme and is based on an analogy he draws between physic and mental epidemiology, the growth and decline ideas in populations being described in terms epidemics and immunity. Corresponding to the thr factors distinguished by Stallybrass in physic epidemiology—namely, the infective agent, the mea of transmission, and the susceptibility of the expose population—so also in mental epidemiology the are: the quality of the idea; the visual, audito and other means of transmission; and the ment state of the recipient. Apart from the analogy wit single epidemics, analogies may also be drawn wit periodic epidemics and with persistent diseases. Th notion of mental epidemic is illustrated by referenc to phenomena of crazes, panic, religious outbreak politics, war and the general transmission of ideas i populations. Two examples are provided of quant tative representation: one, a craze in medical trea ment; and the other, voting in the America presidential elections over the period of a century The various ways in which the above factors may b influenced is discussed, in particular by isolatio which heightens receptivity to ideas, especially idea of suspicion. Isolation and suspicion thus produce vicious circle.

Prof. Penrose does not, however, glorify statistic analysis at the expense of clinical and experiment methods. Nor does he regard an epidemiologic model as the only useful one. He makes a numbe of enlightening remarks on the psychopathology c crowds. For example, he points out that, just as th individual mental patient is often unaware of hi sickness, so a crowd may be unaware of disturbanc in its behaviour, and "the recognition of the patho logical nature of many aspects of crowd behavio may prove a stabilizing factor in the development human cooperation".

It should perhaps be mentioned that the bo deals primarily with phenomena of collectiv behaviour, not with those phenomena of mutu interaction in groups which are increasingly occupyin the attention of experimental workers in soci psychology.

Prof. Penrose's suggestions are at once original an ingenious. They can be readily applied to experimental as well as to historical data, and they ma have an important bearing on such questions as th best size of national representation in a worl assembly.

JOHN COHEN

Stereoptics

An Introduction. By Leslie P. Dudley. Pp. 112. (London: MacDonald and Co. (Publishers), Ltd., 1951.) 15*s.* net.

THIS is a fascinating little book which should prove excellent relaxation for the physicist specializing in other fields and a good introduction for the serious student of the subject of stereoptics. The author, who is the originator of the apt term 'stereoptics' to describe the theory and applications of stereoscopic principles, particularly in the field of photographic optics, is also the technical director of Stereoptics, Ltd., London, and has played a large part in Great Britain in developing new processes of stereoscopy.

The book is chiefly concerned with the application of stereoptics to photography, cinematography and radiography, the first part dealing with general principles and processes which require some form of viewing device in order to perceive the stereoscopic effect, and the second part with a discussion of some of the more important auto-stereoscopic processes. An auto-stereoscopic photograph is one which exhibits a three-dimensional or solid effect without the use of a viewing device by the observer. Such photographs are now familiar objects, but it is good to be reminded that it was in 1902 that Frederic Ives filed his classic patent application for the first practical method, probably based on a suggestion of Berthier's, in 1896, of producing an auto-stereoscopic photograph. The various parallax stereogram and panoramagram processes and developments which have since been patented and used successfully are clearly described in an attractive and interesting, though technical, manner.

The author's own important contributions are modestly mentioned. The final chapter in the book deals with stereoscopic radiography, the use of which offers great potential advantages both industrially and medically. In this field the author can claim to be an authority, and his enthusiasm and optimism about the rapid advance and promising future of three-dimensional pictorial presentation should win over even the most sceptical of readers.

S. WEINTROUB

British Journal of Applied Physics

Editor: Dr. H. R. Lang. Vol. 2 and Supplement No. 1, 1951. Pp. v+370+viii+96+vi. (London: Institute of Physics, 1951.)

THE decision of the Institute of Physics in 1949 to commence a separate monthly periodical, the *British Journal of Applied Physics*, in addition to its *Journal of Scientific Instruments*, has been more than amply justified judging by the excellence of the contributions received and by the welcome given to the new *Journal* by physicists generally and more particularly by those employed in industry. In Vol. 2 the high standard set by the preceding volume is, if anything, surpassed.

In addition to the twelve monthly issues, containing special articles, conference reports and original contributions, the volume includes a supplement of some ninety pages on the physics of lubrication, in which the proceedings of the conference on that subject held in Manchester by the Institute and the British Society of Rheology during 1950 are reprinted. Four other conferences—on the aspects of fluid flow, spectroscopy, the development and application of Fourier methods in crystal-structure analysis, and the texture and structure of metals – form the subjects of special reports. Three of the nine special articles will be of particular interest to teachers of physics in technical institutions: these deal with the rationalized M.K.S. system of units, procedure in industrial physics and its implications for education, and impressions of a discussion on technical universities. The numerous original contributions, on the average four per issue, cover a very wide field, but nearly all have direct applications in industry.

The editor and advisory committee are to be congratulated for maintaining in these difficult times such a high standard, both as regards content and production.

Science and the Christian Man

By Charles E. Raven. Pp. 60. (London: S. C. M. Press, Ltd., 1952.) 4*s.* 6*d.* net.

THIS book consists of six broadcasts delivered by Canon C. E. Raven. It suffers from the unavoidable defects of all broadcasts—the covering of too much ground with too few words, of using insufficiently established premises and of leaving a multitude of loose ends. Such a book should be regarded as a provoker of thought rather than an authoritative manual. All will agree with the author that the Christian man cannot say no to science, which is a great achievement of the human spirit, and from which the man of to-day can scarcely stand aside: but the treatment of the relation of science to the beliefs of the Christian is less satisfactory. Canon Raven dismisses almost all the miraculous element in the Christian evidences, and indeed seems to select for credence only such passages from the Scriptures as suit his views; modern churchmen who think as he does will doubtless find the book much to their minds. On the other hand, Roman Catholics take a more stringent view of the interpretation of the Scriptures in a fashion other than literal; consequently Canon Raven's book will, for them, miss the point. This said, the book is to be commended. Many things are finely said, and few will read it without discovering in it some new facet of the great problem it discusses.

F. SHERWOOD TAYLOR

The Southern Marches

By H. J. Massingham. (Regional Books Series.) Pp. xv+368+25 plates. (London: Robert Hale, Ltd., 1952.) 21*s.* net.

THE Southern Marches—the southern borderland between England and Wales—comprises the region between the Wye and the Usk, between the Bristol Channel and north Herefordshire. Apart from places like Monmouth, Tintern, Chepstow, Symonds Yat, Ross, Raglan and the Channel of the Lower Wye, these southern marches are little known. In this book the late Mr. H. J. Massingham set out to bridge this gap in knowledge, and he succeeded very worthily. The ground is surveyed not only topographically but also in such aspects of the region as its architecture, its agriculture and its atmosphere. Local 'worthies' are given generous attention, while issues arising out of the author's travels are freely ventilated. Occasionally Mr. Massingham's views, like his prose, are extravagant, but these merely serve to accentuate the virility of a book which those who know and love the Southern Marches will treasure for years to come. "The landscape between Tintern and Chepstow" will indeed "continue to operate as tho' Paradise had never been lost". T. H. H.

CHAUCER'S ASTRONOMY

By Dr. DEREK J. PRICE
Christ's College, Cambridge

A FOURTEENTH-century astronomical manuscript in Peterhouse, Cambridge, was recently put forward* as a holograph draft of an unknown work by Geoffrey Chaucer. The tentative case has now been considerably strengthened by a photographic comparison of the handwriting with that of another suspected holograph in the Public Record Office. The similarity is striking in spite of a gap of seventeen years between the two specimens, and, taken with the linguistic and circumstantial evidence, it poses a problem which it is difficult, if not impossible, to answer without accepting Chaucer as the author of this "Equatorie of the Planetis".

A certain amount of interest in the text arises from its providing a new example of Chaucer's prose, for the first time unsullied by scribal perversion, and there is also the sentimental regard that one must have for a work in the poet's own hand. Two other aspects demand attention from the historian of science: What light is shed on Chaucer as a scientific writer, and what light is shed on medieval astronomy?

Chaucer's writings supply all the information we have about his interest and participation in scientific activity, and any comparative study is hindered by the fact that the interesting astronomical literature in Middle English has not been accorded the scholarly attention given to the Latin writings. From the frequent astronomical allusion in the "Canterbury Tales" and in his other works, it is clear that Chaucer was very well grounded in the "Almagest" of Ptolemy, and was competent as an observer and calculator. More certain evidence is provided by his "Treatise on the Astrolabe", written in 1392, and still to-day the best work in the English language on this extremely important medieval instrument which served both for observation and as an ingenious calculator for determining the positions of the stars at any time.

It is apparent that for astrologer and astronomer there is a complementary problem of finding the positions of the planets at the same time, and indeed in the Prologue of the "Astrolabe" we are told that such a section is to be included. The extant manuscripts, however, give only slightly more than two of the promised five portions, and we therefore possess only the sections on the astrolabe itself, with a little additional matter.

The new "Equatorie of the Planetis" together with its accompanying sets of astronomical tables go far to providing these missing sections. It seems as if Chaucer first wrote his table of contents and then modified his plan as the work proceeded—a technique that is also to be found in the "Canterbury Tales". As with the "Astrolabe", he was working from a Latin translation of an Arabic original, and if we are to judge by the frequent errors and corrections, and the large sections which have been struck out as erroneous, it must be admitted that an increase in complexity towards the end of the text led finally to the abandonment of the matter. The writer adopts the same personal and repetitious (but pleasant) tone of elementary instruction as in the "Astrolabe", and it is not surprising that he should ultimately fail when describing the finer detail of a topic which held a position similar to that of the theory of relativity in the first quarter of our present century. We can only conjecture how much of the failure was due to impossibility of simplification, and how much to imperfect understanding—certain errors show that the latter factor was not altogether wanting. On the other hand, original observations and computations show that he was not just translating or plagiarizing from an already existing work, but attempting a bold and popular account of an instrument which he considered important. He speaks of his own instrument and comments on its being smaller than would be desirable.

On the whole we get the impression that, although Chaucer did not attain the standard of coeval professional astronomers, he was nevertheless thoroughly well-schooled and competent. Aided perhaps by personal contact, he must have been abreast of the tremendous intellectual activity of the astronomers at Merton College, Oxford, who had made England pre-eminent in that field of learning during part of the thirteenth and fourteenth centuries. The existence of this second major piece of scientific writing also causes us to wonder whether Chaucer may have spent more of his later years in treating other technical subjects in the vernacular.

The new manuscript volume commences with some long sets of tables and then proceeds to describe the construction and use of an instrument which employs these tables for determining the position of the planets in the zodiac at any given time. It does this by simulating the geometrical construction required by the Ptolemaic theory, with its system of eccentric deferent circles and epicycles. The several constants of each planetary orbit are marked, once and for all, on the 6-ft. diameter board and ring of the *equatorie*; then two angles, each of the form $\theta = \theta' + \omega t$, are laid off on the instrument, and the position of the planet may then be read on the graduated limb.

The ingenious character of this particular form of equatorium, as opposed to all other reported varieties, lies in making the centre of the instrument represent the point (Aryn) at the centre of the earth, while permitting one standard-sized circle to serve as the deferent of all the planets. The very existence of such an instrument serves as confirmation, if such be needed, that the professional astronomer regarded the Ptolemaic system as a mathematical model, and not as the arrangement of material crystalline spheres described in more popular tracts. The construction of a facsimile of Chaucer's instrument has shown that results may be read to an accuracy of about five minutes of arc, and to this order of fineness the Ptolemaic theory serves well. In spite of widespread belief to the contrary, the Ptolemaic and Copernican planetary theories are almost identical in their mathematical consequences, and must give similar results for latitudes and longitudes and changes in apparent brightness of the planets. Copernicus modified and improved the theories of the moon and Mercury and threw new light on the system as a ole by considering motion relative to the sun, but s does not bring any new principles or accuracy his basic mathematical theory.

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* *Times Lit. Supp.*, Feb. 29 and March 7, 1952

The astronomical tables used by Chaucer are based that version of the "Alfonsine Tables" which was entually published in Venice and Paris (first ition, Venice, 1483). At least three different forms these tables are known, the present one being tinguished by the use of *signa physica* of 60° tead of the more usual *signa communia* of 30°. It also noted for the tabulation of variables to ten agesimal places instead of the maximum of four five places that are demanded by the accuracy of observations on which they are based, and to ich other versions of these tables are restricted. ch excessive zeal in computation could not have en of much use in the Middle Ages (it corresponds an order of accuracy of about 1/1,000 sec. in 00,000 years), but it is invaluable now as providing mistakable evidence for reconstructing the prosses, approximations and assumptions used in the ginal calculations. One result of this analysis is show that their 'bad' value of precession, one volution in 49,000 years, does not refer to precession the modern sense, but to the calender error introced by the assumption that the (solar, tropical) year is actly 365¼ days. This is, of course, the error that now corrected by dropping three intercalary days four hundred years, that is, 365¼ days or one volution in 48,700 years. It accounts for just er half the true precession, the remainder being owed for by making the sphere of fixed stars cillate ± 9° with a period of 7,000 years, this being e 'trepidation' introduced by Thebit.

The form of these planetary tables is responsible r the invention and use of such equatoria as that scribed by Chaucer. The Ptolemaic theory is well apted to the calculation and explanation of specific ses and limiting examples (such as the location and agnitude of retrogradation), but it is not at all nvenient, even with the best tables then available, r the routine calculation of planetary positions—ch as were required for horoscopes and for practical tronomy. One can, it is true, make very good proximations as Ptolemy himself did; but medieval holars much preferred an exact solution. It would ve been possible to draw up a complete calender computed positions for, say, the next hundred ars, but before the era of the printed book this was expensive and wasteful procedure. Alternatively e could make use of the fact that after some propriate period the anomalies of any one planet turned quite closely to a previous position, and this owed the computation to be restricted to one such cle only. Such sets of cycles forming "perpetual hemerides" were calculated by Azarchiel in the venth century and continued in use until the mulative errors of several cycles made them viously invalid.

The only remaining possibility was to retain the ll theory for exact calculation, but to substitute ecise geometrical construction for intractable gonometry. The earliest examples of such means distinct from ancient demonstration devices milar to the orrery) seem to be due to Azarchiel d Ibn al-Samh in the eleventh century. Going nd in hand with the re-making of tables, these orks were translated by the Alfonsine *atelier* and lapted for use with the tables made during 1263–72. hereafter it seems to happen frequently that a new t of tables, or a revision, is accompanied by a *Canon* describing some type of equatorium. We have accounts of instruments designed by John of Linières and by Profatius, and one is ascribed to John Campanus of Novarra (who was probably only the translator); there is also the "Albion" of Richard of Wallingford, which was improved by Simon Tunsted and elaborated by John of Gmunden. Contemporary with that of Chaucer is a similar but more complete instrument described by the Iranian al-Kāshī, and finally, in 1540, the series of instruments culminated in the publication of the sumptuous "Astronomicon Caesarum" of Peter Apian, who made the ultimate improvements of dispensing with the auxiliary tables and separating the various functions of the instrument so that it could be reduced to a set of paper volvelles bound into a book.

The "Equatorie of the Planetis" provides us with the only account in English of this device, and focuses attention on an important medieval astronomical instrument the very existence of which had been almost forgotten.

SPORE CONTENT OF THE ATMOSPHERE NEAR THE GROUND

By P. H. GREGORY

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A KNOWLEDGE of the composition of the spore flora of the air is important to agriculture because it includes crop pathogens, and to medicine because of the occurrence of respiratory allergens. Yet its composition and concentration remain undetermined because there has been no suitable quantitative method of measurement. The population of air-borne particles of plant or animal origin, which will here be called the air 'spora' (taking the Greek σπορά as a word of similar usage to 'flora' and 'fauna'), contains spores and pollens of various shapes ranging in size from 100 μ in diameter for some tree pollens down to 3–5 μ with some of the smallest fungus spores.

Methods in use for routine survey[1] generally depend either on exposing sticky surfaces (such as horizontal or vertical glass slides) and counting the spores deposited, or on exposing Petri dishes containing culture medium and counting the colonies developing after incubation. Data from these surface traps have been interpreted on the tacit assumption that the relation between the number of particles suspended in the air flowing over the surface and the number deposited on the surface is known. In wind-tunnel experiments[2] it was found that spore concentration is only one factor in determining deposition, and that particle size, wind speed and the dimensions and orientation of the trap surface can have an overriding effect on deposition. In still air a horizontal surface may sample the air according to simple rules. When the air is moving, however, the windward surfaces of the trap, such as the edges and supports, or even the trapping surface, deflect the air-stream, and also deflect the spores themselves to an extent varying with their momentum and hence with their ability to slip out of the deflected air-stream and continue their trajectories. The efficiency with which a sticky surface removes spores from the oncoming column of air varies with the speed of the wind, and the deposit may alter very greatly with no change in concentration of the air spora. Records from surface traps are therefore difficult to interpret in terms of spore concentration per unit volume, as the wind speed at the time of deposition is usually unknown. The fact that they actually measure spore deposition on the particular surface in use and not spore concentration in the air is often ignored.

For efficient sampling of the air spora an apparatus is required which draws in a known volume of air without altering its spore content, removes all particles over the 2–100 μ size range, and leaves them in a form in which they can be examined, counted and classified.

The slit-sampler[3] of Bourdillon, Lidwell and Thomas is well adapted for volumetric sampling still air for those moulds and bacteria which grow on artificial media. Like earlier equipment, however, it is less suitable for sampling fungi and pollens from moving air out of doors. I have used the cascade impactor designed by May[4] for sampling aerosols in the field and have found it well suited for volumetric sampling of the outdoor air spora for visual inspection under the microscope. When used in the field a fin directs the orifice of the cascade impactor into the wind. A source of suction is required to draw air through the orifice, behind which is a sticky slide where the larger particles are impacted. The air is then accelerated by being drawn through three successively smaller jets each impacting on a separate slide. The catch is thus fractionated into four size-groups and deposited in narrow bands on four slides which can be mounted for microscopical examination, or removed for culture if desired. If the orifice is to collect all spores in the sampled air the speed of intake through the first jet should be adjusted to the speed of the wind; but deviations from 'isokinetic' sampling are small except for large spores. The impactor retains approximately 80-100 per cent of all spores collected by the orifice, down to about 1 μ diam.

For continuous records the cascade impactor suffers from the disadvantage that the deposit becomes too dense unless the slides are changed frequently, and for continuous operation in the open air the Hirst automatic volumetric spore trap[5] is more convenient. In this trap, which is based on the second jet only of the cascade impactor, a clockwork mechanism moves the slide past the orifice at 2 mm. per hour, so that the spores entering the trap are deposited on a 24-hour trace 48 mm. long, and diurnal changes in the air spora can be determined with an error of about ± 1 hour.

In the experiments at Rothamsted, the cascade impactor (Casella's model) has been used in several series of six consecutive four-hour runs at a height of 2 m. in the open air in dry weather. The concentration of spores and pollen of different types as directly measured reveals an air spora differing markedly from that indicated by surface traps.

Beginning at 09.00 hr. G.M.T. during each of the 24-hour periods chosen, sets of four slides were exposed in the cascade impactor for six four-hour periods, with a sampling rate of 10 litres per minute as measured by a 'rotameter', giving a total volume of 14·4 cubic metres in twenty-four hours. After mounting, the slides were scanned unstained under the oil immersion objective and the spores classified nto convenient morphological groups. Identification uld sometimes have been carried further, but with re characters alone specific identification is seldom possible. The concentrations during a typical 24- series are shown in the accompanying table.

COMPOSITION OF THE DRY AIR SPORA AT ROTHAMSTED, JUNE 10–
1952
(Number of spores per cubic metre of air)

Spore group	Period (G.M.T.) 9–13 hr	13–17 hr.	17–21 hr.	21–1 hr	1–5 hr.	5–9 hr.
Unidentified minute hyaline spores	2,340	2,510	2,550	3,120	4,700	2,25
Cladosporium	3,280	5,030	1,770	2,850	1,220	1,98
Hyaline basidiospores	1,170	610	530	1,110	7,010	4,38
Grass pollens	1,030	2,120	1,210	615	230	48
Unclassified	240	430	260	780	330	43
Ustilago 'avenae'	350	680	420	520	230	4
Erysiphe conidia	580	230	100	60	40	1
Other pollens	170	210	90	90	30	7
Coloured basidiospores	0	40	15	220	180	10
Uredospores	15	40	30	7	0	1
Total	9,175	11,900	6,975	9,372	13 970	9,83

The first slide, with the largest size-fraction, co tained most of the pollens. The catch in the tab represents the concentration of grass pollen at t height of the season in a position 2 m. above t ground with no great quantity of grass within hundred yards. Uredospores of *Puccinia* spp. we not abundant in spite of the presence of whe heavily infected with *Puccinia glumarum* within s hundred yards upwind of the trap. Conidia of t powdery mildew, *Erysiphe graminis*, may have com from a field of heavily infected spring-sown bar about fifty yards from the trapping site. Mu greater concentrations of powdery mildew occurr later in the season.

The second slide, with the next smaller fractio contained a few of the types found on the first sli The records of *Cladosporium* illustrate the conce trations observed a few weeks before its season maximum. The spores of *Cladosporium* vary wide in size and degree of aggregation. Large clumps ma be found on the first slide, while the smallest individu spores often penetrate to the third slide. Spores *Ustilago avenae* type (including, no doubt, the morph logically similar *U. perennans* from wild grasses) al occur singly and in clumps of varying size, and for a substantial part of the dry air spora at this seaso Coloured basidiospores, mainly from the Agaricace and from the bracket fungus *Ganoderma*, also occurr but were only few in comparison with those found Rothamsted[6] in August and September 1951; b again they occurred predominantly at night. Sma numbers of spores of *Helminthosporium*, *Alternar* *Epicoccum*, *Botrytis*, *Polythrincium trifolii*, and various other smuts, formed a regular component the "Unclassified" group in the second fraction, b are not shown separately in the table.

The third slide contained minute hyaline spor some of which also occur on the second slide. T most interesting of these are minute hyaline basid spores, which were rare during the day, but reach the high concentration of 7,000 per cubic metre duri the early hours of the morning (exceptionally a co centration of ten times this value has been recor during the period 01.00–05.00 hr.). Other evide suggests that a large proportion of these are basid spores of the mirror yeasts, *Sporobolomyces* sp Apparently these basidiomycetous yeasts, inhabitin the surface of leaves, discharge their basidiospor into the air in immense numbers when moist wit dew, and at this time they constitute a major elemen of the dry air spora. Soon after dawn, as the da me spora becomes re-established, they disappear ysteriously. Petri dishes (9 cm. diam.) of medium xposed horizontally for ten minutes at the beginning each period during a similar series of tests on ly 24–25 gave 1, 7, 5, 4, 5 and 28 colonies respect- ely of *Sporobolomyces*. Their occurrence as a gnificant element of the air spora does not appear have been recorded hitherto; but Mr. Merfyn ichards (*in lit.*) informs me that this observation nfirms earlier experiments in which he trapped rge numbers of *Sporobolomyces* on plates exposed uring the night at Llandough Hospital in August 951.

Another group of minute hyaline spores in the cond and third fractions consisted of rod-shaped, inted or septate spores. The smallest of these could ssibly be confused with bacilli; but bacteria would ot be expected to occur singly, free in the air, in rge numbers, though some Actinomycetes might do . Some of this fraction may consist of ascospores, ut its composition is at present obscure and merits rther investigation because of its potential interest plant pathology. Some structurally characterless inute hyaline spherical spores have probably been verlooked and omitted from the count.

The fourth fraction is free from plant spores, but ontains a copious deposit of smoke particles. The bsence of spores among the smallest particle fraction n the fourth slide shows that all particles in the size- ange of plant spores are deposited on the first three tages, and that the cascade impactor can be relied pon to give a reasonably undistorted picture of the ntire air spora. The emptiness of the fourth slide ives confidence in the end point.

The cascade impactor thus allows a preliminary isual examination of the whole air spora, and shows hat the smaller spores make up a very large pro- ortion of the total number present. This was not hown by the surface traps in general use, which lthough giving some information of the relative bundance of large spore types at different times, are eavily weighted in favour of larger spores. For a omparison of the relative concentration of different pore types at any time the data given by surface raps can perhaps not unfairly be described as a garithmic lie.

The species making up the smaller size fraction of he dry air spora are largely unknown, but transient louds of small hyaline basidiospores occur during the ight in high concentration. Well-marked fluctuations ith time of day and changes in weather, differing ith different species, are also observed, and have een studied in greater detail in both dry and damp r by Hirst[5,6], using the more convenient automatic lumetric spore trap. Simultaneous comparisons in e field between the cascade impactor and the Hirst ap have shown that the models of the latter at esent in use retain spores of all sizes with a higher ficiency than previously expected.

The greater part of the solid material larger than μ suspended in the atmosphere in dry weather under ur conditions consists, not of inorganic dust, but of nt spores of one sort or another. It is clear that reasing knowledge of the air spora depends on the der use of power-operated sampling equipment such the cascade impactor for spot sampling, or the irst automatic volumetric trap for continuous cords. The results obtained at Rothamsted show r the first time that a quantitatively complete icture of the air spora can be obtained. The pos- bility is opened up of applying these methods at other times and in other places and of attempting to correlate the findings with the occurrence of crop diseases and of respiratory allergy.

[1] Committee on Apparatus in Aerobiology, *Phytopathology*, 31, 201 (1941).

[2] Gregory, P. H., *Nature*, 166, 487 (1950); *Ann. App. Biol.*, 38, 375 (1951), and unpublished.

[3] Bourdillon, R. B., Lidwell, O. M., and Thomas, J. C., *J. Hyg., Camb.*, 41, 197 (1941).

[4] May, K. R., *J. Sci. Instr.*, 22, 187 (1945).

[5] Hirst, J. M., *Ann. App. Biol.*, 39, 257 (1952), and unpublished.

[6] Gregory, P. H., and Hirst, J. M., *Nature*, 170, 414 (1952).

THE NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS

By Prof. GRANVILLE POOLE

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An event of great historical interest to the mining industry in Great Britain occurs this year, for the members of the North of England Institute of Mining and Mechanical Engineers are celebrating the hundredth anniversary of its formation in 1852.

Most fortunately, the first president—Nicholas Wood—was a man of outstanding ability and fore-sight. He was born in 1795 and in early life was thrown into the society of George Stephenson, to whom he became an assistant in that series of persevering experiments which at last resulted in the steam locomotive. Mr. Wood made the drawings from which, under its inventor's instructions, the Stephenson safety lamp was constructed. Mr. Wood also accompanied Stephenson to Darlington to engineer the Stockton and Darlington Railway. He wrote a book on the "Establishment and Economy of Railways" in 1825.

On July 3, 1852, a meeting of coal owners and 'viewers' in Newcastle resulted in the formation of a Society called "The North of England Society for the Prevention of Accidents"; but at a second meeting the title was changed to "The North of England Institute of Mining Engineers". As mining involved much engineering, it was considered desirable to include engineers among its members, and the title was later again changed to its present form.

Mr. Wood's contributions to the *Transactions* of the Institute included articles on the relative value of steam jets and furnaces to increase the ventilation of mines; on safety lamps; on the conveyance of coal underground; on sinking shafts through the water-bearing magnesian limestone and on the geology of the Northern Coalfield in Great Britain. He also paved the way for the establishment of a collegiate institution "for the cultivation, improvement and the teaching of mining science".

Nicholas Wood's inaugural address displayed that high sense of professional obligation and resolve which activated the original members and which resulted in the growth of the stature of the Institute being recognized in 1876 by the grant of a royal charter by Queen Victoria. The following tribute is to be found in this charter: "that it has during its existence of a period of nearly a quarter of a century steadily devoted itself to the preservation of human life and the safer development of mineral property, that it has contributed substantially and beneficially to the prosperity of the country and the welfare and happiness of the community".

By this time the Institute membership had grown to more than eight hundred, and in terms of the charter "included a large proportion of the leading Mining Engineers in the United Kingdom". Indeed, a review of the list of members reveals that membership was beginning to be world-wide, and the Institute was becoming a clearing-house of technical information on coal mining in many countries.

The example set by the North of England was followed by the formation of mining institutes in other coalfields, and the North of England Institute played a leading part in the establishment in London in 1889 of the Institution of Mining Engineers—now a federation of eight mining institutes from all parts of Britain.

Many historic papers have been read at the meetings of the North of England Institute. In the early years, when many disastrous explosions occurred, particular attention was paid to the ventilation of mines. John Buddle, the 'father of English mining', realizing the possible danger of using a furnace to assist in the natural ventilation, invented an air pump—the forerunner of the modern fan. A series of papers by J. J. Atkinson on the principles of mine ventilation laid the foundation of modern ventilation technology. Though Humphry Davy had improved the then safety lamp, his 'Davy lamp' was proved to be unsafe in certain circumstances and improvements were gradually brought about.

Many valuable papers on methods of working and the control of the strata are to be found in the *Transactions* of the Institute. With regard to methods of working coal seams, as the very shallow seams became exhausted it became necessary to sink deeper shafts and to work a greater area from each shaft, and the first method of really underground working was evolved, namely, the room and pillar method of mining. G. C. Greenwell in 1852 wrote "A Practical Treatise on Mining Engineering" at a time when there was practically no literature on mining in the English language. The first edition was based on a series of lectures delivered at the Newcastle College of Practical Science—the forerunner of the King's College of to-day. In passing, reference may be made to a statement made by a prominent mining engineer in the United States of America to the effect that their modern method of working is based more or less on Greenwell's ideas.

The Institute had from time to time set up committees to study specific mining problems, and in 1924 "The Support of Workings in Mines Committee" was appointed to investigate the causes of falls and accidents due to falls. In 1930 the Committee was provided with funds by the Safety in Mines Research Board for the appointment of a full-time investigator. The reports of this Committee provide a comprehensive statement of the fundamental factors determining the behaviour of the strata in mining operations.

In 1948 the Northern Divisional Strata Control Research Committee of the National Coal Board was set up. The Committee has a membership representative of the Durham and Northern Divisions of the Coal Board and of the North of England Institute of Mining and Mechanical Engineers, including members of the staff of the Mining Department of King's College, University of Durham. In this way the Institute has been enabled to continue its contributions to its historic work in this field. This is an ideal combination of observation and experiment in mines, together with academic work in the University such as photo-elastic research on plastic mod of mine workings.

The early pioneers would have been astounded they could have listened to the most recent pap read at a meeting of the Institute, when successf experiments were described in the getting of co from very thin seams without any men on the worki face at all. Such is the progress made in t mechanization of mining operations.

With such grand traditions, it will not be su prising that the North of England Institute Mining and Mechanical Engineers is still very active engaged in research to secure the increased safe and health and well-being of those employed in t mining industry. In addition to the research me tioned on roof control and prevention of falls ground, there are committees on the lighting a ventilation of mines.

The research on lighting is being carried out wi the view, ultimately, of being able to predict t performance of any lighting fitting under any set mining conditions. The series of tests being done the moment are designed to investigate the effect shape of a mine roadway and the reflexion factor its walls and roof on the utilization factors. Th work is being done in the Mining Laboratories King's College, Newcastle upon Tyne, and tests a also being carried out underground so as to obtain continual correlation of results. A special photomet has been designed and constructed with which t spherical distribution of any source can be foun Investigations also cover the safety of fluoresce lamp units for use in gassy mines, and a se signalling system on longwall faces.

The immediate object of the research on ventilati is the formulation of rules and formulæ as the ba for the design of fan drifts.

The first meetings of the Institute were in t lecture room of the Literary and Philosophical Socie at Newcastle upon Tyne; but through the enthu iastic efforts of its members and with the co-operati of the coal owners, the present well-known home the Institute, Neville Hall, Newcastle upon Tyn was built and opened in 1872.

The beautiful Wood Memorial Hall Library a ideally arranged lecture theatre, together with t other offices provided, bear witness to the profession spirit aroused by the inauguration of the Institut and have done much to inspire succeeding generatio of mining and mechanical engineers in devotion the task of following the objectives so clearly set o by Nicholas Wood.

In order adequately to maintain this building a to ensure continuity in research, a Centenary Appe Fund has been opened, and it is hoped that t appeal will meet with generous response.

INTERNATIONAL SEAWEED SYMPOSIUM

AN international seaweed symposium, organi by the Institute of Seaweed Research, University of Edinburgh and the Scottish Mar Biological Association, with the assistance of co responding delegates from Australia, Canada, Chil France, Germany, New Zealand, Norway, Sou Africa, Spain, Sweden and the United States America, was held in Edinburgh during July 13–1 The symposium, which was the first of its kin attracted world-wide interest, and was attended by some 160 scientists and technologists from more than twenty countries and Colonial dependencies. Lord Bilsland, chairman of the Board of Management of the Institute of Seaweed Research, presided at the opening ceremony in the Zoology Department of the University of Edinburgh and offered a warm welcome to all the members. In his address in formally opening the symposium, Mr. James Stuart, Secretary of State for Scotland, considered that many of our present industrial and agricultural problems might be alleviated to a very appreciable extent by making better use of the hundreds of thousands of tons of seaweed growing naturally around our shores, whether by way of animal feeding-stuffs or in the many other ways which are being investigated by men of science in their present research programmes.

At the first session, which was devoted to 'Phycology", Dr. E. M. Burrows (Great Britain) opened the proceedings with a paper on "Intertidal Plant Populations with Special References to the Genus *Fucus*", in which she referred to the effect of habitat variation, genetical variation and hybridization occurring in *Fucus spiralis*, *F. vesiculosus* and *F. serratus*. Dr. D. de Virville (University of Paris) delivered a paper on "Algal Population Decrease on the East Coast of Cotentin", in which he discussed the main types of marine plants gathered for agricultural and industrial use from the Atlantic coast of France. The Fucaceæ (*Fucus vesiculosus*, *F. serratus* and *Ascophyllum nodosum*) are collected chiefly for manure, the Laminariaceæ (*Laminaria*, *Saccorhiza* and *Alaria* species) for the extraction of iodine, *Chondrus crispus* and *Gigartina mamillosa* for the preparation of gels, and *Zostera marina* as a packing or filling material. A progressive decrease of these plant growths, due often to excessive gathering, has been recorded in recent years, and Dr. de Virville suggested that more severe control of harvesting should be introduced in an effort to halt this serious depopulation.

Several papers were devoted to a detailed study of the seaweeds occurring in different parts of the world. Dr. E. Jaasund (Sweden) discussed the marine algæ of the north Norwegian coast-line, Dr. L. Bellon (Spain) dealt with the seaweeds of the Malagan coast, Mr. C. Primo (Spain) described the algal population of Spanish West Africa, and Dr. J. R. Nunn read a paper on the seaweed vegetation of South Africa. Contributions dealing with the purely botanical aspect of the marine algæ were given by Dr. P. Kornmann (Germany), who discussed the development of *Giffordia fuscata* (Zan), Prof. J. Feldmann (France) on the evolution of the female organs of the Florideæ, Dr. H. B. S. Womersley (Australia) on the *Macrocystis* species of southern Australia, Dr. T. Levring on the reduced forms occurring in the Swedish marine flora, and Prof. M. Chadefaud (France) on the staining techniques developed for the cytological study of the algæ. Dr. B. L. Moss (Great Britain) discussed the variation in chemical constitution occurring during the development of the Fucales, and emphasized the importance of giving accurate descriptions of any plant material submitted for chemical analysis. Mr. B. Grenager spoke on the surveying of the Norwegian seaweeds by means of the spring grab technique developed by the Scottish Seaweed Research Association.

"Algal Chemistry" was the subject for the second session, and Prof. T. Dillon (University of Galway) opened the proceedings with a lecture on "The Constitution of Some Seaweed Mucilages". He described the preparation and purification of a polysaccharide sulphuric ester from fruiting *Ascophyllum nodosum*, which contained one galactose to seven fucose residues and having one sulphate group attached to each monosaccharide anhydride unit. The galactan sulphuric esters from *Gelidium latifolium*, carragheen moss, *Furcellaria fastigiata*, *Dilsea edulis* and *Dumontia incrassata* were also discussed. Dr. F. J. Coll (Eire) dealt with the constitution of floridean starch extracted from *Furcellaria fastigiata* and *Dilsea edulis*, and presented evidence to show, from methylation and β-amylolysis studies, that at least 50 per cent of the molecule consists of α-D-glucopyranose units linked through carbon atoms 1 and 4 as in ordinary starch. The quantitative liberation of carbon dioxide from uronic and polyuronic acids, such as alginic acid, when heated at 255° C. in the absence of any catalyst, was discussed by Dr. A. S. Perlin (Canada). The evidence suggests that the reaction is a true decarboxylation, and it has been employed for the analysis of several polyuronides, such as oxidized cellulose and starch. Dr. R. W. Watson (Canada) read a paper on "The Molecular Weight of Algin as determined by Sedimentation and Diffusion", in which the weight average molecular weight of four samples of sodium alginate ranged from 32,000 to 165,000, and appeared to be linearly related to the intrinsic viscosity. The variations in chemical composition among individual *Laminaria digitata* plants, collected at the same time and from the same habitat, were described by Mr. A. Haug (Norway), who found large individual variations in the dry matter and ash content with smaller variations in the alginate content. He emphasized the importance of these results in recording analytical data for the brown algæ. The alginate, ash, mannitol, laminarin, combined fucose and iodine content of various South African Phæophyceæ was dealt with in a paper read by Dr. J. R. Nunn, while Mr. C. W. Bonniksen (Great Britain) described the various uses of alginates and alginate materials in medicine and surgery. The nitrogenous constituents of the marine algæ were reviewed by Dr. E. Gordon Young (Canada) and Dr. G. T. Young (Great Britain). Algal peptides and proteins are difficult to extract, relatively strong alkali being required to extract 50 per cent of the total nitrogen. Dr. G. T. Young described the nitrogen distribution in various common brown seaweeds between volatile base nitrogen (chiefly ammonia), nitrate-nitrogen and residual Kjeldahl-nitrogen, and pointed out that the α-amino-nitrogen after hydrolysis was invariably less than the residual Kjeldahl-nitrogen, due probably to decomposition of the amino-acids in presence of carbohydrates. Acid hydrolysates of *L. saccharina* and *A. nodosum* contained the following amino-acids: glycine, alanine, valine, leucine, isoleucine, aspartic acid, glutamic acid, serine, threonine, proline, phenylalanine, lysine and a trace of arginine. Mr. L. E. Ericson (Sweden) spoke on the occurrence of vitamin B_{12}, folic acid, folinic acid and various amino-acids in different brown and red seaweeds from the Baltic and North Seas; the content of vitamin B_{12} in some algæ appears to be comparable with that of liver.

At the session with "Utilization" as the subject, Mr. R. W. Moncrieff (Great Britain) reviewed the present uses of alginates in foodstuffs, textiles, toilet goods, paints and engineering; recent developments include a washable flame-proof fabric and table jellies that set in hot weather. The expansion of the seaweed industry has hitherto been limited not by any shortage of seaweed or difficulty of extracting alginates, but by the limited number of known uses for seaweed derivatives, and the development of the alginates is at present being actively studied. The utilization in the United States of agar and carragheenin, the two chief gelling agents extracted from the red algæ, was discussed by Mr. E. C. Jertson (United States), and Dr. D. C. West read a paper on "A Survey of Certain Seaweeds of Commercial Importance in South West Nova Scotia". The survey revealed the presence of approximately 200,000 tons of rockweed, 900,000 tons of *Laminaria* spp., while in 1950 almost 8,000,000 lb. of *Chondrus* were harvested. Recolonization of these species was also discussed. Industrial applications of the seaweeds in Spain were dealt with by Dr. J. Aravio-Torre, who spoke of the rapidly increasing production of agar from 1944 to the present time, production in 1951 amounting to some 62,000 lb.; the brown seaweed industry, however, has not grown to the same extent. The session on utilization was concluded by Mr. C. J. E. Hand (Great Britain), who described the results of feeding various seaweed meals to laying hens: the introduction of 10 per cent of seaweed meal into the basal ration, although causing increased water consumption, did not produce any ill-effect upon egg production, egg weight and shell weight in small-scale trials of 100 days involving groups of four birds. When 15 per cent of the basic ration, however, was replaced, water consumption was further increased, and live-weight and egg production decreased.

The final session, entitled "World Seaweed Resources", was introduced by Dr. F. N. Woodward (director of the Institute of Seaweed Research), and the following spoke on the seaweed resources of their respective countries: Dr. H. B. S. Womersley (Australia and New Zealand), Dr. D. C. West and Dr. G. M. Shrum (Canada), Mr. E. C. T. Holsinger (Ceylon), Prof. H. Etcheverry (Chile), Dr. S. Lund (Denmark), Mr. D. T. Flood (Eire), Prof. J. Feldmann (France), Prof. C. Hoffmann (Germany), Mr. F. T. Walker (Great Britain), Dr. J. R. Nunn (South Africa), Dr. L. Bellon (Spain), Dr. T. Levring (Sweden), and Mr. G. W. Anderson (Zanzibar). Papers from the following authors, who were unable to attend the symposium, were read by title: Prof. T. Rayss (Israel), Dr. S. Suto (Japan), Prof. T. Braarud (Norway), Dr. G. T. Velasquez (Philippines), and Drs. K. S. Pillai and N. S. Varier (Travancore–Cochin).

Many members contributed to the discussion on each group of papers at the end of the various sessions, and a résumé of these discussions, together with abstracts of the complete set of papers presented and read by title, will appear in the "Proceedings" of the symposium, copies of which should be available before the end of this year. Dr. M. Knight (Great Britain), Dr. T. Levring (Sweden), Prof. C. G. C. Chesters (Great Britain), Dr. E. Gordon Young (Canada), Prof. E. L. Hirst (Great Britain), Mr. E. C. Jertson (United States) and Dr. F. N. Woodward (Great Britain) presided at the various sessions.

There were three excursions connected with the symposium. On July 13, a joint meeting with the British Phycological Group was held at St. Andrews, where members and their friends visited the Gatty Marine Laboratory and were given ample opportunity of studying the marine flora of that part of the coast. On the afternoon of July 15, members visited the Institute of Seaweed Research, Inveresk, Midlothian, to inspect the laboratories and workshops. Mr. Philip Jackson, deputy director of the Institute, gave a brief description of the different methods developed for harvesting sublittoral brown seaweeds, and on the morning of July 17 demonstrations of this equipment were held at Dunbar and Fisherrow.

There were also three social events held during the evenings. On July 14, delegates were provided with an opportunity of meeting in very pleasant circumstances at a cocktail party given by the Secretary of State for Scotland, while on July 16 the Magistrates and Council of the City of Edinburgh showed their interest in the purpose of the symposium by holding a reception in honour of its members in the City Chambers; in the absence of the Lord Provost members were welcomed by Senior-Bailie James Campbell, and Mr. E. C. Jertson replied for the visitors. On July 15, a dinner was held in the hall of the Royal College of Surgeons, where the principal speakers were Dr. F. N. Woodward and Sir Alexander Gray, professor of commercial and political economy and mercantile law in the University of Edinburgh.

Dr. T. Levring expressed the feelings of members when, at the closing session, he spoke of the success of the symposium, not only from a scientific but also from a social point of view. He suggested that the next symposium should be held in Norway three years hence, and this motion was very cordially supported.

E. T. DEWAR

NEWS and VIEWS

Commonwealth Scientific and Industrial Research Organization: Mr. G. A. Cook

MR. G. A. COOK is retiring from the post of secretary of the Commonwealth of Australia Scientific and Industrial Research Organization, after thirty years with the Organization and its predecessors, the Institute of Science and Industry and the Council for Scientific and Industrial Research. Mr. Cook graduated at the University of Melbourne with first-class final honours in science and in mining engineering. After service in the First World War, he worked with Sir Edgeworth David collating geological information from the French and Belgian Geological Surveys, and on his return to Australia undertook research in several phases of the mining and metals industries. When Mr. Cook joined the Institute of Science and Industry as scientific abstractor in 1922, there were only two people with a scientific training on the staff. He has seen the growth of that Institute into the present Organization, with a total staff of more than three thousand, including eleven hundred scientists. In 1927 he was appointed assistant secretary to the Council for Scientific and Industrial Research, and for many years was also officer in charge of its Information Service. He succeeded Mr. G. Lightfoot as secretary in 1944. Mr. Cook has always kept in personal touch with all phases of the Organization's work, and his long service as an administrator has given him wide experience of science and its organization. He has taken a particular interest in making the results of scientific research available to industry both as an editor of scientific publications and as a writer of non-technical accounts for the general reader.

The administrative work of the Commonwealth Scientific and Industrial Research Organization will now be the responsibility of four senior members of the secretariat: Mr. F. G. Nicholls, secretary (general administration); Mr. G. B. Gresford, secretary (physical and industrial sciences); Mr. W. Ives, secretary (agricultural and biological sciences); and Mr. M. G. Grace, secretary (finance and supplies).

Agricultural Census in Iraq

THE first agricultural census to be undertaken in the Middle East is now nearing completion in Iraq. This census, organized and directed by Dr. K. G. Fenelon, who is Government statistician, will provide information much needed for the planning of developments made possible by the rapidly increasing revenues from oil royalties. The statistics now being collected relate to such matters as land utilization, and tenures, farm labour, size of farms, crops and the livestock carried on farms or owned by nomadic tribes. Special emphasis has been placed on the need for early publication, and already data for certain districts are available. The census is a nation-wide survey and has necessitated a farm-to-farm visitation by specially trained enumerators drawn largely from the ranks of teachers and college students on vacation. As the majority of the farmers are illiterate, the verbal information given by them has had to be entered on the forms by the enumerators themselves and, where necessary, translated into Arabic from Kurdish or Turkish. In taking the census, which began in June and is expected to be completed in November, many difficulties have had to be overcome, especially in those districts where land settlement is not yet completed or where the flocks of nomadic tribes have to be enumerated. Many of the farms and villages are far removed from any main road, and though motor transport has been used where possible, other means of transit, such as mules in the mountains, camels in the desert or small boats in the marsh-lands, have been employed to reach these more remote villages.

Nuffield Botanic Garden, London

WHEN the Nuffield Foundation moves into its new headquarters at Grove House, Regent's Park, London, a large part of the four acres of gardens in which the house stands will be made available by the Foundation to University College, University of London, for botanical research. The garden will be known as the "Nuffield Botanic Garden". In the first instance, research is envisaged which will deal with some of the genetical aspects of the taxonomy of native British species and also with the problems associated with intersexes in plants, under the direction of Dr. J. Heslop Harrison. It is expected that later developments may include both ecological and experimental studies of native species, particularly those of taxonomic and ecological interest. Botanists will note with appreciation this important extension of the interests of the Nuffield Foundation to the field of experimental taxonomy.

Television in Wales and Scotland

ON August 15, the Postmaster-General, Lord De La Warr, opened the new television transmitting station for South Wales at Wenvoe, near Cardiff, thereby completing the first stage of the installation of the British television network. At the present time, this station is operating with a 5-kW. transmitter, but it will be raised to at least ten times this rating as soon as possible. Two days later, the Scottish station at Kirk o' Shotts was brought into full high-power operation by the completion of the new vision transmitter supplied by Electric and Musical Industries, Ltd., which is capable of delivering 75 kW. into the aerial. The corresponding high-power sound transmitter, supplied by Standard Telephones and Cables, Ltd., has a carrier output of 18 kW. at 100 per cent modulation. These installations replace the low-power standby transmitters which have been in use since the Scottish television service was opened last March (see *Nature*, March 22, p. 482). When the corresponding high-power transmitters are completed at Wenvoe, Scotland and Wales (including the west of England) will have the most powerful television stations in Britain and, it is thought, in the world. The completion of these stations will bring the British television service within the reach of some 40 million people, or about four-fifths of the population of the United Kingdom.

Social Insurance and the Problems of Poverty

THE Beveridge report on social insurance and allied services in Great Britain defined freedom from want as the basic purpose of the social security scheme. A recent broadsheet issued by Political and Economic Planning (No. 344. "Poverty: Ten Years After Beveridge") examines the extent to which efficient and permanent defences against poverty have been built up in Britain in fulfilment of this purpose during the past ten years. Attention is focused principally on the information and methods available for giving a definite meaning to poverty and thus fixing a poverty standard which can be used both by investigators in charge of social surveys and by administrators in determining the level of social payments. In particular, an attempt is made to give a clearer meaning to the term 'subsistence minimum' and to indicate the steps involved in arriving at such a minimum. At present, insufficient information is available to enable a satisfactory subsistence standard to be worked out, although the proposed inquiry of the Ministry of Labour into family budgets, intended to supply facts for a revision of the index of retail prices, could supply much of the missing information. The use of family budget data is the only practical way, the broadsheet points out, of limiting the arbitrariness of judgments for items other than food, and there is a strong argument for adding a few specific items, such as postage, shaving and hairdressing, laundry, contraceptives, sanitary towels, certain subscriptions, soap and other cleaning materials, to the list of necessities usually adopted in a standard, on the ground both that they occupy a consistent place in family budgets and that 'by conventional standards' they are necessities. In the last resort, decisions must be based on contemporary views about the lowest living conditions that are tolerable in the community. Whatever policy of preventing poverty is adopted, a carefully determined subsistence standard is essential for its success.

Sociological Bulletin

THE first issue of the new journal of the Indian Sociological Society, entitled the *Sociological Bulletin* (1, No. 1; 1952. Pp. 88; from the Indian Sociological Society, Jamnalal Bajaj Nagar, Kurla Road, Andheri; Rs. 3, or 4s.), is given a characteristic flavour of its own by the essay it includes by Prof. D. P. Mukerji on "Sociology in Independent India". The subject has, he thinks, been ignored hitherto by the Government of India, and insufficient use has been made of sociologists in the drafting of legislation. Nevertheless, sociology can now be offered in the competitive examinations of the Union Public Service Commission, which will give it a new status. Still more important than this, however, the shaping of a new society in India depends in large measure on the intelligent analysis of social trends and, in particular, on what Prof. Mukerji terms "culture-assimilation", and this is one of the more important tasks for the Indian sociologist to accomplish. Prof. Mukerji and his colleagues see themselves as members of a society attempting to avoid domination by both American and Russian culture and civilization. American sociology is sometimes presented to the Indian scholar as "a scientific discipline to save the world from Marxism"; but Dr. M. N. Srinivas roundly declares in his article on "Social Anthropology and Sociology" that, for all their claim to be 'scientists', American sociologists implicitly, but none the less deeply, believe in the values of contemporary America. The Indian sociologist, therefore, appears to be embarking on an attempt to develop his own study in his own way, rejecting both the American and the Russian patterns. His colleagues throughout the Western world will watch his work with interest and sympathy.

Japanese Researches in Biophysics

The Research Institute of Applied Electricity, Hokkaido University, Sapporo, Japan, has followed up its first monograph, entitled "Theory and Application of High Frequency Phenomena" (see *Nature*, **167**, 102; 1951), by a second interesting monograph on "Some Researches on Biophysics" (Monograph Series No. 2; pp. 69; August 1, 1951). This latter publication, which is edited by Y. Asami, contains six articles: the first two are concerned with the effects of radiation on proteins, the next two with the methods of excitation of and electrical conduction along nerves, and the remaining two with physio-chemical problems. M. Wakabayashi and F. Kawamura describe what is probably the first reliable investigation of the effects of large doses (10^5–10^6 r.) of X-rays on the serum proteins. The chemical changes produced were examined, and the results obtained were compared with the changes produced by ultra-violet radiation or by heating. The rapid vapour-pressure method of determination of the water content of easily purified proteins, devised by K. Hirota and F. Kawamura, is the subject of the other article on proteins, and the results of the application of the method to gelatin and fresh muscles support Wakabayashi and Kawamura's work. The other articles deal with the following topics: the spike and dome potential observed in the oil/saline-water nerve model; study of the discharge pattern of Hering's sinus nerve and the excitation mode in the chemoreceptors of the carotid body; polarographic measurements of oxygen concentration *in vivo*; and dielectric absorption and anomalous dispersion of polar solutions.

Forest Taxation in New Zealand

In Information Series No. 11 of the New Zealand Forest Service (Wellington, 1950), Mr. M. B. Grainger discusses the question of forest taxation, a recurring problem which appears still to be far from settled, since opinions differ widely on what should be a fair burden to lay upon forests, the produce from which is essential to all types of the human race in one form or another, quite apart from industrial utilization. Private forests, especially commercially owned private forests, as apart from the Government forests, play an important part in the forest economy of New Zealand. As Mr. Grainger says, "The National Forest policy has always envisaged private forests playing a significant part in New Zealand's timber and wood economy and therefore the Forest Service has sought to encourage good standards of forest management". The methods of taxing forest land and forest operations have proved increasingly difficult during the past thirty years and have come in for a good deal of criticism, certain anomalies, not unknown in other countries, having become apparent. It must be obvious to all that a property like a forest cannot be looked at from the same point of view as a house or industrial buildings, or even a farm with its short-term growing crops, and so forth. The forests, even short-rotation crops of 15–20 years or so for firewood, paper pulp, etc., are not so easily assessed for taxation purposes. There is no doubt that excessive taxation based on inability to grasp the different growing conditions and the longevity of these conditions have been in the past, and are at the present day, a serious threat to the perpetuation of the forest in parts of the world where this maintenance is of the first importance to the population of the country concerned. Before he formed the opinion that contemporary tax practice in New Zealand is prejudicial to good forestry, Mr. Grainger visited a number of selected European countries. In this brochure taxation methods in Great Britain, Sweden, Finland, France and Norway are briefly dealt with, the various systems compared and then contrasted with those of New Zealand, and proposals made with reference to the latter country.

Planets and Sunspots

The third part of K. G. Meldahl's paper on "Tidal Forces in the Sun's Corona due to Planets", which has recently been published (pp. 14 of text, and pp. 16 of illustrations. Copenhagen: Berlingske Forlag, 1952), carries on the work of the other two parts, published in 1938 and 1949 respectively (see *Nature*, **144**, 726 (1939) and **165**, 301 (1950); and also **166**, 1058 (1950)). In Part 2 it was shown that a period of 308·52 years has a powerful influence on the vertical tides, confirmatory evidence of which was found in the observations of auroras and sunspots. It was also pointed out that the partial force periods of the sun include one of 22·38 years, which approximates to Hale's estimated period for the changing polarity of the spots, and in Part 1 it was suggested that the disturbance which caused the spots moved along the meridian plane or nearly so. It remains to be seen whether Hale's observations will confirm Meldahl's views. While Part 3 repeats some of the results previously obtained, it also contains many new features and includes a separate portion with sixteen illustrations. These show that there is a preponderance of meridional forces pointing towards the equator, with maxima at about 45° latitude, and it is suggested that there may be corresponding currents in the coronal gases, such currents being subject to similar centrifugal forces in addition to the ordinary forces due to the sun's rotation. A number of photographs of solar eclipses are reproduced for 1860–1901, and these show the diamond shapes in the corona with four cusps at 45° latitude, thus corroborating the meridional forces already referred to. Certain hydrodynamic phenomena—in particular the case of a fluid surrounding a rotating sphere—are outlined in two illustrations, and it is found that a number of configurations resembling those found on the sun are in evidence in the experiments. Disappointed with the lack of satisfactory explanations of currents n the corona, Meldahl has formulated a hypothesis—dmittedly rather speculative though partly based on bservational data—leading to his "Characteristic Curves" for the sun regarded as a centrifugal fan, and this is explained in two illustrations and also at ength in the text. Deductions with this hypothesis s a basis seem to explain a number of phenomena ssociated with eclipses of the sun at various times; t will be interesting to learn whether the hypothesis s supported by observations of the eclipse of February 25, 1952.

Research Developments by British Thomson-Houston Co., Ltd.

An interesting illustrated article appears in the May–June issue (23, No. 3) of *B.T.H. Activities*, in which Mr. L. J. Davies, the director of research, reviews the work of the British Thomson-Houston Research Laboratory during 1951. New materials for use at high temperatures and new glasses, including a new phosphate glass for sodium-vapour discharge-lamps and tellurite glasses of unusual properties, have been developed, and the work of the Physical Analysis Group has been expanded considerably. The creep properties of alloys for steam turbines and gas turbines have been the subject of special interest and study. Work on the applications of lead sulphide photocells has resulted in the development of an infra-red radiation pyrometer for the measurement of surface temperatures down to 150° C. Other instruments developed were infra-red photoelectric relays and a halogen vapour leak detector. Single-crystal germanium has received considerable attention, and a new *p*—*n* junction-type germanium rectifier capable of handling considerable power has been produced. Improvements have been made in valves for marine radar, and new glass toroids of reduced size but which allow full use to be made of the magnetic flux available have been devised for use in betatrons and proved successful. A 2-MeV. impulse generator has been erected in the heavy plant factory at the Company's works at Rugby. It incorporates specially designed aluminium electrodes which together with the generator form a standard of capacitance for use with impulse voltages up to two million. The article concludes with a description of some very interesting developments in electroluminescence and in lamps of the high-pressure gas and vapour, fluorescent, germicidal and other types.

Libraries of the University of Leeds: Report for 1950–51

The annual report of the librarian of the University of Leeds for the session 1950–51 (pp. 12; from the University; 1951) records a total of 337,787 volumes and 151,645 pamphlets in the collections at June 30, 1951. Accessions during the year totalled 14,435 volumes, 3,042 pamphlets and 25,883 parts of periodicals, a decrease of 8 per cent on the previous session. Catalogue additions totalled 47,774, an increase of 19 per cent; loans to readers, 78,358, an increase of 10 per cent; and inter-library loans totalled 1,294 books borrowed and 1,495 books lent, increases of 31 and 10 per cent, respectively. On a quinquennial visit on November 15, the University Grants Committee saw the Brotherton Library, and the Medical Sub-Committee the Medical Library. A revised list of periodical holdings in the Brotherton Library is being prepared for the British Union Catalogue of Periodicals, and when this list is complete, in about two years time, it may be published separately as a handlist of periodicals in the University Library. In view of the forthcoming revised edition of the Short Title Catalogue of English books, 1475–1640, a list has been prepared of the items in the Catalogue which are possessed by the Library and also of a few items possessed by the Library which are not in the first edition of the Catalogue. The use made of the Medical Library has further increased in spite of serious difficulties due to inadequate accommodation. The library of the Institute of Education moved in August 1950 to more commodious quarters in University House, and the Library of the Department of Textile Industries became a sectional library under the central library administration from September 1. A new departmental library was started during the session in the Department of French, and the Library of the Department of Adult Education and Extra-Mural Studies will be incorporated as a section of the University Library from the beginning of the next quinquennium.

Society for Visiting Scientists: Annual Report for 1951–52

The report of the Secretary of the Society for Visiting Scientists, to the fifth general meeting, on July 24, refers to the reduction from £4,000 to £2,000 of the grant from the British Council, necessitated by the reduction of the Government grant to the latter body. The task of raising a sum of £4,000 for the financial year, starting on April 1 this year, has been undertaken by the honorary treasurer, Prof. A. Haddow, mainly by an appeal to industry (from which £900 has already been received). The Society is now registered as a charity, and four organizations have already signed a deed of covenant with the Society. Some saving has been effected by the reduction of the Society's activities. With the co-operation of the Science and Engineering Department, the Student Department and the Welfare Department, an Overseas Science Students Association, with a membership of 120, has been founded to welcome postgraduate science students from overseas and to bring them into closer contact with the scientific life of Great Britain and with one another. This Association is affiliated to the Society for Visiting Scientists. Prof. A. V. Hill is succeeding Sir Harold Spencer Jones as president of the Society, which has a membership of 1,900, but the report emphasizes that membership of British scientific workers is not increasing as much as is desired.

Reference List of Cultures of Protozoa

The Society of Protozoologists is establishing a centre of information for available cultures of free-living and parasitic Protozoa and algal flagellates maintained in various laboratories in the United States and other countries. This system will relieve the scientific worker who has isolated, or is maintaining, the cultures of the need to give technical information every time that a culture is requested. Those who are willing to co-operate in the formation of this reference list and are willing to send cultures to other investigators should request from the Committee on Cultures of Protozoa a data card for each species that is being maintained in their laboratory. On each card pertinent information regarding the origin of the culture, procedures for maintenance, key references and other essential data will be entered. These cards will form the basis for an alphabetical file of species and a taxonomical cross-reference list. In addition, the card will indicate where the culture may be obtained. Upon request for a certain species, a photostatic copy of the master card will be sent upon payment of a nominal fee. This information will be made available to all who are interested in obtaining cultures. The chairman of the Committee on Cultures of Protozoa is Dr. L. Provasoli, Haskins Laboratories, 305 East 43rd Street, New York 17, N.Y.

U.S. National Science Foundation: Research Grants

THE National Science Foundation (2,144 California Street, N.W., Washington 25, D.C.) has announced the award of the final group of research grants, approved during the fiscal year which ended on June 30, in its programme for the support of basic research. This group consists of twenty-nine grants, totalling 263,535 dollars, for biological and physical sciences, and the fields covered are as follows: astronomy, chemistry, developmental biology, earth sciences, engineering, environmental biology, experimental psychology, genetic biology, mathematics, microbiology, molecular biology, physics, regulatory biology, and systematic biology. Altogether ninety-eight grants have been awarded during the past year, totalling 1,181,175 dollars, and these were distributed to sixty institutions in thirty-five States and Hawaii, the average grant amounting to 11,032 dollars for 1·9 years, or about 5,800 dollars a year. While grants were selected primarily on the basis of scientific merit, the Foundation is attempting in its programme for the support of research to encourage the development of research activities in smaller institutions throughout the United States. This policy is aimed not only at increasing the research potential of the nation, but also at improving the teaching of science at both the graduate and undergraduate levels. Application forms for both predoctoral and postdoctoral graduate fellowships for the academic year 1953–54 can be obtained after October 1 from the Foundation. Completed applications must be returned to the Fellowship Office, National Research Council, by January 5, 1953. The special examination for predoctoral candidates will take place at various places throughout the United States on January 31, 1953.

National Smoke Abatement Society

THE annual conference of the National Smoke Abatement Society will be held at Portsmouth during September 24–26 under the presidency of Alderman F. E. Tylecote, of Manchester, emeritus professor of medicine in the University of Manchester. The Des Voeux Memorial Lecture this year will be by W. R. Hornby Steer, standing counsel to the Society, on "Smoke and the Law". The programme includes reports on air pollution and cancer of the lung (Dr. Percy Stocks), prevention of domestic smoke (Dr. J. L. Burns), work of the Fuel Research Station (Department of Scientific and Industrial Research) on atmospheric pollution (Dr. E. T. Wilkins), a session on incentives for the prevention of industrial and domestic air pollution, and a discussion on pollution problems in the iron and steel industry, to be opened by Prof. R. J. Sarjant. Further information can be obtained from the Society, Chandos House, Buckingham Gate, Westminster, London, S.W.1.

Announcements

WE regret to announce the death, on September 1 of Sir Richard Gregory, Bart., F.R.S., editor *Nature* from 1919 until the end of 1938, aged eighty eight.

THE Medical Research Council has appointed D J. C. Gilson to be director of its Pneumoconiosi Research Unit at Llandough Hospital, near Penarth Glamorganshire. Dr. Gilson, who was formerl assistant director of the Unit, takes the place of D Charles Fletcher, who resigned on August 31 to tak up an appointment at the Postgraduate Medic School of London.

A JOINT Committee consisting of representative of the Royal Society and the University of Cambridg has appointed Dr. R. J. Eden, of the University Cambridge, to be Smithson Research Fellow, for fou years in the first instance, from October 1. Dr. Ede will work in the University of Cambridge on th theory of fundamental particles.

THE biennial Conference of the Oil and Colou Chemists' Association will be held at Eastbourn during June 3–5, 1953. There will be three technica sessions, each composed of three papers, which wi be under the general title of "The Optical Propertie of Films of Surface Coating Materials". These paper are being arranged by the Honorary Research an Development Officer of the Association, Mr. P. J Gay, Hangers Paints, Ltd., Stoneferry Works, Hull

THE tenth annual meeting of the Electron Microscope Society of America will be held at the Statle Hotel, Cleveland, Ohio, during November 6–8 Programmes and abstracts of papers are availabl from C. E. Willoughby, DuPont Experimenta Station, Wilmington 98, Delaware. Informatio about local arrangements can be obtained from Mrs Mary S. Jaffe, LDL-85, General Electric Company Nela Park, Cleveland 12, Ohio.

A NEW multiple fellowship for long-range investigations in synthetic organic chemistry, with genera emphasis on chemotherapy and in particular th preparation of compounds for combating viruses an tumours, has been established at the Mellon Institut of Industrial Research, Pittsburgh, by the firm Parke, Davis and Co., of Detroit. The leader of th research group is Dr. A. M. Moore, who is a specialis in the synthesis of potential drugs and in the classification of organic compounds, and with him are thre senior Fellows (Drs. R. S. Tipson, Alice G. Renfrew and M. S. Morgan) and one Fellow (Pauline C. Piatt) Several other scientific workers and assistants ar also joining the group.

WE have received from Messrs. J. E. Buck a Co. a convenient little map measure which will b very useful in measuring the distance of one's rout on a one-inch or smaller-scale map. The instrumen which easily goes in the vest pocket, is made plastic material covering metal wheels. It is set f a scale of one inch to a mile. This measure can obtained direct from the makers at 47 Brewer Stree Piccadilly, W.1 (5*s*., post paid).

ERRATUM. In the communication "Micro-spherica Aggregation of Barium Sulphate" in *Nature* o September 6, p. 423, by D. I. Stock, in column 2, line 3, for "of the spheres" read "of the barium sulphate within the spheres".

xternal) degree in natural science or engineering. His regular commission will be granted at the end of is second year at the College, and on graduation his eniority will be antedated to agree with that of an fficer who has passed through Sandhurst, his exact osition being determined by the class of honours btained in his degree. This scheme is open to hoolboys between the ages of 17½ and 19½, and to fficers or men between 18½ and 20½ already doing National Service. Officers who take advantage of this scheme are required to agree to serve as Regular officers for at least five years from the date of graduation.

This is additional to the normal mode of entry, via the Royal Military Academy, Sandhurst. The effect is that, by whatever channel an officer enters the army, he is given an opportunity of studying for a university degree in science or engineering; and even if on entry he is not in possession of all the requisite ualifications, he will find at Sandhurst an opportunity for further study to complete them.

In April, the Ministry of Supply sponsored a scheme for ten studentships for civilians, value £265 er annum plus fees, tenable for three years at the College. The holders of these studentships, which re awarded on school reports and a competitive nterview, are required to read for a London External pecial Degree in natural science or for the degree in engineering. The primary object of the scheme is to train young men for posts in the Government scientific service, and on graduation the student is xpected to enter the competition for scientific fficers and to accept a suitable post, if offered. This is the first time during its history of nearly a century that the College has opened its doors to civilians, and the large entry received for the first ten studentships showed that the prospect of life at a residential college in an attractive area of English countryside ppealed to many.

O. G. SUTTON

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND

ANNUAL REPORT FOR 1951–52

THE annual report for 1951–52* of the Council for the Preservation of Rural England again tresses the need for a dispassionate assessment of he country's national resources in land as a whole, ut records the view of the Council that the balance eeds to be redressed more in the direction of agriculture and the safeguarding and creation of amenity, in which other interests are encroaching unduly. Insufficient attention is also being paid to land eclamation in all its aspects and to the important roblem of restoration after exploitation. Such forms f exploitation as open-cast coal working should, in the Council's opinion, be terminated at the earliest ossible moment. The safeguarding and creation of menity, in fact, are receiving less and less consideration, whereas they should be one of the main purposes f planning legislation; moreover, while the requirements of the Departments of State are by law outside the control of the planning authority, something ther than mere consultation at departmental level is equired in assessing true priorities where the relative alues of land use on a national scale are concerned.

Much time is still occupied by the consideration of the land requirements of the Armed Services so as to ensure that evidence is provided on amenity and scientific grounds wherever appropriate. Settlement of the outstanding requirements is regarded as unlikely to give a total varying much from the present figure of 550,000 acres compared with the estimate of 619,000 acres of the 1947 White Paper. The report comments pointedly on the delays in announcing the results of public inquiries and on the little time allowed to the Council or the local authorities in submitting comments on the Services' proposals as compared with the extreme leisure in which the proposals are handled by government departments.

Further reference is made in this report to the question of mineral extraction, and particulars are given of some cases with which the Council has been concerned. The situation as regards electricity undertakings was described fully in last year's report and is regarded as unchanged, but the Council records its opinion that much more could and should be done to avoid disfigurement in rural areas. In regard to the administration of national parks, the Council supports the view of the National Parks Commission and endorses the Commission's stand against the schemes of the British Electricity Authority in the Snowdonia National Park. The problem of refuse disposal in rural areas has caused some difficulty, and examples of successful action by the Council are quoted.

The efforts of the Council and associated organizations succeeded in securing certain amendments to the Forestry Bill in Parliament which removed the misgivings caused by the original Bill's disregard of amenity, and the Rivers (Prevention of Pollution) Act, 1951, was likewise greatly improved during its passage through Parliament, by amendments sponsored by the Council through its representation on the Central Council for River Protection. All such achievements must, however, be considered in the light of the growing tendency to disregard amenity, which is stressed at the outset of the report, and of the precarious financial position of the Council, which requires at least four thousand additional annual subscribers of one guinea or more to provide a sufficient income for the current year.

SECOND INTERNATIONAL CONGRESS ON RHEOLOGY

IT will be recalled that the First International Congress on Rheology was held in Scheveningen, Holland, in September 1948 (see *Nature*, 162, 747; 1948). A Dutch Organizing Committee was responsible for the arrangements for the Congress, which was held under the auspices of the Joint Commission on Rheology, International Council of Scientific Unions. Dutch industry provided the necessary funds. It was generally agreed that the Congress was most successful.

With the approval of the Joint Commission, the British Society of Rheology is organizing a Second International Congress, to be held in Oxford during July 26–31, 1953. The headquarters of the Congress will be at St. Hilda's College; accommodation has also been reserved in other Colleges.

The programme will include an address by the president, Sir Geoffrey Taylor, and invited lectures from some half-dozen prominent rheologists. Mme. A. Dobry-Duclaux (Paris), Dr. P. Eggleton (Edinburgh), Prof. F. H. Muller (Marburg), and Dr. R. S. Spencer (Midland, Michigan) have already accepted invitations to lecture ; Prof. E. Forslind (Stockholm) has accepted provisionally ; a Dutch rheologist and perhaps one other are also being invited to lecture. There will be an open discussion on the international organization of rheology.

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* Council for the Preservation of Rural England. Annual Report, 51–52. Pp. 50+4 plates. (From the Council, 4 Hobart Place, London, W.1, 1952.)

The Congress will cover the whole field of the study of the deformation and flow of matter, except such specialized subjects as have come to be regarded as branches of applied mechanics, such as the classical theory of elasticity and aerodynamics. Contributions to the Congress, which must not exceed 2,000 words in length (including space for figures), will be welcomed, subject to referee's approval, if received by the organizing secretary by December 1, 1952.

The Proceedings will be published in book form, and, since it is intended to circulate proofs of the papers at the Congress itself, contributions cannot be guaranteed inclusion in the Proceedings if received late. It will facilitate discussion if papers are written and delivered in English. If this is not possible, French or German may be used. Contributions cannot be accepted for publication unless one of the authors is present to read the paper personally or, in very exceptional cases, can provide a colleague from his own laboratory who is fully competent to answer questions in the discussions. Lantern slides may be shown. Speakers, other than the invited lecturers, will be strictly limited to about 15–20 min. in presenting their papers. The exact time available will depend on the number of contributions received and, if necessary, several programmes will be run simultaneously.

Invitations have been or are being sent to rheologists in all countries where it is known that rheological research is in progress. It is hoped that the Congress may provide an opportunity for an exchange of views for rheologists from all over the world. It is requested that, if any groups of rheologists have been inadvertently overlooked, they will make themselves known to the organizing secretary as soon as possible.

Arrangements will be made for excursions, visits to colleges, etc., during the Congress. The wives of rheologists are welcome. The fee for the Congress, including available preprints, and a copy of the final Proceedings, is expected to be about £4, payable before May 1, 1953. (The cost of board and lodging varies : in college, it is at present estimated at about £1 10*s*. per day, inclusive.)

Final application for membership of the Congress should be made on forms which will accompany the provisional programme. Provisional application, on forms now available from the Organizing Secretary, should be returned to him, if possible, by October 1, 1952.

The Organizing Committee consists of the following : Mr. A. G. Ward, chairman (president, British Society of Rheology) ; Dr. G. W. Scott Blair, honorary organizing secretary ; Dr. J. G. Oldroyd, honorary treasurer ; Dr. V. G. W. Harrison, honorary editor ; Mr. P. Feltham (honorary secretary, British Society of Rheology, and deputy organizing secretary to the Congress) ; Mr. E. B. Atkinson ; Mr. L. Grunberg ; Dr. E. W. J. Mardles ; Dr. Barbara S. Neumann ; and Mr. N. Wookey. Local arrangements in Oxford are being made by Captain E. W. Geidt. Further information can be obtained from the organizing secretary, Dr. G. W. Scott Blair, University of Reading.

GEOPHYSICAL AND METEOROLOGICAL CHANGES IN THE PERIOD JANUARY–APRIL 1949

By R. P. WALDO LEWIS and D. H. McINTOSH
Meteorological Office, Edinburgh

FROM a study of the daily meteorological ionc spheric and geomagnetic observations made nea London during January–April 1949, Beynon an Brown[1] concluded "that quite marked 27-day recu rence tendencies may sometimes occur throughou the terrestrial atmosphere from the ground to th highest levels, and that such tendencies can b associated, directly or indirectly, with the occurrenc of large sunspot groups and their accompanyin radiations". The truth of this assertion is well estab lished for ionospheric and geomagnetic phenomena but in spite of attempts by many authors, no direc relationship between solar activity and meteorologica events has yet been proved real. The conclusion o Beynon and Brown has, by implication, more tha theoretical interest, since the effect on surface pressur is large enough to merit being taken into account i practical long-range weather forecasting. The perio in question has therefore been examined in som detail, and the results are presented here.

The midday (G.M.T.) values of surface pressure a each of the stations New York, Horta (Azores) Reykjavik, Aldergrove (Northern Ireland), Lerwick Kew, Bordeaux, Lisbon, Copenhagen, Strasbourg an Malta during the four solar rotations (108 days) from January 12 to April 29, 1949, were analysed by mean of a 'successive difference' method to obtain th length of the most marked oscillation period o between 9 and 33 days at each place. At the firs six of the above stations a main period varyin between 25 and 30 days was indicated, while at th remaining five, various other periods were mor marked. This illustrates a feature of meteorologica data which is in contrast to that of most othe branches of geophysics. Whereas, for example, conspicuous ionospheric and geomagnetic events ar generally world-wide in character, even large-scal meteorological events appear to affect only relatively small parts of the earth's surface. The existence o a direct link between solar radiations and regiona meteorological events seems therefore to have an inherent improbability which makes it particularly necessary for any apparent connexion to satisfy stringent statistical tests of reality.

The evidence produced by Beynon and Brown consisted mainly of a striking similarity, at times even in fine detail, of the five-day running mean curves of Kew surface pressure and of deviations from the monthly mean curve of the vertical incidence critical frequency of normal E region (Δf_0E). There was also less striking similarity between the smoothed pressure curves and those for the $F2$ region (Δf_0F2 and magnetic indices K. For reasons to be mentioned later, attention is confined here to the origina unsmoothed data. The amplitude (c) and phase (φ of the Fourier component of length of period 27 day were separately determined for the Kew pressure an Slough Δf_0E series from January 12 to April 2 1949. Allowance was made for eighteen missing Δf_0E midday values by an interpolation process The standard deviation (σ) was determined for each series and the amplitude ratio (a) calculated from the equation :

$$a = \frac{c}{\sigma\sqrt{2}}.$$

s unity for a pure sine curve. The coherence of h series, as measured by the correlation coefficient ween successive terms (r_1), was evaluated and the dified amplitude ratio a_1 was obtained from the mula:

$$a_1^2 = a^2 \cdot \frac{1 + r_1^2 - 2r_1 \cos q\,\alpha}{1 - r_1^2}$$

used by Walker[2]. a_1 represents the amplitude io of the original series with the effects of coherence noved. The values of c, φ, σ, a, r_1, a_1 for each ies are listed in the accompanying table, together th the values of the probability criterion of huster (P_S) and of Fisher (P_F).

	c	φ	σ	a	r_1	a_1	P_S	P_F
ssure	5·6 mb.	224°	8·8 mb.	0 45	0·67	0·23	0·057	0 989
$_0E$	0·08 Mc./sec.	44°	0·10 Mc./sec.	0·68	0 87	0·35	0 001	0 043

From the table, it can be seen that the 27-day ves in the respective series were exactly out of ase, which is in keeping with the inverse relation- p found by Beynon and Brown. For the pressure ies we find that, from a series of 108 random terms, out one period in eighteen, chosen at random from the independent periods of a complete Fourier alysis of the observations, would have an amplitude tio greater than 0·23 (P_S = 0·057), while there is very high probability that at least one of the riods would have such an amplitude ratio $_F$ = 0·989). If, therefore, the 27-day period were e selected at random from the harmonic analysis a group of 108 pressure readings (also selected at ndom), it would be significant at about the 5 per nt level. However, the group of pressure readings nsidered was deliberately chosen because it had the culiarity of a "sequence of four maxima in atmo- heric pressure at approximately 27-day intervals", d we are considering the amplitude-ratio of this -day period which is the greatest in the whole set independent amplitude-ratios occurring in the rmonic analysis of the group of pressure readings. e therefore need to consider the chance that the eatest amplitude-ratio M occurring in the harmonic alysis of 108 random numbers should exceed 0·23. om above we see that 99 times out of 100 M ceeds 0·23. The 27-day period occurring in the lected pressure groups cannot therefore be con- lered physically significant. For the Δf_0E series, s and P_F are respectively about 1 in 1,000 and 1 in , values which suggest that the 27-day period in is series is probably significant, especially since the riod was not chosen because of any feature shown these observations.

The correlation coefficient between the unsmoothed idday pressure values and the corresponding values Δf_0E (90 available pairs) was found to be − 0·22. is common practice in meteorological and geo- ysical papers to imply the significance of a cor- lation coefficient by writing it as $r \pm E$, where

$$E = 0{\cdot}67 \cdot \frac{1 - r^2}{\sqrt{n}}, \qquad (1)$$

being the number of pairs correlated. This practice akes two assumptions which are rarely justified. rst, there is the assumption that the n pairs are dependent, which is never true of successive daily lues in geophysics. It can be shown that the quivalent number of repetitions' in a series of n lues is given by

$$\epsilon(n) = 1 + 2\left(1 - \frac{1}{n}\right)r_1 + 2\left(1 - \frac{2}{n}\right)r_2 + \dots + \frac{2}{n}r_{n-1} \qquad (2)$$

where r_1, r_2, r_3 . . . denote the correlation coefficients between successive terms, terms two apart, terms three apart . . . and so on. In most practical cases r_n becomes negligible after n = 4 or 5. Applying (2), a value of $\epsilon(n)$ = 6 was obtained for the pressure series and of $\epsilon(n)$ = 2 for the Δf_0E series. Such a large difference in the degree of coherence of the respective series is in itself strong evidence against the existence of a significant relation between them. In actual figures, the effective number of independent pairs in the correlated series can be assumed to be between 15 $\left(\text{that is, } \frac{90}{6}\right)$ and 45 $\left(\text{that is, } \frac{90}{2}\right)$. The second assumption made in the application of (1) is that r is distributed normally with standard deviation $\frac{(1 - r^2)}{\sqrt{n}}$. This is true only for $n > 500$: for smaller n, the distribution of r becomes skew[3], and for $n < 50$ the approximation is not valid. The probability that a coefficient r is derived from a population with coefficient ρ is, however, easily obtained from an approximation due to Fisher[4]. This states that $\{(\tanh^{-1} r) - (\tanh^{-1} \rho)\}$ is normally distributed about $\frac{\rho}{2(n-1)}$ with variance $\left\{\frac{1}{n-1} + \frac{4 - \rho^2}{2(n-1)^2}\right\}$. Applying this approximation in the present case, we find a probability of 0·436 that 15 pairs from an uncorrelated normal population will have a correlation coefficient $\geqslant 0{\cdot}22$; for 45 pairs the probability is 0·148. The highest of eight lag correlation coefficients evaluated (four days either side of correspondence) was only − 0·26, when Δf_0E lagged two days behind pressure. It is evident from these figures that the relationship between the two series cannot be considered significant.

The correlation coefficients were also evaluated between the unsmoothed pressure values and those of f_0F2 and K indices. Insignificant coefficients of − 0 06 and + 0·04 respectively were obtained, both from 108 pairs of values.

These results show conclusively that the apparent close relationship between surface pressure and the ionospheric and solar data over this period cannot be accepted as real. The erroneous conclusion drawn from the smoothed data illustrates the danger of attaching too much significance to such data. This is because the taking of running means introduces a high degree of artificial coherence into a series, thereby greatly reducing the number of statistically independent terms. The serial correlations r_1 to r_4 for a series of five-term running means of a random series are: r_1 = 0·8, r_2 = 0·6, r_3 = 0·4, r_4 = 0·2, and are thereafter zero. Only every fifth term may be taken as independent ($\epsilon(n)$ = 5 in equation (2), for large n). It is thus apparent that a large correlation coefficient between two smoothed series may be no more significant than a small one between the corresponding unsmoothed series. In practice, even the unsmoothed series frequently have a high degree of coherence, so that the number of independent pair is in any *case small* compared with the total; th application of five-term running means reduces th number almost to zero.

[March 8.

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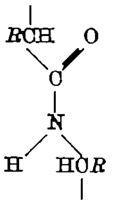
[4] Fisher, R. A., *Metron*, *1*, No. 4, 1 (1921)

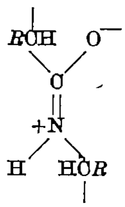
INFRA-RED DICHROISM AND PROTEIN STRUCTURE

CURRENT ideas of the configuration of polypeptide chains in proteins are based largely upon observations of X-ray diffraction patterns[1,2] and infra-red dichroisms[3,4]. While the interpretation of X-ray data is possible by well-established methods, the interpretation of infra-red dichroisms is, at present, subject to certain difficulties. Briefly, these are: (*a*) the lack of information concerning the precise nature of the atomic motions associated with certain absorption bands, and (*b*) the uncertainty in our knowledge of the directions of the transition moments associated with these absorption bands, which depends upon electronic factors as well as the atomic displacements. In the past, it has been generally assumed that the principal absorption bands observed in the infra-red spectra of proteins arise from highly localized bond-stretching or bond-deformation vibrations, so that the associated transition moment directions are along or perpendicular to the bonds according to the type of vibration involved. In view of the weight placed on observations of infra-red dichroisms in the determination of the configurations of protein chains[5], it is important that the inadequacy of these concepts should be pointed out.

An exact mathematical treatment of the normal vibrational modes of the peptide group is impossible in the present state of knowledge, but an approximate treatment may be carried out by analogy with the well-known normal modes of simple molecules. It has been established by X-ray studies of simple peptides[6] that considerable resonance occurs between structures (I) and (II).



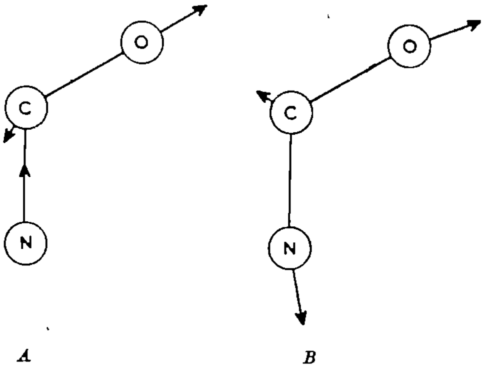
(I)



(II)

As a result, the stretching force constant of the CN bond is greater than that of a normal C—N bond, and that of the C=O bond is correspondingly reduced. The stretching force constants of the CO and CN bonds have been calculated from the observed bond-length, using Gordy's empirical method[7]; the values are $10 \cdot 5 \times 10^5$ and $7 \cdot 8 \times 10^5$ dynes cm.$^{-1}$ respectively, so that considerable mechanical interaction will occur between these bond vibrations. The resulting modes involve motion of all three atoms simultaneously and will, in first approximation, correspond to modes *A* and *B* of a bent triatomic molecule. Mode *A* corresponds to the 'CO'-frequency observed at *c*. 1,650 cm.$^{-1}$ in the spectra of peptides and proteins. The direction of transition moment in this mode will be somewhere intermediate between the directions NC and CO. The extent of the displacement from the CO direction will depend upon the degree of [illegible]echanical interaction.

Approximate calculations indicate that the fre[illegible]ency of mode *B* lies fairly close to that of the NH [illegible]nding vibration. Geometrical considerations show [illegible]t the coupling between these vibrations is very



great, and will result in the appearance of two band the first, corresponding to the out-of-phase mode which there is relatively small motion of the nitrog atom but fairly large deformation of the hydrog atom, is identified with the so-called NH-bendi frequency observed near 1,550 cm.$^{-1}$. This view supported by the spectra of deuterated peptides which this accidental degeneracy is removed[8]. band appears near 1,130 cm.$^{-1}$ in the expect position for an ND-bending vibration, and a furth band appears at *c*. 1,490 cm.$^{-1}$ corresponding mode *B*. The identification of the in-phase cor ponent, confined mainly to motion of the carbon a nitrogen atoms, presents some difficulty; but it m represent the band at *c*. 1,270 cm.$^{-1}$ which is reduc in intensity, as would be expected, upon deuteratio

While the argument outlined is based on an ove simplified treatment of the mechanical problem, su treatments have been applied successfully in the ca of hydrocarbons[9], and should be applicable here. is clear that the transition moment direction asso ated with mode *A* is not along the CO bond, b displaced towards the NC direction. This is purely result of considering the mechanical vibration.

The second factor which influences the transiti moment, and which is probably the more importa one, is the orbital-following associated with the ' vibration. As the CO distance increases, the pr portion of the resonating structures (I) and (I alters in favour of (II). Thus, during the vibration varying negative charge appears on the oxygen, a a corresponding positive charge on the nitrogen ato giving rise to a changing dipole moment in the N direction. There is strong evidence for this effe which results in increased intensity of the carbon absorption in conjugated ketones as well as in amides A similar orbital-following effect is responsible f much of the intensity of the antisymmetrical vale vibration of carbon dioxide at $4 \cdot 2\,\mu$ and accou very satisfactorily for the sign of the bond–bo cross term[11]. A rough calculation based on extinct coefficients indicates that the transition moment the 1,650 cm.$^{-1}$ band in the amide group is inclin at 10–15° to the CO direction as a result of th effect alone.

In order to test the conclusions arrived at, we ha calculated the dichroism to be expected from oriented polypeptide in which the chains have t configuration described by Pauling and Corey f their $3 \cdot 7$ residue helix[12]. The transition mome associated with the 3,300 cm.$^{-1}$ absorption band w assumed to be in the NH direction, that of t 1,650 cm.$^{-1}$ absorption being displaced by 20° fro the CO direction towards NO. The figure of 20° w arrived at by assuming a value of 15° as the displacement due to orbital following and a further 5° due to the mechanical form of the vibration. The effects of imperfect orientation were approximated to by assuming the orientation of 90 per cent of the material to be perfect and the remainder completely random. The values arrived at for the dichroic ratios of the 3,300 and 1,650 cm.$^{-1}$ bands are 15 and 4·1 respectively. These are close to the values observed experimentally by Elliott *et al.* for poly-γ-benzyl-L-glutamate in the folded configuration[13]. We consider, therefore, that these observations are in good agreement with the existence of a 3·7 residue helix, and cannot be maintained as valid objections to it[14].

One of us (R. D. B. F.) wishes to acknowledge the receipt of a Nuffield Foundation Fellowship during the tenure of which this work was carried out.

R. D. B. FRASER
W. C. PRICE

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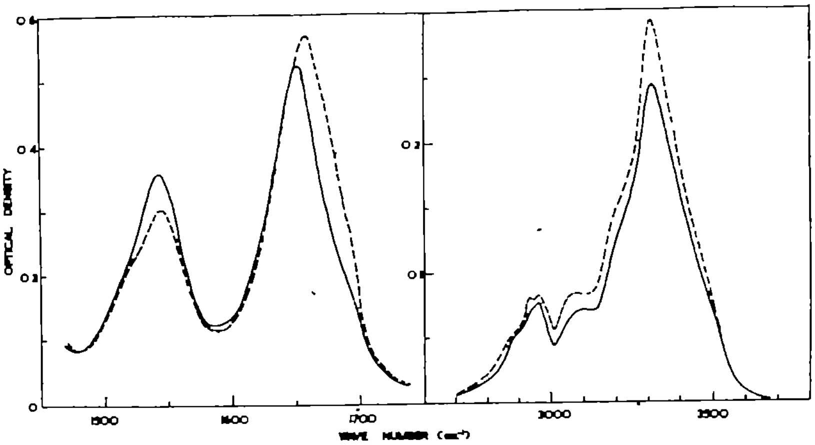
Infra-Red Dichroism of Tobacco Mosaic Virus Nucleoprotein

It has been shown by Elliott and Ambrose[1,2] that the configuration (α- or β-) of a polypeptide chain may be characterized by the dichroism of the infra-red absorption bands associated with the in-plane vibrations of the amide groups. They have also noted that the transformation from the α-configuration to the β-configuration is accompanied by frequency shifts of the so-called CO-stretching and NH-bending absorption bands. From these observations it is possible, therefore, to determine both the configuration and direction of polypeptide chains in an oriented protein structure.

The infra-red dichroism exhibited by oriented tobacco mosaic virus nucleoprotein has been measured in this laboratory using a 0·8 N.A. reflecting microscope in conjunction with a Grubb–Parsons infra-red spectrometer[3]. The microscope attachment was housed in a 'Perspex' box so that the absorption bands of atmospheric water vapour were eliminated. The polarized infra-red radiation was obtained with a selenium film transmission polarizer[4] placed immediately after the exit slit of the spectrometer. Suitable specimens were obtained by smearing a concentrated gel of the nucleoprotein on a silver chloride plate, and the absorption was measured with the electric vector vibrating perpendicular and parallel to the direction of shear, that is, to the axis of the tobacco mosaic virus rod[5]. The results obtained are given in the accompanying record, in which optical density is plotted against wave number for the two directions of the electric vector.



Infra-red dichroism exhibited by oriented tobacco mosaic virus. Absorption with electric vector vibrating parallel to the direction of shear (full curve) and perpendicular to the direction of shear (broken curve)

The dichroisms exhibited by the absorption bands at 3,300, 3,065, 1,657 and 1,544 cm.$^{-1}$ are those to be expected from either β-chains parallel, or α-chains perpendicular, to the direction of shear. The frequencies of the last two bands are, however, those associated with the α-configuration.

It may be inferred, therefore, that the major component of the protein in tobacco mosaic virus exists in the α-configuration, and that the chain axes are preferentially oriented perpendicular to the axis of the rod-like tobacco mosaic virus particle. It is interesting to note that in other fibrous protein structures which have been investigated[6,7] the chain direction has been determined to be parallel to the direction of shearing.

I wish to thank Prof. J. T. Randall for his continued advice and encouragement, Dr. M. H. F. Wilkins, who suggested the problem, for helpful discussions, and Dr. G. Markham for supplying the tobacco mosaic virus. I also wish to acknowledge the receipt of a Nuffield Foundation Fellowship.

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LETTERS TO THE EDITORS

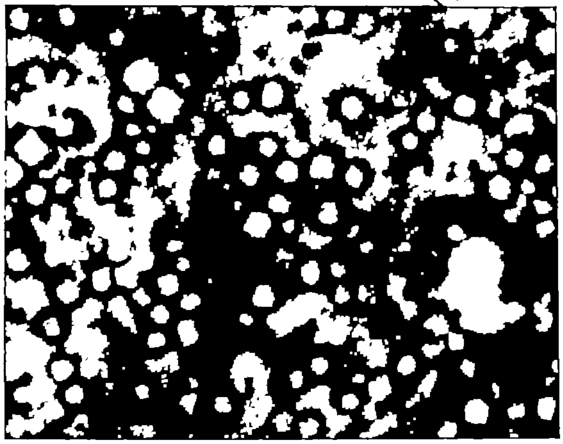
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Transmission of Polyhedral Viruses between Different Insect Species

MOST workers with the polyhedral viruses affecting insects have regarded them as strictly species-specific and only transmissible to closely related species with great difficulty. Indeed, previously in such attempted cross-transmissions we have had little success although we have transmitted the polyhedral virus of the common clothes moth, *Tineola bisselliella*, to the case-bearing larva of another species of clothes moth, *T. pellionella*.

Most of the attempts to transmit polyhedral viruses from one insect species to another have been carried out between closely related or similar insects, on the assumption that transmission would be easier in these circumstances. We have, however, disregarded this assumption which, even with plant viruses, is not entirely justified, and have, instead, attempted transmission between the most distantly related lepidopterous larvæ we could find. This gave immediate success, and we have had positive transmissions to the larvæ of the small tortoiseshell butterfly (*Aglais urticæ*) and the peacock butterfly (*Vanessa io*) of no less than seven and five different viruses respectively. These include viruses from the larvæ of the currant moth (*Abraxas grossulariata*), the scarlet tiger (*Panaxia dominula*), the cream spot tiger (*Arctia villica*) and an American species of silk moth (*Telea polyphemus*). Similarly, we have infected the larvæ of the privet hawk moth (*Sphinx ligustri*) with viruses from *P. dominula*, *A. grossulariata* and the silk moth (*T. polyphemus*), and the larvæ of the cinnabar moth (*Callimorpha jacobææ*) with viruses from the larvæ of *P. dominula*, the muslin moth (*Cycnia mendica*), the privet hawk moth and the silk moth previously mentioned. Altogether we have carried out a total of thirty successful cross-transmissions of viruses between larvæ of very different types.

The importance of this discovery lies in the fact that it opens the way for fundamental investigation into the nature of the polyhedra-virus complex, the metabolic basis of polyhedroses and the relationshi between the virus and the type of polyhedral cryst formed. As regards this last point, in the experiment thus briefly outlined, we have found that in stainin properties and morphology the polyhedra whic develop in the new host are similar to, but not alway identical with, those developing in the original hos In the accompanying illustration is shown a phot graph of the polyhedral bodies produced in larv of the peacock butterfly by a virus of the scarle tiger moth. Note that the rectangular shape cha acteristic of scarlet tiger polyhedra is still preserve We do not think, however, that it is permissible t make a definite statement attributing the characte istics of the polyhedral crystal to either virus or hos For example, much seems to depend upon the age the larva at the time of infection, and this in tur seems to be closely connected with yolk metabolis



Polyhedra from a larva of the peacock butterfly produced by a virus from a larva of the scarlet tiger moth ; note the rectangular shape of the polyhedra

One of us (N. X.) has carried out independen experiments on this question, investigating prediction made on the lines of a theory on the development insects and the metabolic basis of polyhedrose Further experimental study of this theory is in pro gress, and the theory and observations will b published elsewhere.

In conclusion, we would state that these experi ments on the cross-transmission of viruses do no invalidate the idea that latent viruses exist i lepidopterous larvæ as previously suggested[1], thoug they do throw a new light on the situation.

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Variation in *Vi*-Phage II of *Salmonella typh*

THE recent description of phenotypic variation i bacteriophages by Luria[1] and Bertani[2] has prompte us to publish the results of experiments carried ou in 1947 which show analogous features.

The object of the work was primarily to investigat the possibility of tracing a specific *Vi*-phage type o *Salmonella typhi* in which 'degraded' variants ha arisen (see Craigie and Felix[3]). It was hoped als to gain more information about the mechanism o 'degradation' of cultures and the processes concerned in the adaptation of *Vi*-phage II of Craigie and Yen[4] to the specific *Vi*-types of *Salm. typhi*. Degradation in a specific *Vi*-type can take all forms from th appearance of minor cross-reactions with heterologou phages, typical of partly degraded strains, to th full susceptibility to all adapted phages whic characterizes Type *A*.

Our experiments showed that it is not possible by the adaptation of *Vi*-phage II to a degraded variant to prepare phages bearing the specificity of the typ from which the degraded variant has sprung. Thi was reported at the fifth International Congress fo Microbiology in 1950[5].

Valuable information was obtained on the mechanism of adaptation of *Vi*-phage II to the various *Vi*-types of *Salm. typhi*, and it is this aspect of the work which is summarized here. A full account will be given by us later.

In their original description of the *Vi*-typing phages, Craigie and Yen[4], and Craigie[6] suggested that the acquisition of type specificity by the adapted typing preparations was due to the selection by the different strains of *Salm. typhi* of host-range mutants already present in any phage preparation used for adaptation. This concept was used as the working hypothesis on which they selected their different *Vi*-type strains of *Salm. typhi*.

Our work was carried out with degraded strains isolated from specific *Vi*-types of the typhoid bacillus. The strains were further subdivided by plating into single-colony lines, some of which reacted as Type *A*, while others gave the incomplete cross-reactions characteristic of 'degradation'. Table 1 shows the origin of the eight strains employed, with a description of their *Vi*-phage reactions.

Table 1

Original *Vi*-phage type of strain	No. of strains	*Vi*-phage reaction of selected 'degraded' substrains
D 5	2	Type *A*
N	3	Degraded
O	2	Type *A*
T	1	Type *A*

The following ten adapted *Vi*-typing phages were propagated on these strains: phages *C*, *D* 4, *D* 5, *D* 6, *E* 1, *F* 1, *L* 1, *N*, *O* and *T*. All phages were grown from selected single plaques.

Results. The phages grown on organisms which gave the full Type *A* reaction fell into two groups, as shown in Table 2.

Table 2

Phages changed to phage *A* on propagation	Phages propagated unchanged
C	*D* 5
E 1	*D* 6
F 1	*O*
L 1	*N*
T	

Phage *D* 4 was propagated as phage *D* 1 on Type *A*; this will be discussed later.

The change from the various adapted phages to phage *A* occurred uniformly in all the many plaques cut. The phage *A* so produced was indistinguishable from the ancestral phage *A* and again contained variant particles able to attack other types; no indication could be found that the phage had propagated as the former type, and it was concluded that the change from the former type (that is, *C*, *E* 1, *F* 1, etc.) to phage *A* had occurred in a single step commencing with the particle initiating each plaque which had been cut. This 100 per cent reversion of adapted phages to the original phage *A* suggested that, whatever was responsible for the production of adapted phages with a newly acquired host-range, the process did not involve the selection of stable host-range mutants but of particles capable of undergoing a change which, for convenience, may be described as phenotypic variation.

It is not clear from these experiments whether the initiation of plaques during the adaptation of phage *A* to heterologous types of *Salm. typhi* results from the selection either of particles possessing this susceptibility to modification, or of organisms metabolically different from the general population that are able to initiate the change in any particle. The fact that the number of plaques produced by phage *A* on a heterologous type is proportional to the concentration of phage suggests that the former hypothesis is more likely to be correct.

In contrast, the four phages which were propagated unchanged (phages *D* 5, *D* 6, *O* and *N*) behaved as stable host-range mutants; we were unable to change them to phage *A* by propagation on organisms giving the full Type *A* reaction. That a phage behaving as a host-range mutant may nevertheless show phenotypic variation is evident from the change of phage *D* 4 to phage *D* 1 on Type *A* strains. Phage *D* 4 was first produced by adapting phage *A* to Type *D* 1[4] and then adapting the resulting phage *D* 1 to Type *D* 4[7]. In this case, phage *D* 1 could be regarded as a selected host-range mutant of phage *A* and phage *D* 4 as a phenotypic variation of phage *D* 1.

It may be added that the terms 'phenotypic variation' and 'host-range mutant' are used in order to interpret the phenomena observed in a way comparable to that in current use by bacteriophage workers. It is possible that the whole process of 'adaptation' of *Vi*-phage II may be a phenotypic change, and that the 100 per cent reversion of phages *D* 5, *D* 6, *O* and *N* to phage *A* has not yet been observed because the correct organism has not been employed which can act as a 'trigger' to cause the change. More work is needed on this group of phages.

Phages grown on organisms giving the degraded reaction (see Table 1) gave results which were more difficult to interpret than those described above. In the first place, these strains were much less sensitive to the phages used than were Type *A* strains, and it was often impossible to find plaques which could be propagated. Secondly, plaques when found were extremely small and difficult to cut. Phage *T* propagated on a degraded strain descended from Type *N* yielded a phage which was able to attack Types *A*, *N* and *T* with equal ease. It would appear that a strain cannot change a specific phage to phage *A* unless it possesses the full phage sensitivity characteristic of Type *A*, and that a strain which is a partly degraded variant of one of the specific types is capable of modifying *Vi*-phage II so as to yield a phage of indeterminate specificity. Only a few phages were grown by propagating phage *T* on the degraded Type *N* substrains because of the insensitivity of the latter to phage *T*, but all these phage preparations conformed to the pattern described above. The change involved could, therefore, be provisionally regarded as fitting into the phenotypically altered group in which phage *T* has been placed.

It is apparent that the original policy[1] of using phage *A* as the parent phage for adaptation to new typhoid *Vi*-types in the preparation of the routine typing phages was a sound one, because phage *A* is highly specific for Type *A* of the organism and a new phage descended from it acquires the additional ability to attack only the new type used for adaptation. In contrast, phages descended from a host-range mutant, such as phage *D* 6, may retain in full the ability to attack Type *D* 6 and will then lyse Type *A*, Type *D* 6 and the type to which they have been newly adapted.

It is interesting to note that the phenotypic variation which can be induced in *Vi*-phage II is conditioned, in some cases at least, by the alterations produced in the typhoid bacillus by bacteriophages carried by some *Vi*-phage types of the organism[8–11]. The resistance of such types to phage *A* is clearly an exclusion phenomenon, and it seems remarkable that the presence in the bacterial cell of one kind of phage should be responsible for inducing a specific phenotypic variation in another, apparently unrelated, bacteriophage.

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Adrenal Cortical Hormones in Human Placenta

11-Dehydro-17-hydroxycorticosterone (cortisone) and a number of other adrenal cortical hormones and their metabolites have been found in human placentas. The ethyl acetate extract of a finely minced placenta, freed from blood so far as possible, was evaporated to small volume, washed with 0·2 *M* sodium carbonate, 0·2 *N* hydrochloric acid and 0·1 *M* sodium acetate and evaporated to dryness. The residue was taken up in petroleum ether and extracted with 70 per cent aqueous ethanol. The united lower layers were evaporated to dryness, and the residue was taken up in benzene which was extracted ten times with equal volumes of water. The united aqueous layers were extracted with chloroform, and the extract dried and evaporated to dryness. The residue was examined by paper chromatography at 37° using a benzene–50 per cent methanol system[1]. Several α,β-unsaturated ketonic substances were present. That present in largest amount reduced triphenyl tetrazolium chloride, had the same R_F value as cortisone and gave a blue colour with iodine. Elution with 90 per cent ethanol was followed by evaporation to dryness and acetylation with acetic anhydride in pyridine. The resulting acetate was examined by paper chromatography at 37° using a benzene–petroleum ether (1 : 1) : 80 per cent methanol system, and was found to have the same R_F value as cortisone acetate. Rough estimation of the fluorescence in ultra-violet light after treatment with methanolic caustic soda indicated a yield of approximately 100 μgm. cortisone per placenta. Traces of 17-hydroxycorticosterone are also present, and at least three other α,β-unsaturated 3-ketosteroids which are at present unidentified.

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Changes in the Flow Birefringence of Myosin as a Result of Muscular Atrophy

Many of the changes in atrophic muscle are perhaps consequences of diminution of tension. Th special importance of myosin has prompted severa workers to look for changes in its physicochemica properties as a result of atrophy. Apart from decrease in the concentration of myosin[1], an changes in its anabolism[2], there has been noticed onl a greater fragility of myosin threads[1]. While diminution of birefringence of whole muscle has bee observed[3], that of pure myosin has not as yet bee studied.

We have undertaken a systematic study of dilut solutions of myosin, prepared according to the tech nique of Mommaerts[4], from normal and atrophi rabbit gastrocnemius. The muscles were sample ten to thirty days after unilateral section of th sciatic nerve. The intact muscle was always take as control.

Using a technique developed by one of us[5,6], w have measured the angle of extinction from whic the length of the most frequent particles present i the solution was determined. The precision of th method is about 1 per cent. From the measuremen of intensity of birefringence we have determined th mean afferent anisotropy of the particles[6]. Seventee experiments have been carried out with thirtee different rabbits. All determinations were made i 0·5 *M* potassium chloride for myosin concentration ranging between 0·006 and 0 028 per cent and a *p*H 6·2–7 9. Concentrations have been determine by Kjeldahl's method to ± 2 per cent. The result are summarized in the accompanying table.

C per cent	*p*H	Time in days	Atrophic		Normal	
			l_f	$\bar{A} \times 10^3$	l_f	$\bar{A} \times 10^3$
0·012	6 7	16	2750	2 8	3050	2 4
0·006	6 2	,,	2600	6 3	2700	5·4
,,	7 1	,,	2800	6 2	2900	5 2
,,	7 2	,,	2650	6·5	2800	5 3
0 016	6·4	30	2800	2·4	2850	2·1
,,	7	,,	2750	2 6	2850	2 3
,,	7 2	,,	2700	2 6	2950	2 3
,,	7 7	,,	2750	2 6	2800	2·4
0 0076	6 5	14	2750	5 4	2800	5·3
,,	7 9	,,	2700	5 8	2750	5·2
0 015	6 5	,,	2700	2 3	2750	2
,,	7 6	,,	2800	2 1	2850	2
0 019	6·5	,,	2800	2 1	2850	2
,,	7 2	,,	2700	2 3	2800	2 1
0 028	6 6	,,	2800	1·3	2850	1·1
,,	7 7	,,	2800	1 3	3000	1 1
0·025	6 0	30	2700		3000	1 3

For all solutions, the length of the most frequent particles, l_f, is smaller for myosin extracted from atrophic muscle than for myosin from normal muscle On the other hand, the mean anisotropy of particles $\bar{A}$, is higher for atrophic than for normal muscl myosin. The duration of atrophy (ten to thirty day has no detectable influence upon the results. Th mean value of length of most frequent particles i 2850 A. for normal myosin at the concentration studied.

The mean value of the ratio l_f(atrophic)/l_f(normal) is 0·94 ± 0 006; while the mean value of the rat $\bar{A}$(atrophic)/$\bar{A}$(normal) is 1·1 ± 0·01. Consideri the precision of the technique, these values ar highly significant.

The afferent anisotropy of the particles varie markedly with protein concentration[7], so that $\bar{A}$ i approximately inversely proportional to myosin con centration. It is therefore necessary to determine th sotropy ratio at the same concentration. A iation of l_f with concentration can also observed[7]; but for a large range of contrations these variations are very small, and nor errors in concentration would have no ring upon the results regarding length of ticle.

urther work is required to explain these rets. However, it may be worth while to consider following provisional explanations :

1) Contamination of the preparations, especially myosin from atrophic muscle, with actin, is unly, since addition of adenosine triphosphate does decrease birefringence, as would be the case if ne actin were present.

2) A modification of extractability of different osins, as Dubuisson[8] observed after muscular contion, is possible. Investigation of the electroretic properties of myosin prepared from normal l atrophic muscle is under way in an attempt to cidate this problem.

3) Finally, it may be that myosin of atrophic scle is actually modified in some manner. If this ved to be true, it would represent, as Pauling described for hæmoglobin, a "molecular disease".

his work was assisted by grants from the Centre tional de la Recherche Scientifique, the Institut tional d'Hygiène and the Caisse Nationale de urité Sociale.

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ectrical Resistance and Structure of the Hen's Egg

HE yolk and white of the hen's egg show wide ferences in osmotic pressure, pH and ionic comsition, which are maintained for a long period of e on storage. This has frequently been supposed result from a property of the vitelline membrane ich separates the two phases, although J. Needham, o has recently reviewed this subject[1], has conded that there must be the co-operation of some sical property of the yolk and white.

s this property can only be a barrier to diffusion, l might be reflected in a low electrical conductivity, s has been measured for the various structures the intact egg. The electrodes were of platinum re coated with varnish except for 3 mm. at the , which was flattened to increase its conducting ea, and blackened.

	White (Δ = −0·44° C.)	Yolk (Δ = −0·56° C.)	
		Broken-up	Intact
Conductivity Median (mho/cm. × 10^{-4}, 18° C.)	8·25	2·84	0·070
Range	6·7–9·4	2·5–3·4	< 0·05–0·11
Diffusional resistance	1·3	4·85	200

One electrode was pushed up from below through the intact yolk until close below the upper surface of the vitelline membrane, and the other brought into proximity in the white lay upon it. When the membrane was ruptured between them, there was no marked change in resistance. This indicated that it was not an important barrier and would have to be isolated in order to estimate its contribution. Accordingly, the membrane was carefully washed free of yolk with homogenized white, and introduced between the closely spaced electrodes of a Kohlrausch cell under some more of the same liquid. On withdrawing the membrane, a just measurable decrease of resistance was produced—one that could have been compensated for by about a 30-μ increase in the electrode spacing.

Two wire electrodes mounted side by side, 4 mm. apart, were used to measure the conductivity of the white and yolk. Summarized in the table are the results from 24 eggs from one day to four months old ; however, no marked trends with age were found. Shown also is the ratio between the median conductivity of each phase and that of an isotonic sodium chloride solution, which is a rough indication of the resistance to ionic diffusion. A stock 1 per cent sodium chloride solution served throughout as a standard of conductivity.

The conductivity of the white was not significantly different *in situ* or after separation and homogenization.

The yolk, however, showed a much lower conductivity when the electrodes were introduced into it through a small cut in the membrane than when it had been broken up by separating it in a syringe. The measured value often differed appreciably from point to point in the intact yolk, probably as a result of damage caused by the electrodes, and, though minimum values are quoted in the table, they are possibly still too high. Making allowance for this variability, the conductivity seemed to be uniform and isotropic throughout the outer ½–1 cm. of yolk, but generally rose tenfold towards its centre.

To explain this high resistance to diffusion, there must be some internal structure in the yolk—a continuous solid phase, which can be easily broken down mechanically to yield a continuous aqueous phase. On the basis of these results, no other factor would appear to be responsible for the delay in equilibration in the intact egg.

This work was carried out while on leave from the Medical Research Council, with a scholarship from the Italian Government. I wish to thank Prof. S. Visco for the hospitality of his Institute and for introducing me to the problem.

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Division of the Flattened Egg

It has long been known that when a fertilized egg is flattened between two plates it may cease to divide. Zeuthen[1] has shown recently that although cell division is inhibited, nuclear division may continue, so that many nuclei may be present in a single flattened cell. I obtained essentially similar results during the summer of 1951, at Roscoff. It was found that, if the egg was not too greatly compressed, it would eventually divide and, once division set in, cleavage of the cytoplasm would continue until the normal ratio of one nucleus to one cell was re-established.

When the degree of flattening is too great to permit cleavage, eventually bodies of granular cytoplasm may segregate around the individual nuclei, separated from one another by gelled cytoplasm. The volumes of these segregates of granular cytoplasm are often similar to the volumes of the cells which would have existed at that stage if division had been possible. For example, at the 16-nuclei stage there are four segregates which are much smaller than any of the others, corresponding to the four micromeres of the 16-cell stage.

It was also observed that if a number of eggs were flattened by the weight of a small glass plate, the degree of flattening was not constant. Between divisions the flattening was maximal. Just before cell division the degree of flattening diminished sharply, so that the upper glass plate was raised. Then after division the degree of flattening increased. This cycle of events was repeated at each division.

The simplest explanation of the change in ease of deformation is that immediately before division there is an increase in the tension at the cell surface, and that in the plane which was occupied by the metaphase chromosomes this tension reaches a higher value than elsewhere, so that cleavage ensues in this plane. When cleavage is complete the tension falls off to its original value, only to rise again before the next cleavage.

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Fish Feeding on *Simulium* Larvæ

During investigations on the food of migrating fish in the Tanganyika region, a species of fish (*Varicorhinus tanganicæ* Boulenger) was found to feed on algæ, diatoms and insect larvæ covering stones and bottom in streams. *Simulium* larvæ proved to be the principal item of the food of *Varicorhinus*.

In 120 fish, 51 per cent were found to contain *Simulium* larvæ or pupæ, 48 per cent Ephemeroptera nymphs, 47 per cent Chironomids, 30 per cent other insects and 40 per cent plant material. In some of the stomachs the number of *Simulium* larvæ was very high, in some cases more than 50 (once 57).

The structure of the mouth in the genus *Varicorhinus*, with sharp edges in place of true lips, seems to be well adapted to scraping stones and weeds. *Varicorhinus* spends a part of its life in Lake Tanganyika, where the mineral content of the water is high, and another part in the affluent streams where the mineral content is low. It is able ascend very rapid streams and withstand strc currents. The temperature of its home waters v found to vary between 17° and 27° C. and th electric conductivity between 49·7 and 566·2 × 1 mhos. The bottom of its home waters is often stor but in the Lake it lives among weeds as w *Varicorhinus tanganicæ* seems thus to be a ve adaptable fish to varied external conditions.

The interest of the observations on food is th *Simulium* larvæ are sometimes very common in t rapid streams of East and Central Africa, and m give rise to swarms of very disagreeable flies, so species of which carry diseases of man and catt *Varicorhinus tanganicæ*, or perhaps other spec of the genus from rivers, could probably be int duced in regions where blackflies constitute a pe as in the Nile near the Ripon Falls in Uganda.

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Discovery of *Tetragonurus* Risso, 1810, in South African Waters

The rare oceanic form *Tetragonurus cuvieri* Ris 1810, has been known with some certainty since t sixteenth century from an account by Rondelet. has at intervals been reported, mainly as sing specimens, from the following localities: Medit ranean (sixteenth century onwards); Madeira (1839 Australia (1882 onwards); North Atlantic (1895 Hawaii (1928); California (1936 onwards); Jap (1939); New Zealand (1948). This fish has therefo been found over a wide range of temperate se but not hitherto in the Indian Ocean or in t adjacent Western Pacific.

A specimen of *Tetragonurus* has recently be found on the south coast of Natal, at about 31° This is noteworthy as the first record from the Indi Ocean. In addition, its characters and the locali have an important bearing on the question of wheth all the specimens so far discovered are all one rath polymorphous species, or whether more than o exists.

A detailed description and figures of this fish w be published later.

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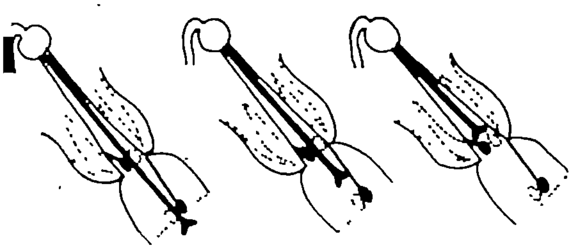
Trimorphism and Self-incompatibility in *Narcissus*

In 1887[1] and 1888[2] the Portuguese botani Henriques described trimorphic heterostyly in tv forms of *Narcissus* which he called *N. triandrus* and *N. reflexus* Brot., both belonging to *N. triandr* *sensu lato*. Though detailed studies have been ma of trimorphic heterostyly in *Lythrum*[3] and *Oxal* the only subsequent investigation of this phenomen in *Narcissus* seems to be a recent one by Fernande who published the frequencies of the three styl lengths in natural populations and speculated on t



Long-style Mid-style Short-style

The three flower forms of *Narcissus triandrus*

enetic determination. The frequencies were 1 long L) : 4 mid (*M*) : 1 short (*S*) in *N. triandrus* and : 2 : 1 in *N. reflexus*.

In 1950, Dr. Fernandes kindly sent me from ortugal collections from two populations of *N. iandrus* var. *concolor*. Fifteen plants have flowered us spring. From this small amount of material it is ready possible to draw several conclusions.

1. Like most other *Narcissus* species, homomorphic nd heteromorphic, *N. triandrus* is self-incompatible, etting no seed or a few shrivelled seeds on selfing.

2. All plants can be classed as long-styled, mid-tyled or short-styled.

3. The anthers are at the same two levels in all ne individuals so far observed. This contrasts with *ythrum* and *Oxalis* in which there are three levels 1 the flower in each form, occupied by stigma or nthers, so that as the stigma alters in height so must he anthers move also.

In *N. triandrus* the three stigma levels are : above he upper tier of anthers ; between the two tiers ; nd below the lower tier (see accompanying figure).

4. Though self-pollination is consistently sterile, ross-pollination between plants of the same style-ength is just as fertile as that between plants with ifferent style lengths (see table).

L selfed	0	*L* × *L*	0	*L* × *M*	74
	0		45		54
	0		48		
M selfed	0	*M* × *M*	71	*L* × *S*	21
					0
S selfed	0	*S* × *S*	9	*M* × *S*	72
	2 (shrunken)		27		
				S × *M*	38
Total ripe seeds from 6 capsules	0		200		259

Seed set per capsule in *N. triandrus* pollinations. Long, mid and short-styled forms are represented by *L*, *M* and *S*

Thus the three flower forms do *not* correspond to hree inter-fertile intra-sterile mating groups as *Lythrum* and *Oxalis*. There is some indication f cross-incompatibility, but since each cross is epresented by a single capsule this would have to e confirmed.

It is probable, then, that the self-incompatibility *N. triandrus* and also of the rest of the genus is ue to a multipolar incompatibility system, the poly-orphism for style-length being an independent henomenon of problematical value to the species.

It may be doubted whether this polymorphism an truly be regarded as trimorphism, for in the small umber of plants examined the style-length within ny one of the three groups has been very variable. t is possible, therefore, that we are dealing with con-inuous variation. If this were so, it would be ex-ected that the mean length (mid-style) would also e the mode (that is, the most frequent), as Fernandes found in natural populations. The idea of 'trimorphism' probably arose from the fact that with the two distinct anther heights as markers any variation in style length falls naturally into three classes : below the lower tier, between the two tiers and above the upper tier.

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Permeability of Isolated Rat Heart Sarcosomes

THE study of the permeability of mitochondria, to which the sarcosomes of cardiac muscle are closely related, has depended on indirect, mostly biochemical, methods[1,2]. One of the difficulties in any other approach has been the relatively great (and obviously abnormal) permeability of isolated mitochondria or sarcosomes to most ions at room temperature, which results in swelling and other morphological changes. With the discovery that Ca^{++} ions are intimately related to this abnormal permeability of sarcosomes and that the calcium-chelating agent versene, by removing calcium from the granules, greatly increases their stability at room temperature[3], the problem of sarcosome permeability has become more accessible to attack by other methods.

Two methods, previously used in studies of red cell permeability, suggested themselves for such a study : (i) determination of the rate of onset of the morphological changes in different suspending media (analogous to the hæmolysis method in red cells),

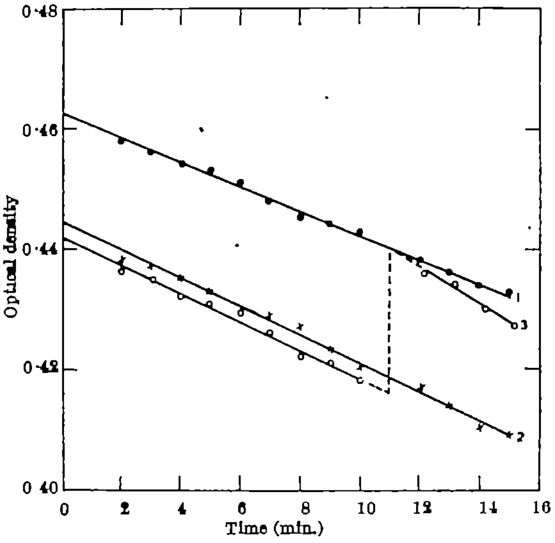

Fig. 1. Measurement of swelling in hypotonic medium and of rate of permeability of solute : curve 1, sarcosome suspension diluted with 0·165 *M* potassium chloride in Beckman cell at zero time ; curve 2, the same, except that 0 125 *M* potassium chloride was used : curve 3, as curve 2, except that at 11 min. sufficient potassium chloride was added to bring final concentration to 0·165 *M*

and (ii) study of the rate of change of the light-scattering properties of sarcosome suspensions. Some observations made with the latter method are here described. The method consists of studying the rate of change in optical density of sarcosome suspensions in 1-cm. cells in the Beckman spectrophotometer at 520 mμ.

When a suspension of sarcosomes in isotonic buffered saline containing versene (0·115 *M* potassium chloride, 0·02 *M* phosphate, 0·01 *M* versene, *p*H 7·4) is diluted in a Beckman cell with isotonic saline (0·165 *M*), the optical density slowly decreases with time, as shown in curve 1 of Fig. 1. The optical density at zero time is obtained by the extrapolation shown. If the sarcosomes are diluted with hypotonic saline (0·125 *M*), there is an immediate rapid fall of the optical density (see curve 2), complete before the first reading is taken, followed by the same slow decline shown in curve 1. By extrapolating curve 2 to zero time, an optical density corresponding to 0·125 *M* potassium chloride is obtained. In this way the curves relating optical density to the concentration of potassium chloride, shown in Fig. 2, were obtained.

Both the rapid decrease of optical density and the slow decline are due to swelling of the sarcosomes, which results in less light scatter, presumably because of a decrease of refractive index of the sarcosome on swelling. The rapid change is due to movement of water in response to the hypotonic conditions; the slow-decrease is due to permeability to solute and affords a quantitative measure of the permeability. In this communication, the permeability is expressed as the reciprocal of the time (in minutes) required for a change of 5 per cent in the initial optical density (0·3–0·5) of the suspension.

After short time exposures to hypotonic conditions, the original density is regained when isotonicity is restored, although in most experiments there was evidence that the hypotonic swelling had caused an increased permeability to the solute. A typical experiment is shown in curve 3 of Fig. 1.

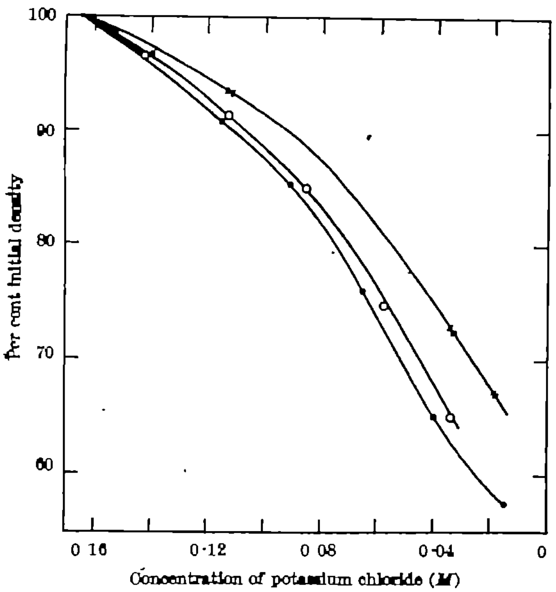

Fig. 2. Relation between initial optical density and tonicity of suspending medium (potassium chloride). The optical density is expressed as a percentage of that found in 0 165 *M* potassium chloride. The curves are for three different sarcosome preparations

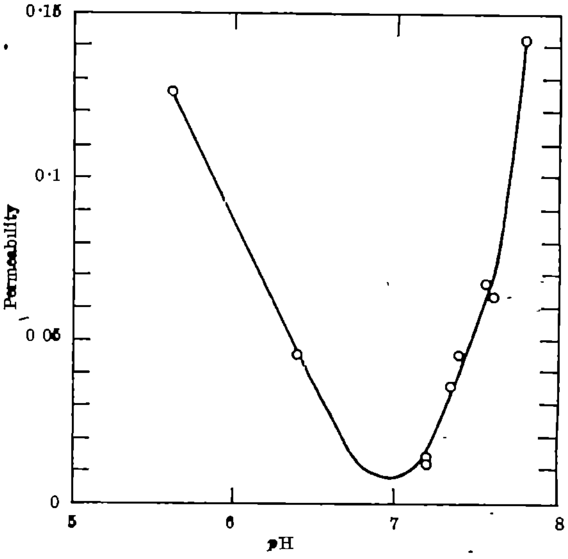

Fig. 3. Effect of *p*H on permeability to potassium chloride

Some typical permeabilities, determined on the same sample of sarcosomes, are: potassium chloride 0·02; sodium chloride, 0·013; glucose, 0·024; and sucrose, 0·006. The initial density in isotonic solutions of these four solutes was the same. Glycero and ethylene glycol exerted no appreciable osmotic effect (permeability greater than 10). The permeability to potassium succinate, fumarate and malate is of the same order as the permeability to potassium chloride.

The permeability to potassium chloride has varied considerably in different experiments (range 0·1–0·01) Slight differences of *p*H may have contributed to this variability, since *p*H has a very pronounced effect on permeability, as shown in Fig. 3. Another source of variability may be the level of endogenous adenosinetriphosphate in the sarcosomes. Added adenosinetriphosphate (0·0025 *M*), which greatly diminishes the permeability to potassium chloride o sarcosomes untreated with versene, also decreases the permeability of those treated with versene. This effect of adenosinetriphosphate is not only, or even mainly, due to a change in the swelling properties o the granules, since hypotonic swelling is not greatly affected by its addition.

The curves for swelling in Sørensen phosphate buffer are different from those of other substances in that there is a rapid initial swelling, complete before readings can be made, and thus resembling the swelling in hypotonic media, followed by a slower penetration ultimately resulting in the same degree of swelling as in distilled water. This suggests that only one molecular species of the phosphate buff acts osmotically, while the other rapidly penetrates the sarcosomes. The degree of the initial swelling suggests that it is the disodium hydrogen phosphate component which is rapidly penetrating. In agreement with this explanation, it was found that, when phosphate buffer calculated to be isotonic in respect of potassium dihydrogen phosphate (0·825 *M* Sørensen buffer, *p*H 7·4) was used as suspending medium, the initial density was the same as that found in isotonic potassium chloride.

This work will be continued and will be published in full elsewhere. It was done during tenure of a intenance grant from the Agricultural Research uncil, while on leave from the Department of stology and Embryology, University of Sydney.

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Inhibition of Gastric Secretion of Hydrochloric Acid *in vivo* by Carbonic Anhydrase Inhibition

THIS preliminary communication on the inhibition acid secretion *in vivo* in dogs by one of a new group potent carbonic anhydrase inhibitors is prompted the recent report of Davies and Edelman[1], which s appeared since our work was completed. These orkers have shown that several other known carbonic hydrase inhibitors, which include prontosil, *p*-luenesulphonamide, *p*-sulphonamidobenzoate and iophene-2-sulphonamide, can suppress the *in vitro* id secretion of the isolated frog and toad gastric ucosa, although sulphanilamide was without fect.

We employed the hetero-cyclic sulphonamide -acetylamino-1,3,4-thiadiazole-5-sulphonamide, hich is 440 times as potent as sulphanilamide for e 100 per cent inhibition of carbonic anhydrase *vitro*[2]. The single intravenous injection of this aterial in doses of 20–60 mgm./kilo inhibited 79– per cent (mean, 89 per cent) of the output of drochloric acid from Heidenhain pouches in three anaesthetized dogs, stimulated by the subcutaneous jection of 0·025 mgm. of histamine base every min. This inhibition, which occurred after a tent period of 20–80 min., persisted for at least -6 hr., and the secretory function appeared to be mpletely recovered in 24 hr.

It has been predicted by previous workers that any gree of carbonic anhydrase inhibition sufficient interrupt the process of acid secretion by the rietal cell must lead to the speedy death of the mal by virtue of interference with carbon dioxide nsport by the blood, yet no toxic reactions were erved in this dose-range.

When the dosage was extended to 120 mgm./kilo, o of these dogs expired in respiratory arrest, while e two other pouch dogs as well as two unoperated gs tolerated this dose well. There was no increase the degree of acid inhibition at this dose-level.

The details of these experiments will be published ewhere.

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Nature of Reticulin

THE main obstacle to the characterization of reticulin has always been its close association with collagen. As a preliminary to an attempt to establish the nature of reticulin fibres, a histological survey of all likely tissues was carried out, and it was found that the mid-cortical connective tissues of the kidneys of children free from renal disease consist almost entirely of reticulin. The only collagen present in this situation occurs in the immediate neighbourhood of the larger blood vessels.

Reticulin was identified histologically as fine branching fibres which appear black when appropriately treated with any of the modifications of the Maresch–Bielschowsky silver-impregnation technique; take up the acid aniline dye in the Mallory connective tissue stain; show little or no fuchsinophilia in sections stained with van Gieson's picro-fuchsin; and appear red when subjected to the McManus periodic acid–Schiff's reagent procedure.

Collagen was identified in histological preparations as bundles of non-branching fibres which assume a yellow-brown colour in untoned Maresch–Bielschowsky type preparations; take up the acid aniline dye of Mallory's connective tissue stain; show well-marked fuchsinophilia when stained with van Gieson's picro-fuchsin; and give a negative reaction to the periodic acid–Schiff's reagent test.

By a process of careful dissection, followed by maceration of frozen sections of unfixed tissue in decinormal sodium hydroxide, reticulin was isolated and prepared for electron microscopy and X-ray diffraction study. Histological control was exercised throughout to ensure that the specimens consisted only of histologically acceptable reticulin and contained no collagen.

Other samples of reticulin, known to be contaminated with collagen to a greater or lesser extent, were prepared in the same way from human liver, lung, adrenal, spleen, lymph-nodes and myocardium for purposes of comparison. Reticulin has also been suggested as one of the components of the organic matter of teeth, and the present investigations indicate that it is probably present in dentine.

Reticulin from all sources produced essentially similar appearances. In electron micrographs of unshadowed specimens it appeared as very thin laminated membranes made up of a network of minute randomly arranged fibrils embedded in an apparently structureless membrane, the relative proportions of fibre and matrix varying in different specimens, even in material obtained from the same source.

In specimens shadowed with uranium the fibrils show a striated structure, the period of the striations being of the order of 650 A. Occasional bundles of fibrils were seen which were sufficiently large to be visible in an optical microscope. These bundles were only seen in material from specimens known to contain collagen. No bundles of fibrils which would be visible with an optical microscope were found in the specimens from renal cortex. In specimens in which aggregation of the fibrils into bundles had occurred, the fibril diameters were usually 400–500 A. In other specimens fibrils as small as 100 A. in width were sometimes encountered. The supporting membranes appeared to vary in thickness. Areas photographed were usually in the range 50–150 A. The illustrations (Figs. 1 and 2) are of an adrenal specimen (× 30,000). Electron micrographs of specimens which had been boiled in water and then shadowed showed that

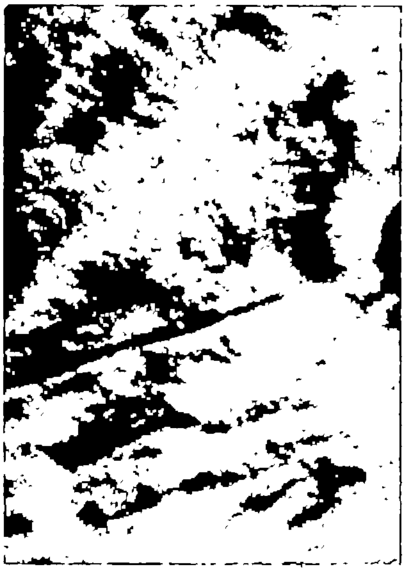

Fig. 1

boiling effects solution of the fibrils but not the underlying matrix. The fibrils differ from ordinary collagen in that no gel results on cooling concentrated solutions.

Preliminary chemical investigations of the apparently structureless matrix in which the fibrils lie suggest that it is a glucoprotein. It is remarkably stable to boiling water; even twenty-four hours boiling does not cause it to dissolve, but merely reduces it to a finely granular precipitate.

X-ray diffraction photographs of specimens which have been boiled to remove the fibrils show a characteristic and as yet unidentified pattern. Samples of dried unboiled reticulin produce photographs which appear to be a mixture of the diffraction patterns of this material and unoriented collagen, with the collagen pattern usually predominating.

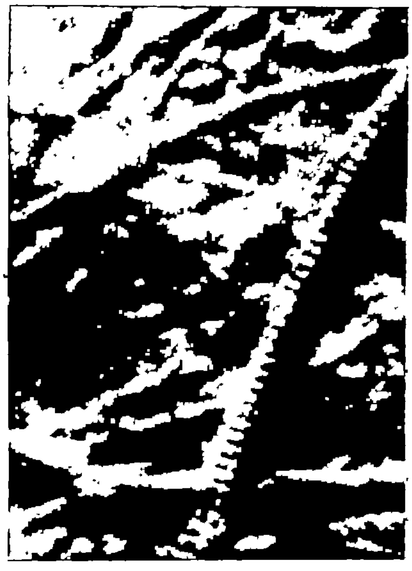

Fig. 2

Preliminary studies thus indicate that reticuli wherever it occurs, has a membranous structure. I consists of minute randomly oriented collagen-typ fibrils embedded in a structureless matrix, which i probably a glucoprotein. In connective tissues ther is a continuous series of structures from this appea ance to the familiar collagen picture, the transitio from reticulin to collagen involving orientation c the fibrils and their aggregation into bundles, an at the same time a decrease in the proportion of th structureless matrix.

Thanks are due to Dr. J. Thewlis and Dr. A. H. T Robb-Smith for encouragement, to the latter fc permission to use post-mortem material, and to th Director of the Atomic Energy Research Establisl ment for permission to publish this communicatioı

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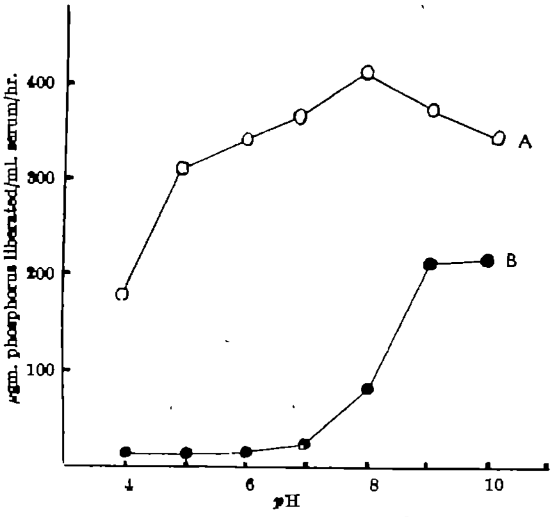
Serum 5-Nucleotidase

Reis[1-4] has demonstrated the presence of phosphatase in various tissues specifically hydrolysin 5-nucleotides, for example, adenosine-5-phosphat One of us has previously reported[5] that norm blood serum has a low 5-nucleotidase activity corr sponding to about 1/10 of its non-specific alkalin phosphatase activity towards glycerophosphate. I bone diseases where serum alkaline phosphatase raised, serum 5-nucleotidase may be normal; but i jaundice, either infective or obstructive, both enzyn levels may be increased, those of the 5-nucleotida sometimes exceeding those of the non-specific alkalin phosphatase.

The serum *p*H activity curves from a particul case of jaundice, having high 5-nucleotidase activit are shown here with adenosine-5-phosphate and β glycerophosphate as substrates, both at concentr tions of *M*/400 in barbitone buffer solution. Th hydrolysis of the adenosine-5-phosphate represen the sum of the 5-nucleotidase and non-specif phosphatase actions. These curves give further co



Hydrolysis of adenosine-5-phosphate and of β-glycerophosphate by blood serum of jaundiced patient (Pr.) at varying *p*H values. *A*, adenosine-5-phosphate; *B*, β-glycerophosphate rmation of the definite occurrence of this specific nucleotidase with an optimum at about pH 7·5 in ome sera.

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Identification of Uric Acid and Ascorbic Acid by Chromatography

P. L. Kirk and E. L. Duggan[1] have described the lentification of various substances of clinical and iological importance, and we have published a uantitative micromethod for determination of urea[2]. n this communication we report on a colour reaction or uric acid and ascorbic acid in paper chromatography. It may be noted that F. Weygand[3] and . Prochazka and S. Koristek[4] have described the lentification of ascorbic acid with, respectively, lver nitrate and dichloroindophenol.

Our method is based on the property of uric cid and ascorbic acid of reducing ferric iron to rrous. With *o*-phenanthrolin hydrochloric acid the rrous ion gives a very sensitive red colour. The mples were applied to paper strips (Schleicher and chüll, paper No. 2043 *b*) and developed by the scending method in butanol/water/glacial acetic acid. fter drying, these strips were quickly immersed in solution of 5 ml. of ferriammonium sulphate (1·5 n./l.) and 45 ml. of *o*-phenanthrolin hydrochloric cid (20 gm./l.), and were then dried at 80–100° C. The following R_F values were obtained: uric acid, 18; ascorbic acid, 0·40. It is possible to identify 5 µgm. of uric acid.

The uric acid shows the red colour reaction at the ual place in the chromatogram of blood serum and ine. In the position of the ascorbic acid spot of re solutions the urine chromatogram shows regurly a second red zone which we could not identify r certain as ascorbic acid.

The red-coloured substances were eluted from the per strip with methanol, and measurement with Beckman spectrophotometer (model *DU*) gave an sorption maximum of 510 mµ. On measuring e optical density of the eluate from the zone of the ot against the eluate of the same height from a rip to which no substance was applied, a relation tween concentration and optical density was obined which was of the same type as a saturation rve.

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Gaseous Contamination of Geiger–Müller Counters

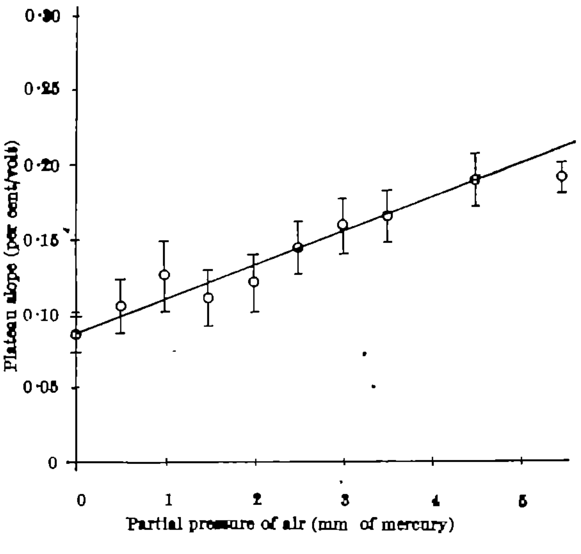
Although it is well known that the characteristics of Geiger counters may be very strongly affected by the presence of contaminated gases in the counter filling, very little quantitative work has, apparently, been published on the subject. In an experiment on extensive air showers in cosmic radiation, in which large metal-cased counters were to be used, it was desirable to know the quantities of gaseous contaminants which could be tolerated in the filling. The papers of Spatz[1], and of Korff and Present[2], include some quantitative data which were not, however, directly applicable in this case. Tests were therefore made of the effects of air and carbon monoxide as contaminants in ordinary glass-cased counters.

Standard Cintel cosmic ray counters were used, 50 cm. long and 4 cm. in diameter, with tungsten anodes and copper cathodes. The filling used was 10 cm. pressure of argon with 2 cm. of ethyl alcohol. Plateaux were plotted with a scaler, using the total flux of cosmic radiation at sea-level as a source. Counting-rates on the plateaux were approximately 520 counts/min. Operating potentials were in the range 1,200–1,400 volts. A stabilized power-pack was used.

In agreement with the work of Fenton and Fuller[3], plateau characteristics could not be reproduced exactly on successive fillings of a given counter. It was therefore necessary to add small quantities of the contaminant gases cumulatively to the same filling. This was done by means of a small gas-lock in the system, which could be evacuated separately from the counter, then filled at any desired pressure with the contaminant gas, and opened into the counter.

On first filling a counter, it was found necessary to leave it for about twenty-four hours before it had settled sufficiently for a plateau to be plotted. After adding contaminant from the lock, the system was also left for some hours so that equilibrium could be reached.

Both the length and slope of the plateau were affected by gaseous contaminants. The length of plateau is not, here, a good guide to the characteristic of the counter, since the slope increases with pressure of contaminant, and the criterion for the plateau



becomes less stringent. A better measure of the characteristic is the slope of the plateau, and this is plotted against pressure of contaminant, for air, in the accompanying graph. The effect is approximately linear for small pressures of contaminant, but appears to reach saturation at about 1 cm. pressure of air. This presumably occurs when all the argon ions moving away from the anode undergo exchange of charge with oxygen or nitrogen atoms. The plateaux were originally about 120 volts long, disappearing completely when the partial pressure of air was about 1 cm. No permanent contamination effects were observed, a plateau comparable, though not identical, with the original, being observed on re-filling.

The effect of carbon monoxide was also observed, since this is a likely contaminant in counters the cases of which are made of cast metal. The effects on the length and slope of the plateau were remarkable, a pressure of 0·5 mm. of carbon monoxide being approximately equivalent to 6·0 mm. of air. The plateau disappeared completely at a pressure of 1·0 mm. of carbon monoxide.

The deterioration of methane-filled counters has been attributed by Farmer and Brown[4] to the deposition of heavy hydrocarbons on the electrodes. It is possible that this effect is enhanced in argon-alcohol counters by the formation of carbon monoxide in the gas.

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Effect of Variation in Diameter on the Torsional Vibration of Bars

During measurements of the resonant frequencies of torsional vibrations in cylindrical bars, it was observed that variation in the diameter of the bar along its axis caused the resonant frequencies to depart from a harmonic series. In order to relate the resonant frequencies to the shape of the bar, we have adapted a method described by P. M. Morse[1] for calculating the modes of vibrating strings in which the tension varies from point to point along the length.

The method consists in expressing the displacement of the bar at any instant as the sum of a series of normal modes for a uniform bar, and regarding the departure from uniformity as a small perturbation function imposed on the mean bar diameter. Substituting in the wave equation for a non-uniform bar :

$$\frac{\partial}{\partial x}\left(a^4 \frac{\partial \theta}{\partial x}\right) = \frac{a^4}{v_0^2} \frac{\partial^2 \theta}{\partial t^2},$$

where a is the bar diameter, x the distance along the axis, θ the angular displacement and v_0 the velocity of shear-waves in the material, and dropping out second and higher order terms, we obtain an approximate equation from which the coefficients of the series representing the bar displacement and also the modification to the resonant frequencies can be determin by a process analogous to Fourier analysis.

The result obtained in this way shows that, if t departure of the bar from uniformity is expressed

$$a = a_0 \left[1 + \sum_{p=1}^{\infty} K_p \cos 2\pi px/l + \sum_{p=1}^{\infty} C_p \sin 2\pi px/\right.$$

then the fractional change in the frequency of t mth harmonic is $-2K_m$. It will be observed th to the order of accuracy of this analysis the frequenc are unaffected by the sine components of the seri Thus, for example, a bar having a uniform ta along its length will have the same torsional resona frequencies as a uniform cylindrical bar.

In order to verify this result, we measured t resonant frequencies on a bar of aluminium appro imately 4 in. long by ½ in. diameter, the diamet being reduced abruptly between points $l/4$ and 3 distant from one end, where l is the length of t bar, to a value 4 per cent less than that at the en of the bar. The coefficients of the series representi the radius of the bar are then given by :

$$K_p = (-1)^{(p-1)/2}\, 0{\cdot}16/\pi p \text{ for } p \text{ odd}$$
$$= 0 \text{ for } p \text{ even.}$$

Table 1 shows the observed and calculated valu of percentage frequency deviation from the me value.

Table 1

Harmonic No.	Observed frequency deviation (per cent)	Calculated frequenc deviation (per cent)
1	−5·1	−5·1
2	0·0	0·0
3	+1·8	+1·7
4	0·0	0·0
5	−1·0	−1·0
6	0·0	0·0
7	+0·80	+0·73
8	0·0	0·0

A similar analysis of the effect on longitudinal wav predicts half the above deviations, since a enters t wave equation to the second power instead of to t fourth as in torsional vibration ; but such an analy ignores the effect of lateral inertia, which modif the vibrations by an increasing amount as the ra of bar diameter to wave-length (λ) increases[2] Measurements confirm this divergence between sim theory and practice, as Table 2 shows.

Table 2

Harmonic No.	$\frac{2a}{\lambda}$	Observed frequency deviation (per cent)	Calculated frequenc deviation (per cent)
1	0·061	−2·6	−2·6
2	0·123	0·0	0·0
3	0·184	+0·9	+0·9
4	0·245	+0·1	0·0
5	0·307	−0·4	−0·5
6	0·368	0·0	0·0
7	0·429	+0·2	+0·4
8	0·491	0·0	0·0

H. Pursey

National Physical Laboratory,
Teddington, Middlesex.
Feb. 20.

[1] Morse, P. M., "Vibration and Sound", 2nd edit., 122 (McGraw-H 1948).

[2] Love, A. E. H., "The Mathematical Theory of Elasticity," 4th ed 289 (Dover Publications, 1944).

[3] Pochhammer, L., *I.C. Math.* (*Crelle*), 81, 324 (1876).

[4] Bancroft, D., *Phys. Rev.*, 59, 588 (1941).

Failure of Vacuum Insulation at Low Field Strengths

PRE-BREAKDOWN currents in vacuum-insulated ystems are usually regarded as due to field emission. the electrodes are not subjected to heat treatment, owever, these currents occur at unexpectedly low eld strengths. We have recently examined a form f conduction at 10–150 kV. D.C. across gaps of a few ntimetres in continuously evacuated systems. The urrent is in this case distinct from field emission ecause (i) it is critically dependent on anode conditions, and (ii) the voltage required is only slightly hanged by large variations in gap-length. Other haracteristics of interest are that the current is selfxtinguishing, after a charge of the order of microoulombs has crossed the gap, with only slight drop n voltage; and that the voltage required may be ncreased by factors up to 2 by increasing the pressure f residual gas in the system.

The mechanism of the conduction is still being nvestigated; but it is clear that there is a resemblance to the 'electron loading' experienced in accelerating tubes in the megavolt field. It is hoped to ublish a detailed report shortly.

We wish to thank the Director of the Atomic nergy Research Establishment, Harwell, and the Ministry of Supply for supporting the work and for ermission to publish the results.

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ueen Mary College, Mile End Road, London, E.1.
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Definition of Chromatography

THE belief that the word 'chromatography' was oined by Tswett[1] about 1906 is incorrect; it appears o have been widely used, though with a different onnotation, for more than a century and a half reviously. As so often happens, Tswett appears erely to have adopted an existing word and given t an additional meaning. Paradoxically, many odern works of reference define chromatography in very way but the one which would first spring to he mind of a chemist.

In 1731, Bailey[2] defined chromatography as a reatise on colour; in 1835, Field published a book ntitled "Chromatography"[3]. As recently as 1949, unk and Wagnall[4] defined chromatography in he same sense and used 'chromatograph' to denote n instrument employed to produce different colours y rotation of a parti-coloured disk. In 1860, Holmes sed 'chromatograph' as a verb meaning to represent n colour[3].

Tswett probably derived 'chromatography', and e allied 'chromatographic' and 'chromatogram', rough the word 'chromatology' used by Sorby[5], ith whose work on the differential partition of igments he was certainly familiar, as he quotes it. echmeister and Cholnoky[6] later characterized swett's principal separation process exclusively as hromatographic adsorption analysis', but, as Koshyants and Kalmykov[7] have recently pointed out, swett recognized the possibility of applying his echnique more widely than by merely forming oloured zones in simple adsorption columns.

So many processes are now by common consent ccepted as forms of chromatography that an unequivocal definition of the word in its present chemical sense presents difficulties. We have proposed the following. "By chromatography is meant those processes which allow the resolution of mixtures by effecting separation of some or all of their components in concentration-zones on or in phases different from those in which they are originally present, irrespective of the nature of the force or forces causing the substances to move from one phase to another"[8,9]. This definition embraces not only the various forms of chromatography hitherto achieved but also all forms which have been postulated as theoretical possibilities.

TREVOR I. WILLIAMS
19 Woodstock Close, Oxford.
HERBERT WEIL
17 Provost Road, London, N.W.3.

---

[1] Tswett, M. S., *Ber. Deut. Bot. Ges.*, **24**, 316 (1906); *ibid.*, 384; "Works of the Warsaw Society of Natural Sciences", **14**, Biol. Sec., Min. 6 (1903).

[2] Bailey, N., "Universal Etymological English Dictionary", 2nd ed. (1731).

[3] "A New English Dictionary on Historical Principles", **2** 394 (Edited by Murray, J. S. H., 1893).

[4] "New 'Standard' Dictionary of the English Language" (Funk and Wagnall, New York and London, 1949).

[5] Sorby, H. C., *Proc. Roy. Soc.*, **21**, 442 (1873).

[6] Zechmeister, L., and Cholnoky, L., "Principles and Practice of Chromatography" (English translation) (1941).

[7] Koshtoyants, K. S., and Kalmykov, K. F. *Biochemistry* (Acad. Sci. U.S.S.R.), **16**, Min. No. 5 (1951).

[8] Weil, H., and Williams, T. I., *Naturwiss.* (in the press).

[9] Williams, T. I., and Weil, H., *Arkiv. för Kemi, Mineralogi och Geologie* (in the press).

Zoological Nomenclature

As from January 23, 1953, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified in brackets against each entry. Full particulars of these cases were published on July 23, 1952, in the *Bulletin of Zoological Nomenclature*, those relating to cases (1) to (4) in Part 8 and those relating to cases (5) to (10) in Part 9 of Vol. 6. (1) *Ancylus* Müller, 1774 (Cl. Gastropoda) (designation of type species); (2) *atrox* Baird and Girard, 1853, *Crotalus* (Cl. Reptilia, Ord. Squamata) (validation); (3) *polysticta* Cope, 1865, *Caudisona* (Cl. Reptilia, Ord. Squamata) (validation); (4) *Palaeopsylla* Wagner, 1903 (Cl. Insecta, Ord. Siphonaptera) (designation of type species); (5) *Heterandria* Agassiz, 1853 (Cl. Osteichthyes) (designation of type species); (6) *Lobacantha* Kirby, 1837 (Cl. Insecta, Ord. Coleoptera) (suppression, to validate *Platypria* Guérin, 1840); (7) *tereticauda* Eschscholtz, 1833, *Triton* (Cl. Amphibia) (suppression, to validate *lugubris* Hallowell, 1849, *Salamandra*); (8) *Euryrhynchus* Miers, 1877 (Cl. Crustacea, Ord. Decapoda) (validation); (9) *Pontonia* Latreille, 1829 (Cl. Crustacea, Ord. Decapoda) (designation of type species); (10) Martyn, 1784, *Universal Conchologist* (Ph. Mollusca) (validation of following trivial names published in: *arabicum*; *canaliculus*; *crenata*; *denticulata*; *granosus*; *haustrum*; *heliotropum*; *iris*; *linea*; *maculosum*; *opalus*; *papulosum*; *punctulatus*; *purpurata*; *smaragdus*; *sulcatus*; *tigris*; *vermis*).

Comments on the above cases should be sent to me as soon as possible.

FRANCIS HEMMING
(Secretary to the Commission
on Zoological Nomenclature)
28 Park Village East,
Regent's Park, London, N.W.1.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Monday, September 22

INSTITUTION OF MINING AND METALLURGY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. A. M. Gaudin : "Radioactivity in Mineral Dressing" (Third Sir Julius Wernher Memorial Lecture).

Monday, September 22—Thursday, September 25

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall and King's College, Newcastle-upon-Tyne).—Centenary Meeting.

Tuesday, September 23—Thursday, September 25

INSTITUTION OF MINING AND METALLURGY (at the Imperial College of Science and Technology, Prince Consort Road, London, S.W.7).—Symposium on "Mineral Dressing".

Wednesday, September 24

TEXTILE INSTITUTE (at the Lesser Free Trade Hall, Peter Street, Manchester), at 9.30 a.m.—Conference on "Factors in Plant Development".

INSTITUTE OF RURAL LIFE AT HOME AND OVERSEAS (at the National Society for Religious Education, 69 Great Peter Street, London, S.W.1), at 5.30 p.m.—Mrs. G. M. Culwick : "Social Development in the Gezira".

Wednesday, September 24—Friday, September 26

NATIONAL SMOKE ABATEMENT SOCIETY (at the South Parade Pier Portsmouth).—Nineteenth Annual Conference.

Thursday, September 25

EAST MALLING RESEARCH STATION (at the Laboratories, East Malling), at 3 p.m.—Prof. H. B. Tukey : "Research Developments in Fruit Culture in America" (Amos Memorial Lecture).*

Thursday, September 25—Saturday, September 27

INSTITUTE OF BIOLOGY (at the Royal Institution, Albemarle Street, London, W.1).—Symposium on "The Biology and Productivity of Hot and Cold Deserts".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned :

ASSISTANT PHYSICIST (with an honours degree in physics)—The Secretary, London Hospital, Whitechapel, London, E.1 (September 27).

CHEMIST (with a degree in chemistry, and preferably some textile experience) for research on problems related to the dyeing and finishing of knitted products—The Secretary, Hosiery and Allied Trades Research Association, Thorneywood House, 4 First Avenue, Sherwood Rise, Nottingham (September 27).

EXPERIMENTAL OFFICERS in Ministry of Supply research and development establishments (most posts concern guided weapons, and require knowledge and experience of electronics)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.253/52A (September 27).

ASSISTANT IN VETERINARY PHYSIOLOGY, an ASSISTANT IN THE DEPARTMENT OF ANIMAL HUSBANDRY, and an ASSISTANT IN BIOCHEMISTRY—The Assistant Secretary of University Court, The University, Glasgow (September 30).

PROFESSOR OF ETHICS AND POLITICS, a PROFESSOR OF ELECTRICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING—The Secretary and Bursar, University College, Dublin (September 30).

ASSISTANT SCIENCE LIBRARIAN (with a degree in a biological subject, library qualifications and special library or other bibliographical experience desirable) at London headquarters—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1 (October 1).

EXPERIMENTAL OFFICER IN THE MECHANICAL ENGINEERING RESEARCH LABORATORY (D.S.I.R.), East Kilbride, Glasgow, for research work on plastic deformation of metals occurring in commercial processes, for example, rolling, drawing and forging—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.153/52A (October 4).

RESEARCH FELLOWSHIP IN THE DEPARTMENT OF NUCLEAR PHYSICS, Australian National University—The Administrative Officer in the U.K., Australian National University, 37 Russell Square, London, W.C.1 (October 10).

LECTURER IN ELECTRICAL ENGINEERING (preferably with experience in electronics or communications engineering)—The Registrar, The University, Sheffield (October 11).

CHAIR OF GEOGRAPHY at Victoria University College, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

UNIVERSITY RESEARCH FELLOWSHIP IN INDUSTRIAL METALLURGY—The Secretary, The University, Birmingham 3 (October 31).

RESEARCH CHAIR OF WOOL TEXTILE ENGINEERING—The Registrar, The University, Leeds 2 (November 10).

EXPERIMENTAL OFFICER IN RADIO DEPARTMENT, Royal Aircr Establishment, Farnborough, for experimental design of aircr aerials for modern high-speed aircraft—The Ministry of Labour National Service, Technical and Scientific Register (K), Almack Hou 26 King Street, London, S.W.1, quoting D.352/52A.

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, T University, Nottingham.

LECTURER IN ZOOLOGY—The Secretary, Royal Technical Colle Glasgow.

PRINCIPAL OF THE MID-ESSEX TECHNICAL COLLEGE, Chelmsfor The Chief Education Officer, County Offices, Chelmsford.

PRINCIPAL OF THE NORTH-EAST ESSEX TECHNICAL COLLE Colchester—The Chief Education Officer, County Offices, Chelm ford.

RESEARCH ASSISTANT for physico-organic researches IN THE CHEMIST DEPARTMENT—The Assistant Secretary, British Coal Utilisati Research Association, Randalls Road, Leatherhead, Surrey, quot Ref. A.37.

SENIOR PHYSICISTS AND CHEMISTS (and new honours gradua in these subjects)—The Secretary, Research Association of Brit Rubber Manufacturers, 105 Lansdowne Road, Croydon.

TEACHER (Grade B) IN BOTANY, to take classes up to final deg standard, and a TEACHER (Grade B) IN CHEMISTRY, for work mai up to intermediate standard—The Director of Education, The Po technic, 309 Regent Street, London, W.1.

REPORTS and other PUBLICATION

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

British Standard 770 : 1952, Methods for the Chemical Analy of Cheese. Revised edition. Pp. 12. 2*s*. net. British Standa 1865 : 1952, Air Rings (Hand-made) for Hospital Use. Pp. 8. 1*s*. n (London : British Standards Institution, 1952.) [1

Scotland, the Wealthy Nation : a Scientist's Survey of So Resources. By Dr. Archie Lamont. Pp. 144. (Glasgow : Scotti Secretariat, Ltd., 1952.) 1*s*. 6*d*. [1

Council for the Preservation of Rural England. Annual Repo 1951–52. Pp. 52+4 plates. (London : Council for the Preservati of Rural England, 1952.) [1

Report of the Astronomer Royal to the Board of Visitors of t Royal Greenwich Observatory read at the Annual Visitation of t Royal Observatory, 1952 June 7. Pp. 30. (London : Royal Observ tory, Greenwich, 1952.) [1

Ministry of Fuel and Power. 29th Annual Report on Safety Mines Research, 1950. Pp. 48+4 plates. (London : H.M. Statione Office, 1952.) 2*s*. net. [1

Catalogue of Types and Figured Specimens in the Geological Depar ment of the Manchester Museum. By Dr. J. Wilfrid Jackson. (Ma chester Museum Publication No. 6.) Pp. vii+170. (Manchester Manchester Museum, and Manchester University Press, 1952.) 10*s*. 6 net. [17

Empire Cotton Growing Corporation. Progress Reports fro Experiment Stations, Season 1950–1951. Pp. 159. (London : Emp Cotton Growing Corporation, 1952.) 3*s*. [17

World Power Conference. Annual Report, 1951. Pp. 22. (Londo World Power Conference, 1952.) 1*s*. 6*d*. [1

British Trust for Ornithology. Eighteenth Annual Report, 195 Pp. 40. (Oxford : British Trust for Ornithology, 1952.) 1*s*. 6*d*. [1

Proceedings of the University of Durham Philosophical Societ Vol. 11, No. 4 : Reactions between some Non-ferrous Metals a their Sulphides. By Dr. J. A. Smythe. Pp. 40–67+10 plates. (Du ham : University of Durham, 1951.) [1

Proceedings of the Royal Society of Edinburgh, Section A (Math matical and Physical Sciences). Vol. 63, Part 3, No. 18 : The Elemen ary Proof of the Prime Number Theorem. By E. M. Wright. P 257–267. 2*s*. Vol. 63, Part 3, No. 19 : A Generalization of the Classic Random-Walk Problem, and a Simple Model of Brownian Motio Based Thereon. By Dr. G. Klein. Pp. 268–279. 2*s*. Vol. 63, Part No. 20 : On the Estimation of Variance and Covariance. By E. Lloyd. Pp. 280–289. 1*s*. 6*d*. Vol. 63, Part 3, No. 21 : The Statistic Theory of Stiff Chains. By Dr. H. E. Daniels. Pp. 290–311. 3*s*. 6 (Edinburgh and London : Oliver and Boyd, Ltd., 1952.) [1

The Xylonite Group, 1877–1952. Pp. 40. (London : B X Plastic Ltd., South Chingford, 1952.) [1

Dental Practitioners' Formulary, 1952, for use in the Natio Health Service. Pp. 28. (London : British Medical Association, a the Pharmaceutical Press, 1952.) 1*s*. 6*d*. ; interleaved, 3*s*. [1

Strength Tests on Driven Large Diameter Aluminium Rivets. J. C. Bailey and A. W. Brace. (Research Report No. 13.) Pp. 6 (London : Aluminium Development Association, 1952.) 7*s*. 6*d*. [1

Memoirs of the Geological Survey. Special Reports on the Mine Resources of Great Britain, Vol. 4 : Fluorspar. Fourth edition. Dr. K. C. Dunham, with contributions by H. G. Dines, T. H. Whi head, Dr. J. R. Earp, J. V. Stephens, C. O. Harvey and H. E. Wils Pp. vii+144+4 plates. (London : H.M. Stationery Office, 195 17*s*. 6*d*. net. [19

Catalogues

Thermometers. Pp. 36. (Pontypridd : H. J. Elliott, Ltd., 1952.)

Periodica in the fields of Exact and Applied Science and Technolog (Catalogue 7, Part 1.) Pp. 36. (London : Lange, Maxwell and Spring Ltd., 1952.)

A List of 35 mm. and 16 mm. Documentary and Instructional Film Pp. 32. (London : Petroleum Films Bureau, 1952.)

A Catalogue of Chemistry Books and Scientific Periodicals. Pp. 1 (Liverpool : A. E. Parry and Co., 1952.)

Photocells for Industrial Applications. Pp. 16. Valves and Tub for Industry and Communications. Pp. 32. (London : Mullard, Ltd 1952.)

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MAN-POWER IN SCIENTIFIC RESEARCH AND DEVELOPMENT

THE tenth report of the Select Committee on Estimates for the Session 1951–52*, dealing with rearmament, covers several matters of special interest in connexion with scientific man-power. It will be recalled that the Estimates Committee for the 1946–47 Session, reviewing expenditure on research and development generally, made some recommendations for correcting certain weaknesses revealed by the inquiry, which had paid particular attention to the question of atomic energy. The Defence Research Policy Committee had then only recently been constituted; but the statement on the functions of that Committee and the note by the Ministry of Supply on research and development in atomic energy appended to that report were supplemented by the evidence which Sir Henry Tizard gave to the Select Committee. Afterwards, in evidence before the Estimates Committee for the 1948–49 Session, Sir Henry expressed the opinion that the Defence Research Policy Committee was a satisfactory co-ordinating body and one that would improve: it was working well and its influence had increased. He did not believe that there was then any unnecessary overlapping in research between the Ministry of Supply and the Admiralty.

This was the report in which the Estimates Committee was severely critical of the omission of details of expenditure on research and development from the Defence Budget and the Estimates, supporting the views of the Estimates Committee of 1946–47; and Sir Henry Tizard himself indicated that he would welcome the opportunity of being able to speak quite frankly to a special committee set up to satisfy Parliament in further detail as to expenditure on research and development. The Estimates Committee also announced in that report its intention of inquiring further into the matter. The present report, however, does not pursue the question of expenditure directly, although its inquiry into man-power problems, and particularly into scientific staff and into the design and research establishments, bears closely on the implied question, which is even more important to-day when research and development work desired by the Services can only be undertaken at the expense of resources equally needed for productive purposes in Britain's economic recovery.

The Estimates Committee of 1946–47 noted that the principal needs were for men and accommodation. These, rather than lack of money, were holding up the pursuit of profitable lines of research. In the present report, the Committee finds that, apart from some difficulty in obtaining skilled labour, the man-power situation is reasonably satisfactory in both factories and research establishments engaged on the rearmament programme, except in regard to the call-up of apprentices and the supply of scientific staffs in government establishments. The Committee is not entirely satisfied with the present method of the call-up of apprentices, and it makes two specific recommendations. First, it recommends that apprentices should never be called up until their apprenticeship is completed. Secondly, it suggests the creation of some form of technical reserve, similar in its nature to the railway companies of the Royal Engineers, in which skilled men who have served their apprenticeship should carry out their military service. The Radio Industry Council suggested in evidence that the call-up of professional engineers and technicians should be limited to five months, followed by service in the Territorial Army for five and a half instead of four years.

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* Tenth Report of the Select Committee on Estimates, 1951–52. Rearmament. Pp. xi+148. (London: H.M.S.O., 1952.) 6s. net.

It could fairly be deduced from the minutes of evidence taken before the Committee that its tenth report does not refer more specifically to expenditure on defence because the security curtain is used by officials to avoid pertinent questions. Sir Ralph Glyn's remark on another occasion: "There has been more extravagance in expenditure due to documents being labelled 'Secret' than from any other single cause. . . . The word secret is very often applied in order to cover up extravagance", is worth remembering. It is the more imperative, therefore, to ensure that every possible means of avoiding waste of trained man-power should be examined, and no excuse of administrative inconvenience can be accepted as reason for not exploring such suggestions.

The second matter, that of the shortage of scientific staff, particularly in the lower grades, which is due to some extent to the higher salaries which young men can obtain in industry or in posts overseas than in the government service, with consequent turnover of staff, deserves more consideration, and the minutes of evidence on this point are of considerable interest. When the Estimates Committee of 1946–47 reported that the new salary scales proposed for the Scientific Civil Service, and the ability to transfer pension rights, coupled with the conditions of service, offered a reasonable prospect of attracting sufficient scientific staff of the requisite calibre, Dr. Cockcroft, as he then was, expressed himself as satisfied with the scales in general although higher salaries were paid in industry. In the interim, those salary scales have fallen further behind those existing elsewhere, and evidence supplied to the 1951–52 Committee plainly shows that responsible and highly trained scientific men employed in posts requiring exceptional ability are seriously underpaid in relation to the importance and responsibility of their work and of their capacities, and in relation to the exceedingly costly capital equipment for which they are responsible.

It was stated, for example, that the Department of the Controller of Guided Weapons and Electronics, Ministry of Supply, is experiencing difficulty in recruiting sufficient scientific workers, as opposed to mechanical, electrical and electronic engineers, to meet the Services' requirements in research and development. At the National Aeronautical Establishment at Bedford, difficulty is expected in obtaining sufficient technical staff due to Government policy in regard to staffing. Vacillation in the policy of staff recruitment was regarded as very detrimental to t recruitment of the best possible men.

Subject to that reservation, the Select Committ on its visit to Bedford found no doubts as to t ability of that establishment to attain the hig intellectual standard characterizing the Royal Ai craft Establishment staff at Farnborough. It w emphasized that, although the scientific man naturally concerned to some extent about salary, attaches great importance to the provision of firs class facilities for carrying out his research. Accor ingly, many men who could command salaries industry as much as double those they receive in t government service choose to remain because of t excellent facilities they are afforded. Apart fro equipment, the aim is to provide the intellectu freedom that is necessary, and in the main, Prof. A. Hall, director of the Royal Aircraft Establishmen claims that the effort has been successful.

The evidence given before the Select Committ casts some doubts on Lord Cherwell's contention the House of Lords before he took office that a alternative form of organization outside the Civ Service would offer some advantage in dealing wit developments like atomic energy, and particular such an establishment as Harwell. Conditions ther as evidence submitted to the Select Committee mak plain, differ from elsewhere. At Bedford, the tur over of scientific staff was estimated as about fi per cent per annum. The corresponding figure f Harwell appears to be about ten per cent; b although the university aspect of that establishme was stressed in evidence before the Committee a in a memorandum submitted by the Ministry Supply, the wastage of scientific officers from oth atomic energy establishments is no higher than th from other defence research establishments, and th from Harwell amounted to no more than twenty-fo officers a year in 1950 and 1951. Harwell, in fa has been regarded as something in the nature of technical university. Its unique facilities for traini workers in the problems and techniques of nucle research naturally attract to it a number of you men who look upon it as a necessary stepping-sto in their selected career of scientific work.

Nevertheless, the wastage of staff at Harwell only comparable with the output of postgradua students from a university, and the attraction working at least for a period in a novel field under scientist with a world-wide reputation to some exte offsets the inability to offer exceptional salary scal to attract outstanding men, but which it would difficult to justify within the Scientific Civil Servic The staffing position for the atomic energy proje does not at present cause undue disquiet; b equally the Ministry of Supply admits that it is n a matter to be viewed with complacency. On th point the Select Committee, which is satisfied th the equipment in government research establishmen is of the highest quality and that it is important ensure that the men recruited to use this equipme are of like quality, recommends that the scales salary and conditions of employment should be ke under constant review.

This is only common prudence, in order to secure e full return from the large sums of public money ready allocated to schemes of scientific research d development; but although there is welcome vidence in this report that the importance of con- tions of service and of securing contented teams of illed staff are more widely appreciated than when e Barlow Committee reported, there is evidence so of waste through neglect of this consideration. he Committee refers, for example, to the probability at the proposed transfer of the Fighting Vehicles esign Establishment to a fresh site will involve not nly a large waste of public money but also the reak-up of a valuable team of scientific experts.

The Select Committee fully recognizes the diffi- ulties which may sometimes be encountered in voiding costly decisions of this type. The risk, too, at expensive constructional work may be rendered ut of date by scientific discoveries made before the ork has even been completed cannot always be xcluded. Apart from the secrecy issue already entioned, the Select Committee's report is on the hole reassuring, and even where the secrecy curtain as most baffling, it appears to be satisfied that the oney spent on the atomic energy project is justified y the results so far achieved. Nevertheless, the arnings given in this report are plain enough, and ufficient material should now be available for ientific men to make sure by their professional ction that the position does not deteriorate.

Some other points in this report merit notice. vidence was submitted of the need for greater ttention to the function of the technical colleges in roviding technicians—a function commonly ignored discussions on technological education. It was stimated, however, that only some 1,750 technicians ould be required for research and development in e rearmament programme, instead of the 3,000 stimated by the Hankey Committee.

Sir John Cockcroft's evidence before the Com- ittee is of special interest. He estimated that about ne-third of the effort at Harwell could be broadly escribed as research and the remainder as develop- ent, including about 15 per cent on the production f isotopes. The demand for these is rapidly in- reasing, and it has since been announced that Great ritain is now the world's largest exporter. Sir John lso expressed the opinion that the numbers and uality of staff recruited for atomic energy work are tisfactory, although it is the younger men rather an the older who are being attracted. He was not isturbed at a wastage of scientific staff running to n per cent. What is disturbing, however, is the ference elsewhere in the evidence before the Com- ittee to a drift of highly qualified men of science om Britain to America, attracted by the much igher salaries offered there.

This loss is not great at the moment: it was put t about fifty last year; but the loss of even that umber of our best brains is nevertheless a serious x on our limited resources of scientific and technical an-power, and the evidence of the Controller of tomic Energy on the disparity of salaries in Britain d overseas is not reassuring in this connexion. The Ministry of Supply's evidence on scientific staffing admitted that the scientific man entering the government service is probably underpaid in comparison with industry—as is also the scientist at the top of an establishment; it is contended, nevertheless, that the men in the middle range compare favourably in salary and conditions with those elsewhere. Sir Frederick Morgan, however, was prepared to argue a case for special scales for those on atomic energy work. He maintained that the man who is capable of original thought and of reducing it in a disciplined way into something which is handed over later to the production side is invariably on a scale of wages which bears no relation to the value of the work he is doing.

This report clearly emphasizes the danger of failing to get full returns from Britain's huge expenditure on research equipment through parsimony in the conditions offered to the men who use that equipment; nevertheless, it will fully justify the Committee's careful inquiries. No less important, however, is its warning of the dangers which also attend the use of the cloak of secrecy to hamper Parliamentary scrutiny of expenditure on research and development. Public scrutiny remains the surest safeguard against either extravagance or duplication of effort, and other evidence of Sir Frederick Morgan rather offsets Sir Henry Tizard's confidence as to the effectiveness of the Defence Research Policy Committee in this regard. His evidence led the Select Committee to correct its earlier impression that that Committee and the Advisory Council on Scientific Policy covered the whole field of research and development. In a strictly formal sense, atomic energy stands apart from the field covered by those two committees, and the complicated position disclosed by the evidence set forth in this report suggests that the position is not entirely satisfactory. Something more appears to be required in the way of co-ordination, even informally, before the organization of Britain's research and development effort can be regarded as adequate. The experience which Sir John Cockcroft brings from the atomic energy field to his new responsibilities as chairman of the Defence Research Policy Committee and of the Advisory Council on Scientific Policy should be a real help; but the need for fresh constructive thought here is as plain as is the need for limiting the use of the security curtain to the minimum consistent with national safety.

LOGICAL FOUNDATIONS OF PROBABILITY

Logical Foundations of Probability

By Rudolf Carnap. Pp. xvii+607. (London: Routledge and Kegan Paul, Ltd., 1951.) 42s. net.

PROF. R. CARNAP is one of the leaders in the modern school of mathematical logic. Perhaps his most striking contribution is his emphasis on the distinction between language and semantics (the theory of the meanings of the expressions in language). For example, Whitehead and Russell are said to have defined the number of a class as the class of all classes cardinally similar to the given class. (At least, this is the usual description of what they did; their actual procedure was more elaborate.) This is one interpretation of number. If it is supposed to be the only one, an ordinary mathematician appears to be precluded from using 'number' to mean anything else, even though other things may appear to follow the same rules. The modern method would be to consider a language containing the signs for the numbers—rules for manipulating the signs are stated in a further language called the metalanguage—and in this way a formal development of mathematics is created. The legitimacy of the interpretation of the signs and operations in a particular way becomes a separate problem. This idea can be applied to logical systems at the most elementary levels, and has led Carnap and others to considerable clarification of the foundations of logic.

The main theme of the present book is the application of this method to probability theory. Carnap distinguishes between two kinds of probability, which he denotes by probability$_1$ and probability$_2$. Both satisfy the same rules of manipulation. Probability$_1$ is regarded as a logical relation between pairs of statements expressible in a given language; probability$_2$ as a limiting relative frequency in an infinite series of experiments. An adequate account of scientific inference must include both. The discussions are very full on both the symbolic and the interpretative levels.

One difficulty of the subject is the distinction between 'subjective' and 'objective'. I have gone so far myself as to say that both words have been used in so many different senses that they should be abandoned as *nomina confusa*. Carnap's method enables him to say that both kinds of probability are objective. For probability$_1$, his argument permits him to avoid the term 'degree of rational belief', on grounds similar to those given by Russell for deductive logic. Russell argued that $2 + 2 = 4$ is a logical relation between sets of classes and has nothing to do with the existence of a mind, rational or not, to appreciate it. The ability of a mind to understand and use it belongs to the interpretative level. Similarly, Carnap would regard probability$_1$ as a ratio of measures of sets of sentences and call it a 'degree of confirmation'; this is *used* in rational belief but is not its whole content. This seems to add some clarity. However, as he himself points out, the measures can be taken in many ways; his theory gives rules that must be satisfied by any system of probability$_1$, but many different numerical assessments would satisfy the rules, and the decisions between them need further discussion on the interpretative level. Most of the argument is quite general, and many controversial questions are well discussed.

Carnap discusses one particular assessment, which appears to be equivalent to Laplace's principle of indifference, and remarks that in some circumstances this leads to contradictions. A second volume is in preparation and will apparently produce more specific results. Some of these are described in an appendix, which states a modification of the principle of indifference to avoid contradictions. This seems similar to the rule that I have stated for the sampling of a population with respect to more than two exclusive properties. I doubt, however, whether this can cover the ground. Carnap does not appear to mind the conclusion (given by Laplace's form) that the initial probability of a general law, applied to a infinite class, is zero; and there is something to b said for that view. But Laplace's form also leads t the conclusion that if an event has succeeded in trials and failed in none, the probability that it w succeed in all the next $n + 1$ trials is ½, and this seem definitely too low to correspond to scientific practic The modified rule appears to intensify this difficult I hope that Carnap will attend to this point, becaus I know of nobody better equipped to produce satisfactory solution.

The book has not much to say about probability except that values of probability$_1$ are often estimat of probability$_2$. I am inclined myself to think tha the idea of an intrinsic probability is useful, thoug I think that the attempt to define it in terms of limiting frequency creates more difficulties than solves, and I cannot see that anything in the boo depends on the definition. It might be argued tha the only cases of probability$_2$ are in quantum physics one, for example, would be the probability that radium atom will disintegrate in the next minute. I coin-tossing, we might make a definition in terms o a limiting frequency (assuming it to exist) for sequence of throws with one coin (assuming that th coin never wears out), or in terms of one throw eac for an infinite set of coins (again assuming the limi to exist). But there is no way of proving that th two definitions would give the same assessment without piling up further assumptions that appea no more plausible than the notion of an intrinsi probability seems to begin with.

The book is far the best analysis of the logic o probability that has yet appeared, and will b indispensable to students of the subject. The specifi applications announced for the second volume will b awaited with interest.

HAROLD JEFFREYS

ORGANIC CHEMISTS' VADE-MECUM

Chemistry of Carbon Compounds

A Modern Comprehensive Treatise. Edited by Dr E. H. Rodd. Vol. 1, Part *A*: General Introductio and Aliphatic Compounds. Pp. xxiii+778. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1951.) £7.

THE hiatus existing between the necessarily highly selective and simplified text-book treatment of organic chemistry and the comprehensive scope of compendia such as "Beilstein" has for long been filled by Richter's "Chemistry of Carbon Compounds". The last edition in English of this work appeared thirteen years ago, and even this was a patchwork overhauling of an earlier version. The need for a successor has been markedly apparent, and the onus of this task has been accepted by the Elsevier Publishing Co. in consultation with an advisory committee of six distinguished British organic chemists headed by Sir Robert Robinson; the herculean task of editorship is being shouldered by Dr. E. H. Rodd. The present book represents the first stage in the compilation of a five-volume work to take the place of "Richter" in providing a modern comprehensive treatise on organic chemistry.

The book opens with an editorial historical survey and sections on the classification, nomenclature and iterature of the subject. There follows a description f the quantitative analysis of organic compounds ; s this is written by a practitioner of the art, Mr. R. elcher, there is a welcome absence of description of he obsolescent apparatus and procedures beloved of nany other text-books. The striking infiltration of hysico-chemical ideas and techniques into organic hemistry is reflected in the contents of the next two undred pages, which are devoted to an exposition f the underlying theory of the science. This subject as been handled by the allotment of a section to very important topic, each being dealt with in essay orm by an expert in that field. Thus the discussion f free radicals and homolytic reactions is in the ands of Prof. D. H. Hey and Dr. W. A. Waters, tereochemistry is expounded by Prof. E. E. Turner, nd the crystallography of carbon compounds is lescribed by Dr. A. F. Wells. A review of the physical roperties used in the investigation of organic comounds is given by Prof. H. D. Springall, who also leals with modern concepts of acids and bases in heir relation to organic chemistry. The section on ight absorption, by Dr. E. A. Braude, is a succinct ccount of the theory and practice of ultra-violet and nfra-red spectroscopy and includes useful charts of he characteristic infra-red frequencies associated vith a large number of organic groupings. An uthoritative article on reaction mechanisms, by Prof. E. D. Hughes, contains the gist of the modern vork on the subject, written as it is by one who has nade large contributions to this study. Very little eference is made, however, to the alternative view f anionotropy as an essentially acid-catalysed proess ; it is surely a little ungenerous to dismiss this onsiderable body of carefully executed work in a wo-line footnote. Owing to the unavoidable comression of this wide topic, the full benefit of this section will accrue to those who already have some cquaintance with the subject.

No attempt has been made to include a detailed ccount of the twin concepts of valence bond and nolecular orbital treatment as applied to organic ompounds, beyond a brief description in the hisorical section. This is a sensible decision ; the ubject does not lend itself easily to compression, nd the recent publication of Prof. C. A. Coulson's nonograph on this topic renders any such treatment edundant.

The remainder of the book is taken up with its rimary task of systematically presenting the known acts of aliphatic chemistry. The exposition deals vith hydrocarbons and their halogen derivatives, lcohols and their sulphur derivatives, amines, rgano-metallic compounds, carbonyl compounds, arboxylic acids, glycols, hydroxycarbonyl and licarbonyl compounds ; the remaining aliphatic ypes will be dealt with in Vol. 1 *B*. Sound arguments r retaining this Richter classification are presented the preface, and indeed no difficulty is experienced finding any required section.

This enormous mass of information is laid out in a ucid and concise manner, clarity being greatly nhanced by the extensive use of tabulation. The xposition succeeds admirably in its aim of rendering asily available the accumulated knowledge of rganic chemistry ; a striking feature is the wealth f up-to-date leading references both to the original iterature and to review articles. Ease of reference is reatly enhanced by the provision of a truly magnificent index, for which grateful tribute must be aid to the editor.

The production of the volume is of the excellence one has come to expect from Elsevier, and the book is a pleasure to handle. The errors are surprisingly few for a work of this range, and such as do occur in the text are typographical trivialities. It is unfortunate, however, that the first entry of tropolone into a text-book should be heralded by a badly malformed structural formula. The price of the book is not excessive in view of its content, and a 15 per cent reduction is allowed both for this and the following volumes if they are ordered prior to publication. The debt already owed by organic chemists to these publishers for their very fine encyclopædia is further increased by their presentation of this authoritative work.

CONVEYING OF HEAT ENERGY

Elements of Heat Transfer and Insulation

By Prof. Max Jakob and Prof. George A. Hawkins. Second edition. Pp. xvi+230. (New York : John Wiley and Sons, Inc. ; London : Chapman and Hall, Ltd., 1950.) 32*s*. net.

IN the preface to this second edition of their book, the authors remind us once more that the subject of conveying heat energy is not of less importance than that of converting it. Many would consider this an under-statement, for not only do heat transfer problems confront the practising engineer more frequently than thermodynamic ones in many fields, but also their solution is more difficult and often requires an intuition of what aspects are vital and what may be neglected, which only experience based on theoretical understanding can provide. However, in universities it is not yet usual to accord the teaching of heat transfer equal status with that of thermodynamics, partly no doubt because the former subject is comparatively new, but partly because of the lack of suitable text-books for undergraduates. Profs. M. Jakob and G. A. Hawkins have set out to make good the lack.

As usual, they divide heat transfer into three parts—conduction, convection and radiation although they do have chapters dealing with the combined effects of all three modes. The main emphasis is on the first of these, and there are excellent simple accounts of the application of relaxation and graphical methods to those problems in heat conduction, both steady and unsteady, which are too difficult for mathematical analysis. Although these matters are often considered 'advanced', the clarity with which they are presented brings them well within reach of the undergraduate. A large amount of useful data on thermal conductivities is provided.

The treatment of convective heat transfer is more sketchy. Despite the authors' statement that forced convection is probably the most important method of heat transfer, only five pages are devoted to it, and these contain little more than a bald presentation of the empirical relations between the dimensionless groups for flow inside and outside tubes.

The dimensionless groups are derived by the algebraic method. This has the disadvantage that their physical significance is not apparent, a disadvantage, however, which appertains not to dimensional analysis, as the authors assert, but to the algebraic presentation of it. Many students find more illuminating the alternative derivation of, say, the Reynolds number as the ratio of inertia to viscous forces, and of the Grashof number as the ratio of buoyancy to viscous forces.

The authors suggest that the theory of convective heat transfer based on the surface film concept of Langmuir and Rice is more "conspicuous". Yet this theory leaves unanswered the question of why such a film occurs, and how its properties must vary with the conditions of flow. It seems a pity, therefore, that space was not found for introducing the idea of a thermal boundary-layer and the heat-balance equation which determines its thickness. On the other hand, the authors have presented Reynolds's analogy between friction and heat transfer in a rather more detailed manner than usual; I feel that this thoroughness is not worth the resulting loss of clarity. The analogy is chiefly useful for rough but speedy calculations; when greater accuracy is needed, it is usually possible and preferable to turn to experimental results or more exact theory rather than to elaborations of the analogy.

The book contains a concise account of radiant heat-exchange between black and grey bodies; but gases and flames are not treated. The emphasis is on providing useful design data rather than the underlying fundamental relations. There is a short chapter on heat transfer in boiling and condensation, but mass transfer is dismissed in a sentence.

D. B. SPALDING

TEXT-BOOK OF PLANT GROWTH SUBSTANCES

Die Wuchsstofflehre

Ergebnisse und Probleme der Wuchsstofforschung. Von Prof. Hans Soding. Pp. xi+304. (Stuttgart: Georg Thieme, 1952.) 33 D. marks.

PROF. HANS SÖDING says that his aim in writing this book is to make a comprehensive presentation of all aspects of research on growth substances, set in their proper perspective in the wider field of plant physiology. To achieve this, he assumes the usual text-book knowledge of plant physiology; but where this is not sufficient to allow a clear exposition of his thesis, he touches on wider physiological problems. In addition to presenting results of published work (as far as 1949, with a few additions for 1950–51), he has attempted to indicate open questions and avenues for further exploration. In this he succeeds admirably.

The first two chapters are concerned with accounts of assay and extraction methods, including full details of Prof. Söding's own 'daylight curvature test', with data on magnitude of response and variability. Such data are useful for comparison with other methods of hormone assay.

Chapters on the distribution of growth substances in plants during development, the role of external and internal environment, auxin transport, tropisms, the role of auxin in cell division, root formation, etc., and the mechanism of auxin action, follow patterns similar to those in existing works in English on these topics. They are useful, however, for the inclusion of much recent Continental work, especially war-time German research, the original reports of which are not always readily available in English libraries.

To appreciate the chapters on extraction of auxins from plants and on the chemistry of growth-promoting and -inhibiting substances, some remarks on nome clature are necessary. The term 'growth substanc (*Wuchsstoff*) is defined as meaning substances (i cluding synthetic compounds) which increase exte sion growth of higher plants, especially the o coleoptile. Naturally occurring growth substanc are considered to be auxins *a* and *b*, with 3-indoly acetic acid (heteroauxin) acting probably as a activator of these substances in the plant. For th benefit of Continental readers, Prof. Söding poin out that in the English literature the term 'auxi denotes not auxin *a* or *b* but any of a range natural and synthetic growth substances, dependin on the context, though usually it refers to heter auxin.

That such explanations should be necessa emphasizes present-day confusion resulting fro indecision on the nature of growth hormones plants. The question whether these are auxins *a* an *b*, or 3-indolylacetic acid and related compounds, still *sub judice*. It must be admitted, however, th with the passage of time convincing evidence favour of the existence of auxins *a* and *b* in high plants becomes more slender, while proof (f example, by chemical identification and by enzymat studies) of the importance of certain indole com pounds as natural growth hormones increases. Muc of the evidence for the existence of auxins *a* and is based on acid- and alkali-stability tests on pla extracts (examples are listed on p. 74), and this wi now need re-examining in the light of the rece discovery of 3-indolylacetonitrile as a naturall occurring growth hormone.

The fact that indolylacetic acid can be extracte from many plant tissues, regarded by the majority British and American workers as strong evidence the importance of this substance as a naturall occurring growth hormone, is considered by Pro Söding to be the greatest weakness of extractio methods. He believes that indolylacetic acid b longs primarily to the protein metabolic cycle an not to the auxin cycle (p. 87), and that deductio about the growing system cannot be made wit certainty from extraction data (p. 23). This approac would seem to rule out the possibility of furthe experimental advance on the chemical side and t make the question of the identity of the natur auxins one which should not be asked.

Possibly the most valuable sections of the book f the English-speaking reader are those on the role auxins in correlative inhibition, polarity of regene ation and other aspects of morphogenesis, since these topics, which have been developed so extensively b German workers, tend to be neglected in British an American text-books.

There are two useful chapters on the positio occupied by growth substances in the hierarchy plant hormones and vitamins (*Wirkstoffe*), and th interactions of these substances in the plant.

In the concluding *Ausblick* the future develo ment of hormone research is discussed. With th increasing tendency to rely on the interpretation mathematical curves and figures, the subject becom ever more *vergeistigt*; but Prof. Soding hopes th the biologist of the future will see behind his figur the same beautiful and harmonious picture of Natu as the Nature-lover sees in the butterfly and th flower.

The book is expensive in British money, but i well produced, and would be a useful addition o plant hormones to any library.

J. A. BENTLEY

reeding Birds of Kashmir

By Lieut.-Colonel R. S. P. Bates and E. H. N. Lowther. Pp. xxiii+367+85 plates. (London: Oxford University Press, 1952.) 38s. net.

BEFORE the Second World War, Kashmir was a favourite resort of Europeans desirous of a hange from the heat of the plains to a cooler climate, wonderful scenery, beautiful flowers, and a great variety of birds. The authors are experienced field naturalists who have made a speciality in photographing birds in India and, in addition to making many studies in the plains, have devoted much time o Kashmir birds. The country they worked in lies between the great Himalayan range and the Pir Panjal range and is drained by the Rivers Jhelum and Kishenganga and the upper waters of the Vardwan River. The whole area consists of valleys with orchards, lakes and marshes, and, on the hillides, forests with bare screes above and upland meadows in the higher reaches.

With this great variety of habitats there is a corresponding variety of bird life. In the lower parts of the valleys there are a few oriental species from the plains of India, such as the magpie robin and he jungle babbler. Higher up there are the grey drongo and slaty-headed parakeet, both Himalayan species. Another plains bird is the pheasant-tailed acana, which is migratory and in the summer abounds among the lotus leaves of the numerous lakes; according to the authors, one was seen on a tarn at 12,050 ft., but they give no date. Of the palæarctic birds some are residents; but the majority descend to the Indian plains with the advent of autumn, while others do not go farther than the foothills of the Himalayas.

The volume is confined to the birds breeding in the area mentioned, and many species recorded as nesting in Kashmir are not included since they resort to the more bleak areas of Ladakh and Baltistan to breed. The habits and nests of 116 species are described, and when the authors have not sufficient experience they amplify their notes with extracts from the writings of other ornithologists.

This is a very interesting book, with a certain amount of new information which does not always agree with the accounts in Baker's "Identification of Indian Birds". There are eighty photographs of nests, birds and scenery, most of which are of a high standard, but this can scarcely be said of the coloured plates—the birds are stiff, and the colours have suffered in reproduction.

Études sur les scorpions

Par Max Vachon. Pp. 482. (Alger: Institut Pasteur d'Algerie, 1952.) 2200 francs.

THE determination of scorpions has for years been a puzzling task, because of the variation which many species show. For this reason M. Vachon has undertaken an intensive study of the scorpion fauna of North Africa, with a revision of their systematics and nomenclature.

He now offers us, first, a general account of the order, taken largely from his chapter in Grassé's "Traité de Zoologie", which will be welcomed by many who do not possess that expensive work. Secondly, he reviews the characters that can be successfully used in identifying a scorpion, emphasizing chiefly the trichobothria or *poils auditifs* on the appendages. There follow descriptions of the thirty-three species of North African scorpions which M. Vachon recognizes, with dichotomic tables summarizing the whole. It is a feature of these keys that they can often be used for mutilated specimens. M. Vachon has no hesitation in adopting a trinomial system for the many subspecies he establishes, nor to extend this by the addition of varietal names for forms which are often distinctive for special localities.

M. Vachon has included an account of the geographical distribution of these animals, and a discussion of their origin and dispersal. His book may be recommended as an impressive example of a truly biological survey of a limited group, almost a model for others engaged in similar work.

T. H. SAVORY

Mellor's Modern Inorganic Chemistry

Revised and edited by Dr. G. D. Parkes. Pp. xxi+967. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 25s. net.

THIS well-known text-book was revised and rearranged in 1939 by the late Prof. J. W. Mellor in collaboration with Dr. D. G. Parkes. Since then it has been several times reprinted; for this present edition the text has been once again reset. Up-to-date matter inserted here and there throughout the book accounts for thirty new pages. In addition, there is a new chapter (nine pages) summarizing the chemistry of the metals.

According to the preface of 1939, a guiding principle of the editors was the keeping of "a proper balance between theory and facts". However, revision of the theory is not of the same high level as that of the factual material. Resonance gets a paragraph in small print; the covalent and coordinate links get less than two pages of small print, and not one of these is sufficiently deeply expounded to make it readily applied. Thus in discussing boron fluoride, Dr. Parkes is not able to relate its structure and its intense activity. All the periodic tables end with uranium. The Bronsted-Lowry conception of acids is not mentioned.

Apart from these points, the revision has been well done, and the book retains those qualities which gained for it its high reputation.

G. F.

Sedimentary Petrography

With Special Reference to Petrographic Methods of Correlation of Strata, Petroleum Technology and other Economic Applications of Geology. By Henry B. Milner. Third edition, reprinted with a new Preface and Corrigenda. Pp. xix+666+52 plates. (London: Thomas Murby and Co., 1952.) 50s. net.

MILNER'S "Sedimentary Petrography" has been in use for many years as a text-book and standard work of reference in British universities. The second (first complete) edition was published as long ago as 1929, and an enlarged and completely revised third edition appeared in 1940. This has been out of print for some years and has now been reprinted. It is issued unchanged except for a page of corrigenda and a corrected and revised list of the British Standards quoted in the book. It is to be regretted, in view of the large amount of research carried out on the sediments in the past decade, that pressure of work has not permitted the author to complete the revised fourth edition that he has in hand. Nevertheless, the ground covered in the work as it stands is so comprehensive, including both descriptive matter and laboratory technique, that it will doubtless continue to provide a valuable introduction to the subject for university students.

NUCLEAR AND FUNDAMENTAL PARTICLE PHYSICS

AT the summer provincial meeting of the Physical Society, which took place in the Department of Natural Philosophy, University of Glasgow, during July 10–11, four main sessions were held and five main topics were considered from both the experimental and theoretical points of view. The president of the Society, Prof. R. Whiddington, was in the chair. The opening session dealt with the excited states of light nuclei, and in the afternoon the subject of π^0-mesons was discussed. On the morning of July 11 the chief topics were β-radioactivity and photo-disintegration, and in the afternoon a theoretical session on the *S*-matrix series was held. Discussion followed each session. The general opinion of all those participating was that the conference had proved very profitable indeed, and it had been a fitting occasion on which to use, for the first time, the new lecture theatre in the extension to the Department.

Excited States of Light Nuclei

Prof. P. I. Dee (Glasgow), in reviewing existing knowledge of excited states of nuclei, indicated the need for some principle correlating nuclear data. He illustrated in an original manner the severely limited field covered by most of the known methods for determining nuclear levels, which methods include neutron absorption, proton capture, β- and γ-activity, scattering, and the different particle reactions such as (*d*, *p*), (*d*, *n*), (*d*, α), (*p*, α) and (α, *p*). Detailed discussion of the measurement of γ-ray energy and the kinetic energy of particles was followed by consideration of resonance excitation. The absence of internal conversion has led to indirect methods of determining quantum energy; but accuracy is reduced (~ 0·1 MeV.). However, the situation is improving with the introduction of scintillation counters. For particle energies a large magnetic spectrometer is the most accurate (errors ~ 0·005–0·01 MeV.), but the low efficiency limits its application. Nuclear photo-emulsions offer a good solution, as shown by work at Bristol and Liverpool.

Regarding data on spin and parity, Prof. Dee considered that the methods are too tentative to be really satisfactory. The study of angular distributions is fruitful, and the method of internal pair creation, as used at Glasgow, seems to be of fairly wide application. It is his belief that as few as 10–20 states are known with complete certainty, and a brief review of the efforts to find regularities in the arrangement of levels leads to the conclusion that these are, at best, hopeful. A determined effort on the theoretical side, therefore, seems overdue.

Dr. J. G. Rutherglen (Glasgow) discussed mainly the resonances for the processes ^{27}Al (*p*, α) ^{24}Mg and ^{27}Al (*p*, γ) ^{28}Si, showing that three out of six observed are common, involving competition. In considering internal pair creation, as applied by Dr. E. R. Rae and himself to the study of γ-ray states, Dr. Rutherglen said that the low values of *I*, the internal pair coefficient (~ 10^{-3}), necessitate considerable care in estimating the number of positrons emitted. The estimation can be made with the magnetic spectrograph or by measuring the annihilation quanta produced on stopping the positrons. Tests with sodium-24 are in agreement with other methods, which show the transitions are electric quadrupol A new method of estimating the absolute number γ-rays by measuring the area under the spectrum Compton secondaries has been found useful when n β-rays are emitted, and the method has operate successfully for capture of γ-radiation (protons c fluorine).

The next speaker, Prof. H. W. B. Skinner (Live pool), discussed stripping reactions using 8-MeV deuterons, and showed how this has become a ver powerful method, of wide applicability, for findin the spins and parities of nuclear states. Early wo with photo-plates yielded valuable data but involve considerable labour in the analysis. More recentl differential ion chambers and proportional counte have operated successfully with (*d*, *p*) reactions, an moreover permit examination down to any sma angle relative to the beam. Both (*d*, *p*) and (*d*, reactions have been assumed to proceed by way of compound nucleus, but results, particularly at sma angles, contradict the early theory and suggest stripping mechanism. Comparison of angular di tributions with the theoretical predictions (based o theoretical studies at Birmingham and Liverpool show that spins and parities of states can be reliabl deduced. Prof. Skinner illustrated the technique wit many interesting examples, directing particula attention to the finding of a mixed state; the fir excited state denoted ^{27}Al, p_1, which was mainly *D* an partly *S* (*S*/*D* ~ 10 per cent). A kind of anti-strippin in which the bombarded nucleus 'seizes' a neutron for example, ^{9}Be (*d*, *t*), and the capture and loss o neutrons as suggested by examination of mag nesium-24, were discussed.

For (*d*, *n*) reactions, negative *Q* reactions are pre ferred rather than high positive *Q*, as for (*d*, *p*) Observations with nuclear emulsions show that i some cases neither theory fits. Finally, Prof. Skinne showed that the excited states of some mirror nucle (carbon- and nitrogen-13, oxygen- and fluorine-17 nitrogen- and oxygen-15, and sulphur- and chlorine 33) are well known, and he suggested that corre spondence between spins and parities is perhaps mor significant than that for energies.

Dr. C. A. Ramm spoke of his work at Birmingham in collaboration with E. R. Collins and C. B. Mac kenzie, in which precision measurements of the energ of particles produced with a Cockcroft-type magne have yielded accurate *Q* values for reactions. H discussed the sources of error in such experiment particularly for the reaction ^{7}Li (*p*, α) ^{4}He. Study o target deterioration has shown that some nove problems arise.

Prof. L. Rosenfeld (Manchester) brought th session to a close with an account of the theory o nuclear models and excited states. He began b stressing that, in attempting to explain the propertie of nuclear states, we are still very far from the idea set by the theory of atoms. In this the predominan influence of the Coulomb field introduces an elemen of simplicity entirely lacking in the nuclear case Moreover, our knowledge of the interactions betwee nucleons lacks the definiteness of the law of electric interaction. We cannot hope to deduce the propertie of nuclei from the mere knowledge of the number o constituent nucleons, and we must take over fron eriment as basic assumptions the existence of sed shells as indicated by the magic numbers. is is the clue leading to the Jensen–Mayer shell del in which the additional assumption is made of trong spin- orbit coupling with a sign such as to e rise to inverted doublets for the individual cleon states. One may expect that some at least the states of low excitation will correspond to the citation of a single nucleon in an incomplete shell. e properties of such excited states are immediately dicted by the model. In experiments involving onances, this type of excited state can be recog- ed by its having a larger width than those due to re complex modes of excitation.

Prof. Rosenfeld pointed out that direct experi- ntal evidence supporting the assumption of large n-orbit coupling is obtained in the scattering of cleons by helium. Here the spin–orbit separation served is ~ 5 MeV.

To improve the shell model it is necessary to estigate the result of the interactions of nucleons ich are neglected in the first approximation. This blem has recently made great progress in two ections: the discussion of the mutual interactions incomplete shells; and the interactions of these cleons with the core formed by the closed shells. e first problem has been treated on the assumption mainly central interaction between any two cleons. The stationary states have been classified methods of group theory, perfected by Racah, th for Russell–Saunders coupling (Jahn *et al.*) and *jj*-coupling (Flowers, Flowers and Edmonds). nerally, the conclusions are found to be very sitive to the assumptions made concerning the pe of the nuclear potential. The results of cal- ations by Talmi using a meson potential are com- tely different, as regards the order of succession the excited states, from those obtained using a ussian potential.

The problem of interaction between the incomplete lls and the nuclear core has been most fruitfully acked by Aage Bohr and Mottelson. The idea is t the interaction deforms the nucleus and excites llations on its surface. There appears to be a ong coupling between the angular momentum of incomplete shell and that of the deformed cleus. The predictions regarding the resultant gular momenta are then obtained by methods nparable to those used in molecular spectroscopy. both cases, comparison with experiment reveals ne discrepancies and shows the need for the next p, which should be to determine the combined ect of the two types of interaction described ve.

In the discussion following the first session, Prof. Peierls (Birmingham) made a number of important nts, and he deprecated the tendency to divide rply between theory and experiment. He thought t at present the most important step is to ask the ht question.

The π^0-Meson

n opening the afternoon session on meson prob- s, Prof. J. C. Gunn (Glasgow) surveyed π-meson ory in relation to experiment, and described the ral considerations from which the pseudoscalar racter of the π-meson can be deduced. In par- lar, detailed balancing applied to the reactions $+ p \rightleftarrows \pi^+ + d$ shows that π-mesons have zero spin, le the observed process $\pi^- + d \rightarrow 2n$ shows that y have odd parity, provided, as is plausible, capture of the meson takes place from a K-orbit. More detailed methods of approach were then considered by Prof. Gunn for some basic meson problems. Combined phenomenological and weak-coupling calculations indicate that mesons should be produced isotropically in the reaction $p + p \rightarrow \pi^+ + d$ (corresponding to capture of S-wave mesons in deuterium). In fact, a $\cos^2 \theta$ distribution is found. It is difficult to explain this disagreement except by the breakdown of the weak-coupling approximation. The reaction $n + p \rightarrow \pi^0 + d$ is to be noted as a powerful test of the 'charge independence' hypothesis for meson coupling.

The weak-coupling treatment of quantum production of mesons, and of meson nucleon scattering, again shows little agreement with experiment. It has indeed proved most profitable to apply the methods of partial wave analysis to data on meson–proton scattering. This confirms the idea that these particles interact so strongly that they can no longer be regarded as simple structures. The two theoretical approaches which are clear at the present time are the *ad hoc* assumption of isobaric states to fit the experimental evidence or the use of the intermediate-coupling method.

Dr. R. G. Moorhouse (Glasgow) described his investigations using the intermediate-coupling method. The nucleon is represented as a superposition of states containing the bare particle, together with arbitrary numbers of mesons and nucleon pairs in given configurations. The variables are the amplitudes with which these states occur. Two cases have been considered: when the surrounding cloud contains only mesons; and when it includes nuclear pairs and no mesons other than those introduced in the pair creation. The first case gives wrong magnetic moments for the neutron and proton; but the second is more promising as the magnetic moments differ in absolute magnitude by a nuclear magneton.

Describing recent experiments on the decay of π^0-mesons, B. M. Anand (Bristol) said that examination of a large number of jets has shown that the life-time T is less than 5×10^{-14} sec. King at Bristol has observed electron pairs arising apparently in the second of the two decay processes: (*a*) $\pi^0 \rightarrow \gamma + \gamma$, and (*b*) $\pi^0 \rightarrow \gamma + e^+ + e^-$. Process (*b*) seems to be the more promising, for the evaluation of T and a method of time dilation applied to the photo-plates have given $T \simeq 1 \times 10^{-14}$ sec. A study of some fifteen hundred stars of low energy gives the ratio 80 for the probabilities of (*a*) to (*b*). The energy distribution of direct to related pairs is $\overline{E}_a/\overline{E}_b = 0{\cdot}86 \pm 0{\cdot}26$, which apparently confirms the theoretical value 1·0, so that the energy is shared equally between the two electrons and the γ-ray. Finally, Mr. Anand spoke of single electrons appearing to come from stars and the origin of which in some cases seems to raise interesting queries.

Dr. R. H. Dalitz (Bristol) discussed his theory of decay of π^0-mesons. In addition to (*a*) and (*b*) above, he considered: (*c*) $\pi^0 \rightarrow e^+ + e^-$, and (*d*) $\pi^0 \rightarrow 3\gamma$, noting that (*d*) is forbidden by charge conjugation. His theory gives for the ratio of probabilities $(a)/(b) = 80$, confirmed by experiment. He stressed the connexion with internal pair conversion, which has a low probability ($\sim 10^{-4}$) at energies $\sim$ 1 MeV., as against 1/80 at the energies here involved.

The meetings for the first day of the conference closed with a discussion of the possible advantages of holding more conferences on nuclear physics. There seemed to be general agreement on the desirability of extra meetings, confined to specialized topics in the field.

Beta Radioactivity

Dr. S. C. Curran reviewed the theory of β-decay and passed to discussion of the results of the Glasgow group with proportional and scintillation spectrometers. He listed the possibilities of disagreement with straightforward theory, which might show in the low-energy region of β-spectra. Here the proportional tube containing gaseous sources, particularly when supported with the scintillation spectrometer, is nearly ideal. Among the possibilities is readjustment of the atom consequent on the change of atomic number in the emission process. Assuming the adjustment energy goes entirely to the electron, a displacement of the spectrum along the energy axis follows, giving a 'hole' at the low-energy end. Tritium shows such a 'hole', but it is too extensive to be explained as readjustment. Work on radium-*D*, mercury-203 and nickel-63 does not support the view that the electron receives the whole energy.

The central problem of determining the mode of interaction (or combination of modes) has been attacked by investigating highly forbidden transitions. Study of rubidium-87 (half-life, 6×10^{10} yr.) shows that both C_{3T} and C_{3V} correction factors give excellent straight lines. This work with the proportional tube has been confirmed closely by G. M. Lewis using crystals of rubidium iodide (thallium) as their own spectrometers. Recent results for rhenium-187 give the transition energy as about 400 keV. and suggest the transition is probably at least third forbidden. This implies that stable osmium-187 has a spin of 11/2 or 13/2, an unusually high value possible, however, on the shell model. Dr. Curran stressed the possible close association of this model with the natural radioactive sources. For potassium-40, rubidium-87, lanthanum-138, lutecium-176 and rhenium-187, or the daughter elements, there seems to be a connexion with the important shell numbers 20, 50, 80, 106 and 112 respectively.

The curved crystal spectrometer used recently to examine the γ-rays of radium-*D* was described by Dr. G. T. Ewan (Edinburgh). A very sharp line at 46·52 keV. was observed, corresponding to the known excited state of radium-*E*. No line corresponding to a state at about 43 keV. was observed. In view of the absence of other apparently established γ-transitions, upper estimates to their possible intensities were given. The new results show that the mode of decay in some 20 per cent of the disintegrations of radium-*D* is still uncertain.

Dr. D. L. Pursey (King's College, London) spoke on his recent work on the theory of β-decay. This is concerned with the experimental determination of interaction in the theory of decay. The spectrum shapes of allowed and first forbidden transitions and the *ft* values of super-allowed transitions lead to the conclusion that the interaction contains either both the scalar and tensor or both the polar and axial vector invariants, the two interaction constants being roughly equal.

The decay of ^{228}MsTh$_2$ was reported by Dr. C. G. Campbell (Edinburgh). A double β-spectrometer was used and the partial spectra separated; six such have been found with end-points and intensities as follows:

Energy limit	2·18	1·85	1·72	1·15	0·66	0·46
Intensity (per cent)	10	9	7	53	8	13

Photodisintegration

J. R. Atkinson (Glasgow) reviewed the field photodisintegration in stimulating fashion. divided the reactions into three categories—(i) γ, γ, *n*; (ii) γ, *p*, *n*; γ, *d*; γ, α; (iii) γ, stars—and discussed for each the excitation curve, angu distribution, experimental methods and theoreti treatment. For (i) and (ii) the curves are ab 5 MeV. wide for a large range of values of ator number, but for (iii) there is resonance at discr γ-ray energies. There appear to be anomalies in form of the excitation curve and the angular d tribution for the processes (γ, *pn*) and (γ, *d*). T stars appeared to be anisotropic. The theoreti models (Levinger/Bethe, Weisskopf, Goldhab Teller) leave much to be desired. The discuss of the work of the Glasgow team (with expansi chambers) centred on helium as target, and t criterion of selection was the close agreement of t quantum energy E_γ of the incident radiation determined by two methods. Current work with t smaller Glasgow synchrotron on the disintegrati of nitrogen promises to be fruitful.

F. K. Goward described the very interesting wc which he and J. J. Wilkins are prosecuting at t Atomic Energy Research Establishment, Harwell, which the photo-emulsion technique has be exploited fully in the study of stars; more recent the gridded ion chamber has helped to improve t energy resolution of levels. The technique w admirably illustrated with slides of a variety star-processes. For the reactions:

$$^{12}\text{C} + \gamma \rightarrow 3\alpha - 7{\cdot}3 \text{ MeV.}$$

$$^{16}\text{O} + \gamma \rightarrow 4\alpha - 14{\cdot}4 \text{ MeV.}$$

about 2,000 and 600 stars, respectively, have be measured. The quantum energy was deduced adding the binding energy to the measured tot energy release. The cross-section curve for (1) sho a doubly peaked curve, suggesting competition wi (γ, *n*) and (γ, *p*) reactions and implying the formati of a compound nucleus. A series of narrowly spac resonances (~ 1 MeV. apart) is probably superpos on a continuum, giving levels of carbon-12. Likewis it seems that the levels of oxygen-16 are excited, a levels of intermediate nuclei—for example, ber lium-8—could be observed.

A paper on photodisintegration, by Mr. J. M. Re (Glasgow), dealing with the application of countr techniques, was given at a special sectional meeti in the afternoon.

The S-Matrix

J. Hamilton (Cambridge) discussed the work C. A. Hurst on the convergence of the renormaliz *S*-matrix perturbation theory expansion (after Dyso regarded as a power series in the coupling consta The theory treated was a scalar meson field coup scalarly to itself—the so-called 'φ^3' theory.

Estimation of the number of irreducible graphs order *n* contributing to a chosen physical proce gives $(n/k)!$ for large *n*, where *k* is a small integ probably 2. The sign and magnitude of the co tributions from these graphs are not easy to find, a Hurst limited his discussion to processes which not relate to real particles, thus avoiding difficulti possibly arising from the creation of new particle It is thought that the restriction can be thrown o by analytical continuation in the energy plane. For rticular process the series of contributions from the educible graphs diverges in an oscillatory manner th great rapidity. When the coupling constant is iall, say 1/137, successive terms decrease rapidly at st, but ultimately the enormous number of graphs comes the predominant factor. In pseudoscalar meson theory the coupling constant may be in the nge 4–40, and at no stage does the series even pear to converge.

During the discussion, Prof. Peierls pointed out at a weakness of the work is the lack of any timate of the finite contributions from the self-ergy and vertex parts occurring in the graphs.

The work of B. F. X. Touschek and of Dr. W. K. irton on field equations and commutation rules is then described by the latter. Dr. Burton re-rred to a recent paper by J. Schwinger[1] which ves an account of a comprehensive scheme for e quantum mechanics of localizable fields based an operator Lagrangian. The theory makes no peal to the correspondence principle or an under-ing classical theory, and all the results are derived om a single fundamental principle analogous to amilton's principle in classical theory. This theory s been shown by Burton[2] to lead to a particularly nple derivation of the S-matrix series in terms of e interaction Lagrangian. Schwinger describes how e commutation relations are to be obtained from e fundamental postulate; and, by studying camples from particle mechanics, Burton and uschek found that the Schwinger method gives a ique prescription for the determination of the mmutation rules for systems free from anholonomic nstraints. If such constraints are present, the ethod may—in special cases—no longer apply as it ands. Equations of the Dirac type belong to this tegory, since the number of degrees of freedom is st half the number of co-ordinates appearing in e Lagrangian.

The final lecture, by Dr. J. S. R. Chisholm lasgow), dealt with the calculation of higher order matrix elements. Dr. Chisholm demonstrated plicitly automatic procedures for carrying out the lculations according to a prearranged programme. evious efforts in this field appear as special cases the general method which he detailed. Dr. iisholm brought out clearly the principles described length in his published work[3]. S. C. CURRAN

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[1] hys. Rev., 82, 914 (1951).
[2] hys. Rev., 84, 158 (1951).
[3] roc. Camb. Phil. Soc., 48, 2, 300 (1951), and Proc Roy Soc. (in the press).

ROGRESS OF CANCER RESEARCH

THE reviewer of a production like the Annual Report of the British Empire Cancer Campaign*, hich covers a wide field of research, will naturally nd to limit his choice of investigations for descrip-on to those with which he feels at home, or which em to him to be especially interesting, original or omising. The subjective element in selection is avoidable and, in fact, will become more pro-unced as cancer research extends, since the range studies as a whole is beyond the scope of any one viewer.

Carr, in experiments on the virus of Rous sarcoma, is found that it is recoverable from the leg of a chick when the muscle is extracted a few hours after injection; after 6 hr. it can no longer be detected in any quantity, but at 66 hr. it can again be separated in amount greater than was injected. It is believed that the infective virus disintegrates into smaller components inside the cell, that these multiply and recombine to give the infective virus. "All these considerations lead to the suggestion that infective virus is present in the cell for only a very short proportion of the mitotic cycle. It therefore seems probable that the malignant condition is caused by some earlier stage of the virus multiplication cycle, and this leads to the possibility that a tumour may sometimes result from a non-infective virus."

Investigations at the Chester Beatty Institute on chromosome abnormalities induced in *Drosophila* by chemical mutagens (nitrogen mustards, diepoxides, ethyleneimines, dimesyloxyalkanes) have shown that these changes are observed as partial deficiencies. This fact has been used in support of a theory of malignancy, the outline of which can be sketched in as follows: (1) Many carcinogens are also potent inducers of mutations in *Drosophila*. (2) There must therefore be some fundamental relation between carcinogenesis and mutation (hence the somatic mutation theory of cancer). (3) Mutagens acting on *Drosophila* induce chromosomal abnormalities, namely, deficiencies and minute deletions. (4) It is possible, therefore, that cancerous transformation also is an expression of a chromosomal deficiency, that is, an interference with the reproduction of the gene pattern. (5) Hence the cancer cell is a normal cell which has irretrievably lost something—clearly it has lost its growth-controlling mechanism. (6) The specific hormones control the growth of their target organs and xanthopterin brings about renal hypertrophy; therefore an obvious aim of cancer research must be to find a chemical compound or an enzyme which can replace the lost growth-controlling material of the malignant cell.

There exist some different types of chromosomal aberrations which are not permanent features of tumour tissue. In an account of the work of Koller and associates, it is stated: "From continued study of cytological abnormalities frequently observed in the cells of tumours induced by the aromatic nitrogen mustards it is clear that these are of 2 classes, those which gradually disappear in the course of serial transplantation, and those which continue to be transmitted to the descendant transplant generations, apparently indefinitely. Even these permanent abnormalities are, however, still regarded only as associated changes, and not in themselves the cause of the malignant alteration, which can clearly occur in their absence. They are nevertheless of great interest as suggesting a likely site of action of these carcinogens, and it is probable that the malignant transformation itself involves a much less tangible or even 'invisible' effect on the chromosome or gene".

Ludford, who has been studying variations in size and structure of the malignant cells of transplantable tumours in inbred strains of mice, says: "On the basis of these observations it seems justifiable to conclude that cellular polymorphism correlated with variations in chromosome numbers and aberrations of the process of mitosis are not specific features of malignancy but occur, although to a lesser extent, in normal tissues. This suggests the probability that after cells have become differentiated the full chromosome complement is no longer essential for their continued life and functional activity".

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* British Empire Cancer Campaign 29th Report (1951) Edited by Heneage Ogilvie (11 Grosvenor Crescent, London, S.W.1)

Cancer of the bladder in dye and rubber workers, and skin cancer due to mineral oils in the engineering industry, have been the subject of investigation by Case and by Woodhouse and Hieger. Case, in a statistical examination of bladder cancer, finds that the great increase of this disease between 1901 and 1950 cannot be entirely attributed to an ageing population, nor to improvements in diagnostic method. The occupational study of the rubber industry shows that a hazard is located in the mixing, extruding and vulcanizing sections of the industry, and that the risk was introduced between 1915 and 1930. This date would be compatible with the time when carbon black, some organic accelerators and anti-oxidants first began to be used on a large scale.

The biological testing of fractions of petroleum oils from different sources has as its objects the identification of the active agent in the oils and the development of a technique for assessing the industrial risk attached to the use of any one particular oil. Fractions of petroleum from oil-fields in the Middle East, Venezuela and the United States were prepared by distillation under conditions in which cracking was avoided in order to preserve the composition of the oil as nearly as possible in its original state. These fractions when tested by an elaborately designed series of experiments on mouse and rabbit skin showed pronounced differences of activity; they were much more carcinogenic for rabbit skin than for mouse skin—a further example of the unpredictable differences of susceptibility of different tissues and species to carcinogens.

Doll has conducted an inquiry into factors which may affect liability to cancer of the cervix uteri. It has been shown by a large volume of data that Jewish women have a lower incidence than Gentile women and that child-bearing is conducive to this form of cancer. Gagnon has now produced some unique evidence on this question. In the medical records of a population of nuns (annual average 3,280) in Quebec for the past twenty years, no case of cancer of the cervix was found. Inquiry is being made as to whether a similar investigation could be made in any other country (for example, Bavaria).

Sir Ernest Kennaway and collaborators have carried out an intensive examination of lung cancer, particularly from statistical material and by a study of carcinogens in the atmosphere and in tobacco smoke. Although it is now highly probable that cigarette smoking is an important factor in the very rapid increase in lung cancer in the past few decades, many other problems of lung cancer remain at present unexplained. For example, cancer of the larynx has shown no equivalent increase during this time. In Norway and in Mexico, cancer of the lung is about as frequent in men as in women; in England it is much more common in men; deaths attributed to cancer of the lung in both sexes and to cancer of the larynx in males are higher in the more urban districts, while in women the relation is reversed. The role of the geographical factor in differences of incidence of cancer presents some attractive problems. "The peculiar position of Wales in relation to cancer was first observed by Stocks (1930), who discovered the high incidence of cancer of the stomach in the north-western counties of Wales."

Gwyn and Salaman, in experiments on co-carcinogenesis, have found that if the skin of a mouse is given a single painting with 9 : 10-dimethyl-1 : 2-benzanthracene, followed after an interval of six weeks by treatment with co-carcinogen (croton oil in paraffin oil), the rate of appearance and yield tumours suggests: (1) that there is a critical size f tumours produced by this method which is rath less than that of the smallest visible; tumou smaller than this do not continue to grow—in fa regress—if co-carcinogenic treatment is stoppe (2) the change produced by croton oil in mouse sk previously painted with a carcinogen is a gradu one; it is reversible during the greater part of i course, but becomes irreversible and independent progressive not long before the appearance of visible tumour.

At Leeds, Dmochowski and co-workers have co tinued their researches on the Bittner milk fact Electron microscope photographs show that in hum milk, and in extracts of human breast tumou especially from pregnant women, there exist particl of a size approximately the same as the Bittn agent. The virus is not antigenic in mice, and t antibodies elicited in mice react with extracts mouse tumours whether or not they contain t agent as well as with different normal mouse tissue No evidence could be found of a common antigen human and mouse tumour extracts. Electrophoret estimations show that the infective dose of the mi agent is extraordinarily low, namely, 3 × 10^{-7} μgr of nitrogen.

Dmochowski finds that after eighty-six successi transplantations of the mammary tumour, the mi factor can no longer be detected, although there is histological difference between the tumour at eighty-sixth and forty-second passage. Apparent the presence of the milk factor is not a permane feature of this transplantable tumour, and the ce can continue to multiply even when the agent cann be detected by the technique employed. A simil disappearance of the virus from the transplantab Shope rabbit carcinoma has been described b workers in the United States. Dmochowski refe also to experiments demonstrating the appearance the milk factor *de novo*, as reported in studies b Bittner.

Bonser and Jull have used a new method of testi carcinogens on the bladder by introducing the com pound as a suspension in a paraffin wax pellet direct into the dome of the bladder of the mouse. Epitheli changes starting with hyperplasia and squamo metaplasia, and going on to benign and maligna hyperplasia, resulted from the introduction into t bladder of 20-methylcholanthrene, 2-amino-naphtho and 3 : 4 : 5 : 6-dibenzcarbazole. Claysen reports th a relationship exists between species susceptibility the carcinogenic action of 2-naphthylamine and t proportion of this compound which is excreted 2-aminol-1 naphthol conjugates. Moreover, sin 2-amino-1-naphthol is also carcinogenic when inject subcutaneously, the suggestion is put forward that carcinogenesis by 2-naphthylamine the amine h first to be converted to the naphthol.

At the Sheffield centre, strenuous efforts have be made to induce stomach cancer in rabbits, rats an mice by injecting rapidly-acting carcinogens in stomach fistulæ, by feeding hot food at 55° C., b administration of 2-acetyl-aminofluorene or methy cholanthrene with croton oil by mouth, by exhausti of the mucosal secretion with dodecyl sulphate (with 50 per cent ethanol followed by 9 : 10-dimethy 1 : 2-benzanthracene in the drinking water. Th results were negative. "All the available evidenc still suggests that the stomach is refractory t chemical carcinogenesis because of its powerful mucou rner. Perhaps the main value of all this work is at it suggests that the inducing agent in stomach ncer is not an extrinsic chemical carcinogen."

Pybus and Miller, at Newcastle, have carried out periments somewhat on the lines of Strong's ethod, namely, the injection of mice with methyl-olanthrene for a number of generations to see if bsequent generations will contain mutations served as spontaneous neoplasms without the cessity of applying carcinogens.

Lasnitzki at Cambridge has confirmed Craigie's port that mouse sarcoma 37 consists of at least two pes of cells, the more active variety (round cells fractile in phase contrast) being convertible *in vivo* nd *in vitro* into the more differentiated spindle cells.

Peacock has reported that hybrid mice from *CBA* rain (virus-free) mothers and C_3H (virus-bearing) thers can acquire the virus if the father remains in e breeding box during pregnancy and the puer-rium. If the *CBA* mother is transferred to a sterile reeding box early in pregnancy and remains gregated until the litter is weaned, the female ybrids show no greater incidence of mammary ncer than pure line *CBA* females.

Peacock has been more successful than the Sheffield orkers in inducing stomach tumours in mice ; he sed feeding with carcinogens and with cottonseed l heated to 350° for some hours. In an experiment which the oil was fed for 300 days in a series of ice of which 230 lived more than 400 days, fifteen ses of papilloma and six of squamous carcinoma or denocanthoma of the forestomach and adjacent landular stomach and three cases of adenosis of the ylorus were found. "Thus it seems probable that e 21 cases of tumour of the forestomach among 30 mice fed with heated cottonseed oil were directly lated to this treatment. Though a 10 per cent yield small compared with many experimental results, it at least as high as the incidence of cancer of the omach in the human subject." However, the omach tumours evoked in the mouse are rather ifferent from human gastric cancer, and Peacock ggests that this difference is due to the occurrence f gastritis, pernicious anæmia and achlorhydria, hich is common in man but rare in animals.

The fundamental problems of dosimetry are still ceiving a large amount of attention in practically ery centre concerned with treatment by any form radiation. Methods of measurement vary from the roportion of survivals of the broad bean root to the duction of ceric sulphate. The use of photographic uclear research emulsion for fast-neutron dosimetry also being compared with the more usual method f using an ionization chamber with walls of a gelatin ixture. Depth-dose measurements vary from those ade on a 30-MeV. beam in a water phantom, to eta-rays using a stack of films as phantom. The rotection of workers in these fields is also being ontinually studied. In a number of departments a lm badge service is provided, and one report dis-usses the method of determining the energy of attered rays by means of secondary electronic mission from metal foils. Reports from two centres sing a 30-MeV. synchrotron indicate that while eatment is tedious owing to the low output of 10 r./min. at 1 metre, yet useful information is eing gleaned about the distribution of the dose in ssue. The few patients who have been treated have own encouraging results.

Numerous reports indicate the ever-increasing use radioactive isotopes as a tool for research as well as for diagnosis and therapy. Considerable strides have been made in the design and operation of scintillation counters, and reports from a number of centres indicate that the increased sensitivity of this means of detecting radiation should lend itself to a much more efficient study of radioactive material in the body. A 4π scintillation counter for the absolute standardization of radioactive isotopes is also reported. The importance of absolute standardization, particularly of radioactive isotopes in frequent use, has been realized, and work is going on in several centres to attempt to reach agreement on this point. There is an increasing demand for discrete sources of radiations, and work is reported on surface applicators, using the gamma radiations from gold-198, which is spread over a 'Perspex' or polythene mould in the form of gold foil of varying thickness, and the entire unit then irradiated at the Atomic Energy Research Establishment. Cobalt-60 is now used as a central source in the intracavitary treatment of carcinoma of the bladder and also in the treatment of carcinoma of the cervix. Superficial beta-ray applicators using phosphorus-32 (as red phosphorus) incorporated into plastics are also giving encouraging early results. The installation of two cobalt-60 beam-therapy units using up to 1,400 Curies of cobalt-60 is reported from Canada (see also *Nature*, 168, 1035 ; 1951).

The clinical and pathological reports consist chiefly of the continuation of orthodox analyses of malignancy at various sites with correlations including stage, histology and response to treatment. The findings confirm the value of histological grading in assessing prognosis. Similar investigations are being carried out independently at a number of centres in Great Britain, but there is little evidence of any co-operative planning. The most detailed survey reported is on seventy-four cases of nephroblastoma from the Hospital for Sick Children.

At the Chester Beatty Institute it is found that 1 : 4-dimethanesulphonoxybutane given in long courses of small doses has proved capable of producing remissions of therapeutic value in myeloid leukæmia. At both the Westminster and the Christie Hospitals it has been found that the nitrogen mustards are useful in the treatment of advanced Hodgkin's disease.

Glucksmann and his colleagues are studying the mechanism of lymph-node involvement and the reaction of the node to the presence of tumour in cancer of the cervix. They have also accumulated impressive results on the value of the cytological analysis of serial biopsies in the assessment of the radiocurability of cancer.

Cuthbert Dukes has confirmed the frequent development of cancer of the large bowel in long-standing cases of ulcerative colitis. He and his colleagues have found that precautions recently adopted to prevent implantation of cancer cells during the operation of restorative resection for cancer of the rectosigmoid have indeed prevented the recurrences at the suture line which were met with formerly.

Price, at Bristol, in an analysis of thirty-six cases of osteogenic sarcoma, found the mitotic ratio (the number of resulting nuclei to one in mitosis) to be the most reliable index of malignancy. A mean mitotic ratio of 238 to 1 was obtained for the whole series, based upon an examination of at least 2,500 nuclei for each count. The tumours were divided into three grades of malignancy on the basis of the mitotic ratio. These showed good correlation with the time of survival of the patients in months from the date of the presenting symptom. The conclusions are most promising, but it would appear that the number of mitotic cells counted, especially in the 'low-grade' malignancies, must have been extremely small. His published article on this work does not give the actual number of mitotic cells counted and therefore does not dispel statistical doubts about the method as it stands.

PHYSICAL CHEMISTRY OF PROTEINS

A GENERAL discussion on "The Physical Chemistry of Proteins" was held by the Faraday Society in the Department of Zoology, University of Cambridge, during August 6–8. During the meeting, introduced by Dr. J. T. Edsall of Harvard University delivering the sixth Spiers Memorial Lecture, some twenty-five papers, a large proportion by foreign authors, were presented.

The programme was divided into five sections arranged in order of increasing complexity: (1) experimental techniques, (2) low molecular weight proteins, (3) high molecular weight systems, (4) protein interactions, (5) conjugated proteins. An audience of 350–400, containing many guests from abroad, attended.

Dr. Edsall, a Fulbright Fellow of the University of Cambridge, began by reviewing the fundamental changes in our ideas on proteins since the middle twenties, when little quantitative information was available. Subsequent years saw the development of the ultracentrifuge and other physical methods by which information on the size and shape of many proteins has been obtained. Among recent developments, Dr. Edsall mentioned particularly the work of Sanger and co-workers, which has provided very complete information on the sequence of amino-acids in insulin, and the structural suggestions of Pauling, Corey and co-workers. Illustrating the state of our knowledge of the physical chemistry of proteins, Dr. Edsall dealt in detail with two important proteins —fibrinogen and serum albumin. There was general agreement that fibrinogen is an asymmetric molecule of molecular weight c. 400,000, but many more detailed questions and the mechanism of blood clotting require further study.

Serum albumin is one of the most-studied proteins. The molecular weight was thought to be c. 69,000 until very recently, when new experimental work has indicated that a somewhat lower value may be correct. As to the shape of the molecule, the greater part of the data is in accord with an ellipsoid of rotation of low axial ratio; details remain to be settled. While the molecule is supposed to be relatively rigid in solution, it is possible that some flexibility of the surface exists; such a property would go far towards explaining the ability of the molecule to combine with a large variety of organic and inorganic materials. Dr. Edsall considered in detail the binding of zinc and mercury atoms.

In section 1, only the more recent advances in experimental techniques were considered. In a paper by A. Tiselius, zone electrophoresis in filter paper and other media was reviewed. Since separate bands are thus produced, the method has distinct advantages over boundary electrophoresis as a preparative tool. It can readily be operated on a micro scal at low concentrations and for a variety of materia of low molecular weight as well as macromolecule On the other hand, electro-osmosis and adsorptio may hamper quantitative work, and special measur are necessary if such effects are to be avoided. (Weber presented a paper on the use of measuremen of the polarization of fluorescence in investigati proteins in solution. Results on several protei preparations were quoted, among which those c bovine serum albumin, indicating reversible dissociation at low salt concentration and acid pH's, were especial interest. Variation of the protein concentration causes no apparent effect on the dissociatio Confirmation of these results was reported fro osmotic pressure and sedimentation-diffusion studie Several workers, however, were doubtful about th interpretation, attributing the apparent dissociatio to effects of the high positive charge of the molecu under the conditions of the experiments. A fin paper in this section, by J. S. Falconer, D. J. Jende and D. B. Taylor, dealt with the application of solubility measurements to the study of complex protei solutions and to the isolation of individual protein In illustration, the fractionation of rat liver wa considered.

The section on low molecular weight proteins bega with a paper by P. Doty and G. E. Myers dealing wit the thermodynamics of the association of insuli Light-scattering measurements at acid pH's an varying salt concentration were used to evaluat the constants governing the equilibria betwee monomer, dimer and trimer over the range 20°–40° C From discussion of the molecular weight of the insuli monomer, it would appear that the bulk of the kineti data now supports the value 12,000. In a paper b H. Neurath and co-workers, the kinetic behaviou of trypsin and related molecules was considere When trypsin is examined under conditions favourable to enzymatic activity, the sedimentation constant, varying with the age and pH of the protei solution, corresponds with autolysis of the protein On the other hand, when the enzyme is stable an inactive, no such anomalies are observed. Trypsinogen and the diisopropylfluorophosphate derivativ similarly show normal behaviour. A molecular weigh of 24,000 was reported for the inactive proteins G. E. Perlmann presented an electrophoreti study of enzymatically modified ovalbumin an casein. The reactions considered were: (1) th ovalbumin—plakalbumin transformation in whic carboxyl groups are liberated, and (2) the dephosphorylation of ovalbumin, plakalbumin and casein In each case, characteristic changes in electrophoreti mobilities and patterns were produced; electrophoresis is thus a useful tool in following enzyme change involving charged groups. E. Barbu and M. Jol dealt with the transformation of certain globular int fibrous proteins by moderate heating, salt effect, (high pressure. Several physical methods we utilized, and the authors suggested that end-to-en aggregation rather than unfolding of the molecule is responsible for the fibrous products obtained Denaturation was treated in the light of the result obtained. In the following discussion, several worker directed attention to denaturation reactions whic would be difficult to explain by end-to-end aggregation and for which chain unfolding is the more likel explanation.

In section 3, the first paper, by P. Johnso and W. E. F. Naismith, reported experimental result reversible association-dissociation reactions curring in the conarachin fraction of the groundnut obulins. Higher ionic strengths and pH favour the ssociated form, whereas low ionic strength and pH's ar the isoelectric point give large proportions of sociation products. Light scattering, which shows e rapid establishment of equilibrium, confirms dimentation results; but electrophoresis gives no dication of the reactions occurring. In the dis- ssion, attention was directed to the possible effects rapid equilibria on the behaviour of moving boun- ries. In a paper by S. Shulman, the effects of rtain ions and neutral molecules on the conversion fibrinogen to fibrin were considered. Many mpounds, under similar conditions, are found to lay clotting by at least twenty-four hours (inhibi- on), though this action is reversible. Others cause uch less delay in clotting (retardation). Correlation tween the structures of the different compounds d their inhibitory action was attempted. Miss M. Petri and A. J. Staverman dealt with the ectrochemical properties of lupin seed protein. he isolation and chemical analysis of the protein ere described; membranes prepared from it were vestigated with respect to their electrochemical haviour. The effect of various chemical modifica- ons has similarly been studied. Considerable dis- ssion of the nature of the reactions involved llowed.

The remaining papers in section 3 discussed uscle and its proteins. G. Hamoir described an ectrophoretic study of the muscle structural proteins -myosin, actin, actomyosin and tropomyosin— bbit and carp muscles mainly being used. Dr. amoir considers that his results demonstrate the frequent occurrence of interaction between the fferent components; but in the discussion following, appeared that other workers do not agree that ectrophoretic diagrams exclude such effects. In art 1 of a paper on energetics and molecular mechan- ms in muscle action, M. Morales and J. Botts mmarized experimental data on thermoelastic operties of myosin threads, and on light scattering d kinetic measurements on actomyosin–adenosine iphosphate systems. This was interpreted in terms a theory which assumes that the elastic particles ntract by virtue of the increased entropy resulting it extend by reason of electrostatic forces. In part by T. L. Hill, several simplified though possible odels of the basic elastic element were considered, d the detailed properties were calculated by atistical thermodynamical treatments. T.-C. Tsao d K. Bailey presented a paper on aspects of lymerization of proteins of the muscle fibril— opomyosin, myosin and actin. Tropomyosin and tin react very differently to the addition of elec- olyte. Myosin, of greater constancy in its mole- lar weight, is thought by them to contain two types sub-unit, a cyclic and an open-chain unit, each quiring special conditions for isolation. A detailed scussion of these papers followed.

Prof. L. Pauling introduced the proceedings of ction 4 with a speculative discourse on the different pes of association phenomena which are likely to llow mild modification of a protein system. For tensive association to occur, a single molecule must provided with at least two active points on its rface; head to tail aggregation would then produce helix the character of which would be determined the relative positions of the reactive points on the otein surface. Different types of packing of such helices, stabilized by appropriate forces, as well as their interpenetration in various ways, were further possibilities. This approach, though speculative (and termed 'snip and fiddle' by one speaker) may well be basic to many aggregation phenomena involving proteins. A paper by E. J. Cohn and co-workers dealt with the interaction of plasma proteins at physiological pH with metals, alkaline earths, carbohydrates, and formed elements of the blood. Much of the information presented is now being utilized in the Harvard laboratory in new fractionation procedures for the plasma proteins. I. M. Klotz and J. Ayers reviewed earlier work on the binding by serum albumin of organic anions and cations and described new work with related neutral molecules. The results indicate that the protein undergoes configurational changes with change of pH or electrical charge. Low hydroxy-amino-acid content was discussed as a cause of the binding ability of serum albumin, and, in confirmation, the binding of α- and β-casein is found to be appreciable though lower than that of serum albumin. B. S. Harrap and J. H. Schulman presented work on the influence of salt on the size and shape of a complex between sodium dodecyl sulphate and bovine serum albumin. Using viscosity and light-scattering measurements in salt solution, definite complexes of low asymmetry were indicated; in absence of salt no definite complexes occurred, though uncoiling of the molecules was indicated. E. Gorter and L. Nanninga reported a detailed study by physical and other methods of the interaction of several proteins with heparin, suramin and chondroitin sulphuric acid. The interaction occurs between the SO_3^- groups of the latter compounds with positive groups on the protein, and is therefore very dependent on pH. The action of heparin as an anticoagulant was discussed in the light of these results. M. Fleming and D. O. Jordan presented results of an electrophoretic study of calf thymus deoxypentose nucleoprotein and of tobacco mosaic virus. Under certain conditions, the nucleoprotein dissociates into two fractions, and it is postulated that one fraction is protein, leaving a conjugate richer in nucleic acid. The final paper in this section, by R. J. Goldberg and J. W. Williams, was concerned with the antigen–antibody reaction. Adapting the statistical mechanical treatment of three-dimensional polymer condensation to the combination between antigen and antibody, predictions of the position of inhibition zones and antibody–antigen ratios in precipitates have been compared with experiment.

Section 5 began with a review of conjugated proteins by Prof. M. Stacey. Concentrating on complexes of proteins with nucleic acid and carbohydrates, Prof. Stacey mentioned particularly virus and bacterial nucleoproteins, the transforming principle of pneumococcus, mucopolysaccharide blood-group factors and certain recently studied mucoproteins. F. B. Seibert dealt particularly with tuberculin proteins, prepared from unheated tuberculin filtrates as well as live bacillary bodies. A study of their amino-acid content, electrophoretic mobilities, ultraviolet absorption, nucleic acid and carbohydrate content was considered in relation to their biological potencies. E. J. Ambrose and J. A. V. Butler presented data on the swelling of nucleoprotein films in the presence of various salts. The concentration of salts required to prevent swelling is of the same order as that required to precipitate the nucleoprotein from solution. Infra-red absorption and double refraction of partially orientated films is compatible with parallel arrangement of β-polypeptide chains in the direction of stretching, the planes of the purine and pyrimidine rings lying perpendicular to this direction. Other structures are, however, possible. K. Meyer presented evidence for the existence of protein complexes of hyaluronic acid and chondroitin sulphates from hyaline cartilage and connective tissue. Reversibly formed polar complexes with the protein are suggested except in the case of chondroitin sulphate from connective tissue, which is stably linked to protein. A. G. Ogston and J. E. Stanier have isolated the hyaluronic acid complex from synovial fluid by ultrafiltration, since they believe that precipitation affects the physical properties. Such preparations contain 27 per cent protein, the removal of which caused a change in properties. Physical methods have indicated that the complex exists as a random coil of nearly spherical shape and large hydration. Its biological function was discussed.

OBITUARY

Sir Richard Gregory, Bart., F.R.S.

"My particular mission has been to make men of science conscious of their power and influence in shaping civilized life." So wrote Sir Richard Gregory in his message of farewell published in *Nature* of January 7, 1939, when he resigned from the editorial chair which he had occupied with such distinction for so many years. Throughout his long life, which came to a close on September 15, his interest in science for its own sake, and equally for the appreciation by others of its value and significance for humanity, was a driving force which brooked no obstacle, and happily that interest was sustained to the end.

Richard Arman Gregory was born in Bristol on January 29, 1864. His first post was as laboratory assistant at Clifton College. From there he passed on to the Royal College of Science, London, where he met several of the men who were to exert such an influence on him, as he on them, in later years—H. G. Wells, T. H. (later Sir Thomas) Holland, and especially Sir Norman Lockyer. He became research assistant to Sir Norman, and from that period arose a lasting love for astronomy and astrophysics. At this time he began to contribute occasional notes to *Nature*, of which Sir Norman had been editor since its foundation in 1869, and in 1893 he was appointed sub-editor of the journal. This marked a turning point in his career. Until then, his first interest had been astronomy, with the general feeling for science as a whole and its applications to human welfare. From then on, this second interest grew in intensity, and as the years went by and Lockyer left *Nature* more in the hands of his young colleague, it became his guiding influence. In articles, in lectures and addresses, he was never tired of developing and enlarging this theme.

While Lockyer had established the general lines on which *Nature* was conducted, and built up its reputation, Gregory did not hesitate to introduce innovations. Thus to make the journal a living force in the nation and the whole world of science, he felt it was necessary to publish more than occasional leading articles ; and in due course—but not without a certain amount of opposition—he got his way, a the leading article expressing a point of view matters scientific or their significance became regular feature of the journal. For some fifteen sixteen years of this period, he virtually conduct the journal himself, carrying out administrat duties as well as the normal tasks of sub-edit During his annual holidays, he remained in touch post. In 1919, Lockyer retired, and Gregory to over the full responsibility which he had already be exercising for some years. His work continued, f he was a true working editor, marking manuscrip for the printer and seeing the journal through t press week by week with all the attention to dete such work demands.

There was never an editorial committee ; neith was there even a special panel of reviewers. The ent scientific world, both at home and abroad, has alwa been *Nature's* willing advisers and critics. Thu through this valuable freedom from committee contr and especially through the integrity and fearlessne of its editor, was Sir Richard able to contribute ve largely towards making the journal what it is— journal of science, published for men of scienc written by men of science. He accepted the sayin that 'a good editor wears out the soles of his sho before the seat of his pants' ; and was always read to consider fresh views even if they conflicted wit those accepted.

In spite of the heavy load of work which h assumed in this way, this did not by any mean exhaust Gregory's seemingly unlimited store c energy. A short period of teaching in the Dockyar School at Portsmouth earlier on, coupled with hi own personal experiences, persuaded him that ther was a dearth of good school science text-book Starting with astronomy and what used to be terme 'physiography', he began writing text-books whic quickly made their mark for their accuracy an practical approach, and their appreciation of students difficulties. Alone and in association with others notably the late H. E. Hadley and A. T. Simmons he wrote and edited a number of such books, man of which are still in use both in Great Britain an overseas after passing through several editions. B his sustained interest in scientific developments h was able to keep these books in line with scientifi progress, even within the past two years.

This interest in education also showed itself in hi activities in the British Association. He was one o the leaders in the formation of Section L (Education of the Association, and for its first ten years serve as one of its secretaries or its recorder. In 1922 h was president of the Section. In 1899 he helped t found the *School World*, which was later incorporate in the *Journal of Education*, and he was joint edito until 1938.

Almost as a by-product of his work for *Natur* was his book "Discovery : or the Spirit and Service o Science" published in 1916, in which he outlined i his characteristically clear and simple style som leading scientific discoveries, using them to illuminat his perennial theme, the worth of science.

From an early date, Gregory had been in consider able demand as a lecturer. On the platform h divided his attention between astronomy and th social implications of science ; and as the years went by he identified himself more and more with the latter topic. Here may be mentioned his work for the British Science Guild. This body, formed to promote the appreciation and application of scientific ethods in public affairs (and incorporated in 1936 to the British Association), owed much to his tiring activities. At the close of the First World ar, the Guild promoted a very successful British ientific Products Exhibition, as a result of which egory was awarded the honour of knighthood.

A list of scientific societies which honoured him electing him president ranges from the Science asters' Association (1927), through the Royal eteorological Society (1928 and 1929), to the Conrence of Educational Associations (1931). Finally, st before the ill-fated Dundee meeting of the itish Association was abandoned in 1939, he was ected president for the ensuing year and held office roughout the Second World War. During this fficult period he was ever mindful of the Associaon's affairs and even succeeded in organizing limited eetings at Reading, Manchester and London. Each dy with which he became associated from time to ne had his enthusiastic attention and support, and ofited from his wide knowledge of men and affairs.

In 1931 he was created a baronet. Honorary grees were conferred on him by the Universities of eds, Bristol and St. Andrews; but the scientific nour which he probably prized most was his ection as a Fellow of the Royal Society under the le which empowers the Council to recommend ection "for conspicuous service to the cause of ience". This was in 1933, when he was recovering om a long illness which had kept him—albeit very willingly—from the editorial chair for two to three onths. This indeed was the first time since his pointment to *Nature* that he had been compelled lay aside his duties and self-imposed tasks for so ng a period. Yet even during that time he arranged see one or the other of his assistant editors to scuss the journal.

It is probably no exaggeration to say that, by rrespondence and personal contact, Sir Richard d a wider acquaintance with scientific men throught the world than any other individual during the st two or three decades of this century. These iendships, many of which were warmly confirmed hen visitors from overseas came to Great Britain, ere strengthened and extended by three visits, to uth Africa (with the British Association), to India d to the United States, where he delivered the lihu Root Lecture in the Carnegie Institution of ashington in 1938.

Since Sir Richard was within two or three weeks his seventy-fifth birthday when he retired from e editorship of *Nature* and took up permanent sidence in the charming old Manor House at iddleton-on-Sea, it might have been thought that would be content to rest from his labours. But has been said, he sealed his long connexion with e British Association—he had attended practically ery meeting for more than fifty years—by accept g the presidency and, as it transpired that this as for a long period (1940–46), he still worked r it while he was supposed to be living in retireent. This was not his only activity. He maintained rrespondence with his many friends, and any ppeal which seemed to offer a chance of promoting e cause of science or its appreciation was sure of is sympathy and advice. For example, during this eriod he was largely instrumental in securing the ansfer of the Norman Lockyer Observatory at Sidouth, of which he had been chairman of the governg body for many years, to the University College f the South-West, Exeter, thus ensuring its future.

One concluding word: we have tried to give an impression of the intense activity which filled Sir Richard Gregory's life. But he was no mere automaton, for he showed a very human enjoyment of his manifold interests, and we who worked with him always found him a very sympathetic, understanding and kindly man.

Sir Richard was twice married. In 1888 he married Kate Florence Dugan (*née* Pearn), who died in 1926 after a long and distressing illness; his son and daughter by this marriage both predeceased him. Secondly, in 1931, he married Dorothy Mary, daughter of the late Dr. William Page, general editor of the "Victoria County History", who survives him. Lady Gregory was his constant companion and helper throughout their married life, and her care and attention were a source of much happiness during his declining years.

THERE are very many of us who held Richard Gregory in close affection—scientists most of us, of all ages, but many with other activities and interests; and we are all feeling very deeply the gap which his going has left in our circle. We could not wish him to linger in his final illness; but, as members of an even much wider community of all who work in science, or are concerned in any way to promote the recognition of its present and future importance in the world, we are feeling sadly bereft of his genial presence, his tireless enthusiasm and his doughty championship. We seem to be looking at the end of a great chapter, with the closing of a long life so completely devoted to science and to all who serve it, during the period in which he watched its amazing development. When we heard his telegram of apology read at Belfast, it was heartening to feel that our gallant old friend still kept so much of his buoyant humour and that the flag of his courage was still flying, in face of the end which he must have known to be near.

A full tribute is being paid elsewhere to his central and most direct service to the progress of science, as the Editor of *Nature*, and to his other work for scientific education at all levels. We who knew him, however, in the intimacy of friendship, are thinking most now of his cheerful, generous, lovable personality, of his memory filled to overflowing with so rich a variety of knowledge and anecdote, of the racy, inconsequent, garrulous flow of his reminiscences. What a life-story he could have written!—from the days of his early, heroic climbing of the educational ladder—there were no escalators then—until, for well over half a century, he made friendly contacts with Britain's scientists, from the greatest to the least, and with many from other countries. Few, indeed, have been so widely known and trusted. Our deepest sympathy, in her bereavement, is with the brave and gentle comrade who brought him such happiness, and cared for him with such loving devotion in his later years.

H. H. DALE

MAY I be allowed among many others to pay my tribute to the work of Sir Richard Gregory in raising science to its present position in our national life, and particularly in insisting on the need for giving it a higher place in our educational system than it had had before. He early recognized the importance of developing agricultural science in Great Britain, even in the days before it was accepted at the universities as suitable for inclusion in their syllabuses, and he always insisted that agricultural education, widely admitted as necessary at least for countrymen, must be based on sound scientific research.

It will not easily be forgotten at Rothamsted how he helped the appeal for funds that had to be made in 1934 when the Lawes family, owners of the estate which included the experimental fields and the laboratories, found they could retain it no longer but must part with it. The fields were then, in the language of the time, 'ripe for development', and builders were already assessing the possibilities for villa residences; no Treasury grants were available for the purchase; the money had all to be raised privately and quickly, and times were hard. Sir Richard gave the appeal whole-hearted support: he and H. G. Wells jointly wrote a letter to *The Times* in which with his accustomed lucidity he expressed his views on agricultural science: "whatever may be said of other branches of science", he wrote, "the results of research in agriculture cannot be used for purposes of destruction but only to give mankind knowledge by which the factors that determine the production of food may be effectively guided and controlled for the comfort of all. No higher motive of research than this can be conceived".

This was no mere passing expression of opinion: it was his consistent attitude to the subject and it inspired his friendly attitude to the workers. Critics had sometimes asserted that they should devote themselves mainly to the solution of specific farm problems; he always supported the Rothamsted view that their proper function was to build up a systematic science which should relate the facts and seek the underlying causes; it would then be possible to make better use of the facts than when they were only imperfectly known and understood. He had the personal link with Rothamsted that his only son Edgar, after retiring early from the Indian Army, joined the staff as guide demonstrator and thus became one of the pioneers in the art of presenting agricultural science to two completely different audiences: the countryman who already knows many of the facts, and the townsman who is often completely ignorant of them but who depends for his daily bread on their proper understanding by the right people. I always hoped that father and son might collaborate in producing a simple book setting forth the material in easily understandable language, but Edgar's untimely death and Sir Richard's many other activities prevented this. But his services to agricultural science, though quiet and unobtrusive, remain in the memories of those who knew him. E. JOHN RUSSELL

SIR RICHARD GREGORY was president or chairman of many societies and congresses, including the Royal Meteorological Society, the Geographical Association, and also the British Science Guild until that was merged, at his instance, with the British Association in 1936. His kindly spirit set store by the social contacts of conferences only less strongly than did his eagerness to further the progress of science. It is therefore probably true to say that his first and last love among the societies to which he belonged was for the British Association. Of this he became an annual member in 1896 and a life member in 1901. There was no more regular attendant at its annual meetings than he, and the last of these at which he was seen was that at Edinburgh in 1951. This his poor health compelled him to leave before its finish, and at the recent meeting in Belfast his telegram of greeting to the Council was welcomed with inevitab regret.

Gregory's early activities in the Association we concerned with the establishment of the Section Educational Science in 1901, and with work o various committees appointed at the instigation that Section. He acted in due course as a secreta and as recorder of the Section. But his first recorde contribution of a paper was not to the education but to the Section of Geography in 1908, when h presented geography as "one of the most valuab subjects in a school curriculum", as providing n only intellectual discipline but also the huma interest of "the most inspiring literature". Th theme recurred incidentally in his finely phrase presidential address to the Education Section in 192

His presidency of the Association came in 194 and was unique in having lasted for six years. Durin the War there were no annual meetings of th Association on the usual scale, but Gregory eager supported the conferences arranged in London b the Association's Division for the Social and Inte national Relations of Science, of which at least on that on "Science and World Order", which broug together not only British speakers but also foreigne of eminence who had found refuge in Britain, attracte attention far outside the meeting-hall, and inde beyond the confines of science itself. Gregory presidential address, too, was given in unique circum stances, the sole public pronouncement at a one-da meeting in 1946 held in the hall of the British Medic Association, since there had not been time to arrang an annual meeting on the full scale immediately aft the end of the War. Whatever disappointme Gregory felt at not presiding over such a meetin was concealed in his readiness to serve the Associatio to the best advantage as judged by those who worke with him, by one of whom this tribute to his memor is gratefully contributed. O. J. R. HOWARTH

MEMORIAL SERVICE

A memorial service for Sir Richard Gregory wi be held in St. Martin-in-the-Fields Church, Londo on Friday, October 3, at 12 noon.

NEWS and VIEWS

Henri Moissan (1852–1907)

BORN in Paris a century ago, on September 2 1852, Henri Moissan was appointed demonstrator a the École de Pharmacie, Paris, at the age of twenty seven. After obtaining his doctorate in scien in 1885, he became professor of toxicology in th following year, and professor of mineral chemist in 1889. In 1900 he was called to the chair of che istry at the Sorbonne. He is best known for havi isolated and liquefied fluorine, for which he receive the La Caze Prize of the Paris Academy of Science in 1887, and for his development of the electr furnace, which made possible the reduction of ve refractory metals. His preparation in 1893 of minu artificial diamonds by extremely rapid cooling of solution of carbon in molten iron created a gre sensation at the time. He also simplified the pro duction of acetylene. Moissan shared the Hofman Medal of the German Chemical Society with Si William Ramsay in 1903 and was awarded the Nobe Prize for Chemistry in 1906. His most importan ooks include "Le Four Electrique" (1897 ; English ranslation, 1904), and "Le Fluor et ses Composés" 900). He died on February 21, 1907.

nter-African Labour Institute

Miss Sheila Ann Ogilvie, at present assistant bour adviser to the Secretary of State for the olonies, has been appointed the first director of the nter-African Labour Institute, with headquarters at amako in the French Sudan. The Institute is to rovide a permanent centre for the collection and istribution of information on labour problems in frica, and is under the auspices of the Commission r Technical Co-operation in Africa, which was set p in 1950 by the Governments of Belgium, France, ortugal, Southern Rhodesia, the Union of South frica and the United Kingdom to promote interational technical co-operation in Africa south of the ahara.

nternational Council for the Exploration of the Sea

Founded in Copenhagen on July 22, 1902, by enmark, Finland, Germany, The Netherlands, orway, Russia, Sweden and the United Kingdom, he International Council for the Exploration of the ea is celebrating its jubilee by a meeting in Copenagen during September 29–October 7. The Council as founded upon the initiative of Sweden, which in 899 held a conference at Stockholm on international nvestigation of the sea ; in 1901 a similar conference ook place at Christiania (Oslo), followed by a meeting t Copenhagen in 1902, at which the Council was ormed, its purpose being to promote practical scienfic investigations of the food fishes, plankton and sea ater, as a basis for international conventions aiming t securing a better output of the fisheries. The first resident was Dr. W. Herwig (Germany), with the ollowing national members of council : Otto Petterson (Sweden), Dr. P. P. C. Hoek (The Netherlands), apt. C. F. Drechsel (Denmark), Prof. Fridtjof Nansen Norway), Dr. Oscar von Grimm (Russia) and Prof. 'Arcy Thompson (United Kingdom). The jubilee eeting will be attended by about two hundred elegates and guests from the member States of the ouncil, and observers and guests from the United tates of America, Australia and Canada. The Interational Council itself consists of two government elegates appointed by each participating State, nd it elects a president, a first vice-president nd three vice-presidents who form the Bureau, hich has always had its central office in the castle f Charlottenlund, Denmark. The present officers re : *President*, Dr. K. A. Andersson (Sweden) ; *irst Vice-President*, Mr. A. T. A. Dobson (United ingdom) ; *Vice-Presidents*, Mr. G. J. Lienesch (The etherlands), Prof. Jean le Gall (France), and Dr. . U. Sverdrup (Norway).

oyal Alfred Observatory, Mauritius : Report for 1950

The annual report for 1950 of the Royal Alfred bservatory, Mauritius (pp. 12 ; Govt. Printer, Port ouis ; 1951 ; 25 cents) deals with the functions of he observatory department, which are meteorological nd magnetic ; the provision of meteorological serices for government departments and all other urposes ; and the organization of meteorological bservations in the Colony of Mauritius and in its ependencies, etc. Pilot balloon observations were made daily at the Observatory, and, when conditions were suitable, additional ascents were made at the islands of St. Brandon and Agalega. A description of tropical cyclones and cyclonic depressions during 1950 is given and also the data on the rainfall, which was 42·36 in.—83 per cent of the normal amount. The organization of returns from rainfall stations has resulted in returns from 157 of these, of which 130 made complete returns in 1950. This shows a marked improvement on 1948 and 1949, in which the returns were fifty-five and ninety-six, respectively. The Kew magnetometer was used to make forty-eight observations of declination and seventy-five of horizontal force, and forty-eight observations of dip were taken with the earth inductor. On August 9 determinations of the scale values of the horizontal-force and vertical-force magnetographs were made, the values obtained being 0·0000327 and 0·0000113 c.g.s. unit per mm., respectively. Tables show the principal magnetic storms during the year, the mean values of the magnetic elements, derived from hourly values, and also the changes in the mean values for 1949 and 1950. The staff of the Observatory includes a total of thirty-two in addition to the director, Mr. N. R. McCurdy. In spite of wide advertising, the two new posts of meteorologist and assistant meteorologist had not been filled at the time of printing the report.

Sectioned Model of the Earth in Manchester Museum

An account of a sectioned globe, which has recently been installed in the Manchester Museum, is contained in the May issue of the *Museums Journal*. The globe is 30 in. in diameter, and emphasis has been placed on data and the lines of evidence bearing on the earth's interior. Current theories are summarized, and a special constructional treatment is reserved for the evidence of earthquake waves. The core and inner core—revealed by earthquake waves—are made to project into the quadrant cut between the planes of the equator and Greenwich meridian. The colour of the globe is a compromise between a reflexion of the possible true colours of the earth's interior, and shades that are arresting and aesthetically satisfying.

Power Sources in Arid Zones

A meeting to discuss the development of sources of power in arid zones through wind and solar energy is to be held by the Advisory Committee on Arid Zone Research of the United Nations Educational, Scientific and Cultural Organization during September 29–October 1. The Committee will also consider other questions related to this field, including the setting up of an Arid Zone Development Centre. The meetings are to be held in the rooms of the Royal Society, London, W.1. The Advisory Committee on Arid Zone Research consists of the following members : Dr. Hassan Awad, secretary-general of the Royal Geographical Society, Egypt , Mr. Richard L. Boke, regional director of the Bureau of Reclamation for California ; Dr. B. T. Dickson, liaison officer for the Executive Committee of the Commonwealth Scientific and Industrial Research Organization, Australia ; Mr. A. N. Khosla, additional secretary to the Government of India at the Ministry of Irrigation and Power, New Delhi ; Prof. Roberto Llamas, director of the National Institute of Biology, Chapultepec, Mexico ; Prof. Joseph Peres, University of Paris ; Prof. L. Picard, director of the Israeli Geological Institute ; Dr. H. G. Thornton, head of the Soil Microbiology Department at the Rothamsted

Experimental Station at Harpenden, Herts; and Dr. Jacobo Zender, director-general of agriculture at the Ministry of Agriculture, Peru.

Commonwealth Fund Fellowships for Advanced Study and Travel in the United States

A NUMBER of Commonwealth Fund fellowships are again being offered by the Commonwealth Fund of New York (1 East 75th Street, New York 21) to British subjects, for advanced study and travel in the United States. All expenses of travel, study and living will be met, with some adjustment of stipends for married men with families. The fellowships, which are open to British men and women who are not normally resident in or near the Americas and who have not previously worked or studied for more than a few months in the United States, are offered annually in six categories as follows. *General:* twenty fellowships to graduates of a university in the United Kingdom of Great Britain and Northern Ireland. Candidates must be available in London for interview in March 1953; age, 23–35; tenure, 12–21 months; applications by December 15. *Home Civil Service:* five fellowships to permanent members in the higher ranks of the Civil Service in Great Britain, three for the administrative grades and two for the scientific and professional grades; age, less than 40; tenure, 6–12 months; applications by December 31. *Dominion Civil Service:* five fellowships to Civil servants in the Governments of Australia, New Zealand and South Africa; age, less than 40; tenure, 12–21 months; applications by December 31. *Colonial Civil Service:* two fellowships to Civil servants in the Governments of British Colonies, Protectorates and Trust Territories; age, less than 40; tenure, 6–12 months; applications by November 15. *Journalism:* three fellowships to journalists practising in the United Kingdom and engaged on the opinion-making or broadly editorial side of their profession; age, 23–35; tenure, 9–15 months; applications by December 31. *American Studies:* four fellowships will be available to faculty members appointed to or holding posts in American studies in universities in the United Kingdom, candidates to be nominated by their universities; tenure, 4–12 months (these fellowships are not limited by previous study in the United States). Application forms and further details of these fellowships can be obtained in Britain through universities or government departments, or from the Warden, Commonwealth Fund, Harkness House, 35 Portman Square, London, W.1.

Nature Conservancy Research Studentships

THE Nature Conservancy has made the following awards for 1952 of research studentships for postgraduate training in ecology, tenable for periods up to three years at the institutions indicated: *Botany,* B. N. Bowden (Lincoln College, Oxford), Miss B. Douglas (Freshwater Biological Association, Ferry House, near Ambleside), J. D. Lovis (University of Leeds), K. J. F. Park (King's College, Newcastle upon Tyne) and I. H. Rorison (University College, Oxford); *Zoology,* A. B. Acton (Keble College, Oxford), J. M. Cullen (Wadham College, Oxford), M. J. Davies (Exeter College, Oxford), and A. M. Jordan and D. H. Murphy (University of Durham); *Physiography,* D. H. Maling (University of Durham).

The Night Sky in October

FULL moon occurs on Oct. 3d. 12h. 15m., U.T., and new moon on Oct. 18d. 22h. 42m. The following conjunctions with the moon take place: Oct. 6 10h., Jupiter 7° S.; Oct. 20d. 10h., Mercury 4° N. Oct. 21d. 15h., Venus 4° N.; Oct. 24d. 11h., Ma 1° N. Mercury is too close to the sun during mo of the month for favourable observation. Venus, a evening star, sets at 18h. 25m., 18h. 0m. and 17 50m. on October 1, 15 and 31, respectively. I stellar magnitude is − 3·4, and 0·90–0·83 of t illuminated disk is visible. Mars is an evening sta setting at 20h. 10m. in the middle of October and on ten minutes later and earlier at the beginning a end of the month, respectively; the stellar ma nitude varies between 0·6 and 0·8. Jupiter rises 19h. 10m. on October 1 and about two hours earli at the end of the month. Its stellar magnitude − 2·4, and during October it is a little south δ Arietis. Saturn is in conjunction with the sun o October 11 and is unfavourably placed during t month for observation. Occultations of stars bright than magnitude 6 are as follows: Oct. 5d. 20h. 08·9m μ Arie. (*R*); Oct. 6d. 21h. 53·5m., 17 Taur. (*D*) Oct. 6d. 22h. 10·6m., *q* Taur. (*D*); Oct. 6d. 22 18·4m., 20 Taur. (*D*); Oct 6d. 22h. 37·5m., 17 Tau (*R*); Oct. 6d. 22h. 51·8m., 16 Taur. (*R*); Oct. 6 23h. 06·3m., *q* Taur. (*R*); Oct. 6d. 23h. 22·1m 20 Taur. (*R*); Oct. 6d. 23h. 26·9m., 21 Taur. (*R*) Oct. 29d. 0h. 21·4m., 232 B.Aquar. *m* (*D*); Oc 30d. 20h. 04·3m., 51 Pisc. (*D*). *D* and *R* refer t disappearance and reappearance, respectively, an observations are for Greenwich. The Orionid mete shower occurs about October 20–23; the radiant this shower is at R.A. 6h. 24m., dec. 15°. The suppose connexion between this stream and Halley's Com has been disproved by the work of Prof. A. C. Lovell, of Manchester, who has shown from determination of the velocity of meteors from th shower that the period must be comparatively sho and hence the shower cannot be associated wit Halley's Comet, the period of which is about 76 year The same conclusion applies to the η Aquarids earl in May, which were also believed to be associate with Halley's Comet.

Announcements

THE sixth Rutherford Lecture of the Physic Society will be given on October 3 at 5.10 p.m. i the Lecture Theatre of the Science Museum, London S.W.7, by Prof. R. E. Peierls, professor of theoretic physics in the University of Birmingham; he wi speak on "The Atomic Nucleus and its Con stituents".

AT an open day which is being held at the Fulm Research Institute, Stoke Poges, Bucks, on Septem ber 30, a memorial plaque to the founder, Colon W. C. Devereux, will be unveiled by Lord Hives, o Rolls Royce, Ltd.

BY an Order of the Committee of Privy Counc for Medical Research, Sir Geoffrey Vickers has bee appointed to be a member of the Medical Researc Council. By the same Order made in this respec after consultation with the Medical Research Counci and with the President of the Royal Society, th following have also been made members of th Council: Prof. G. R. Cameron, professor of morbi anatomy in University College Hospital Medic School, London; Prof. A. J. Lewis, professor o psychiatry in the University of London; and Si James Spence, Nuffield professor of child health i the University of Durham.

EDUCATION OF THE DEAF

DURING the recent meeting of the British Association at Belfast, the session of the Education Section (L) on the morning of September [illegible] was devoted to three papers and a discussion on he education of the deaf. Mr. A. L. Binns, president of the Section, took the chair and there was a large attendance.

The first paper, by Sir Richard Paget, on "The Education of the Totally Deaf", was read in his absence by Mr. E. S. Greenaway, headmaster of the Yorkshire Residential School for the Deaf, Doncaster. Sir Richard put forward conclusions about the relationship between human speech and thought, the origins of speech and the possibilities of lip-reading. He reported that he and his collaborators had evolved a new language of manual signs. He recommended that this should be learned by the mothers of young children who were found to be totally deaf, and taught by them to their children, before speech.

In a second paper, Mr. R. Askew gave an account of the establishment, in 1946, of the first secondary grammar school for the deaf, the procedure adopted in selecting candidates for admission, usually at the age of 13 +, the curriculum and out-of-school activities, the social life of the school, and the educational achievements and range of careers followed by its pupils.

Lastly, Prof. A. W. G. Ewing (University of Manchester) presented a summary of the results of investigations into the capacity of very young deaf children to learn and comprehend speech through lip-reading, into variations in the mental abilities, aural histories and residual capacity to hear of pupils in special schools for the deaf and partially deaf, the use of hearing aids and the ages at which children are ascertained to be deaf. Prof. Ewing illustrated his paper by a short documentary film "Children learning to Lipread". This showed how parents learn to train their children to watch for speech and to understand it through lip-reading, by engaging them, informally, in activities appropriate to their ages and interests.

Sir Richard Paget said that the mentality of uneducated children who are totally deaf is "utterly primitive". Handicapped by wordlessness, they can copy the actions of others and learn the techniques of various trades, but they cannot originate and cannot think logically, because "logical thinking depends upon the rearrangement of 'units of thought', such as our words: but the units of thought of the uneducated deaf are so vague, diffuse and shapeless that they cannot be fitted together with any precision". Their minds work differently from ours; they are probably a million years behind the times.

There is a very close relation, Sir Richard said, between expression by manual pantomime and expression by the tongue, lips and other oral gestures which carry the meaning of human speech. The noises of speech are quite secondary. They carry the gestures. Speech without sound is an effective means of expression, although intelligible only to a good lip-reader. The 'secondary' noises which accompany speech express the emotional state of the speaker. There is what Charles Darwin called "some kind of sympathy" between the movements of man's hands and those of his mouth. Originally, primitive man (with a mentality probably similar to that of present-day uneducated deaf mutes) must have expressed his ideas by pantomime; but "without knowing it, his mouth mimicked his hands".

Oral methods of educating the deaf aim at making the deaf appear to be normal, for example, by good lip-reading, good articulation and a sufficient vocabulary to enable their pupils to carry on simple conversation. But speech and lip-reading are extremely difficult for all but the exceptionally gifted deaf. Successful lip-reading is dependent on good sight and a clear speaker. It is not practicable in large gatherings, such as at a cathedral service. Many of the claims that are made of the successful teaching of speech to the deaf have related to cases of residual hearing, or of deafness appearing after the deaf pupil has already learnt to speak. Only a relatively small percentage of the deaf is actually totally deaf.

Generalized pantomime, Sir Richard commented, is a blind alley, which ignores the use of words. The oralists have been right in condemning the use of natural sign language. With the collaboration of Prebendary Albert Smith, of the Royal Association in Aid of the Deaf and Dumb, and others, Sir Richard said he had evolved a "systematic sign language", in which each sign is the equivalent of a spoken word. He thought that if such a language were used in communicating with a young totally deaf child, as a hearing mother talks to her young deaf child, it is probable that this deaf child would pick up the signs as easily as a hearing child picks up words. In this way the deaf child might acquire a vocabulary of verbal signs which it would use at first in the place of spoken words. At present this vocabulary of the new sign language amounts to about 3,000 signs, of which 900 are designed for quite young children. The principal signs of the children's vocabulary have recently been filmed by the Wellcome Foundation. In 1948 Mr. Greenaway sent one of the oral teachers from his school to London to learn this children's vocabulary. She learned the 900 signs at the rate of 240 signs an hour. Her whole instruction period was only eight hours, and she demonstrated her knowledge by signing one of Edmond Dulac's Russian fairy stories, after going through it once with Sir Richard. A systematic sign language would be incomparably easier to acquire than any spoken language.

Mr. Greenaway said that he firmly believed the oral method of education to be basic for all deaf children. He is concerned about pupils who are taught orally, but unsuccessfully. He believed that research, in the use of hearing aids, for example, would open up many possibilities of better education for the deaf in the future. But "a deaf child who has failed at school has failed to live". Of twenty deaf boys and girls who had left his own school this year, one had gained admission to the Mary Hare Grammar School for the Deaf, three had attended courses of technical training outside the school for the deaf; before leaving, four others were certainly oral successes, and four more would probably be described as oral successes. He was concerned about the rest. He felt that for children like them something should be added to oralism.

In a short discussion which followed, it was suggested that signing, if encouraged in a school for the deaf, might become a substitute for ordinary language. Finger-spelling was suggested by one speaker as a chief method of education, and another speaker asked if the introduction of a variety of methods would not create confusion in schools for the deaf.

Mr. R. Askew said that the Mary Hare Grammar School for the Deaf, which was first opened in 1946, with 44 pupils, now provides 75 places. It is wholly oral, like the two private schools for the deaf from which it took its roots and which it replaced as centres in which secondary education is available to the deaf. In describing the aims of the Mary Hare School, Mr. Askew quoted the late Sir Fred Clarke—"to liberate the intelligence of our pupils, in and through active membership of society"—in this case by the achievement of the pupils, although deaf, of capacity to participate in the hearing, talking society of the general community. To gain this, the pupils have to have confidence in their abilities, particularly their capacity to lip-read and in general knowledge, which they must be able to enrich by reading.

The procedure adopted for selecting candidates for admission is: (*a*) notification to local education authorities of the holding of an entrance examination, (*b*) a preliminary screening test, by written papers in English, general knowledge and arithmetic, taken by candidates in their schools, followed, in the cases of those who attained the required standard, by (*c*) a visit to the Mary Hare School, during which the history of each candidate is studied, in the light of reports from head teachers, tests to determine hearing loss, the results of performance tests of ability and a vocabulary test, and assessments of personal and social behaviour in which all members of the teaching staff participate. The mental testing is carried out with the collaboration of the Department of Education of the Deaf, University of Manchester. On admission, the pupils who were born deaf are from two to three years retarded in vocabulary.

Each school day begins with an assembly at which a hymn is sung, followed by half an hour during which speech training is provided to meet individual needs. Wearable hearing aids are used by many pupils. 'School subjects' are taken by specialist teachers. A weekly 'library period' is an important part of the curriculum of each form. Extra-curricular activities include community singing, free access to a studio for painting and drawing, athletics in which the pupils compete with those of schools and organizations for ordinary boys and girls, hobbies and pets, a pig club and a school magazine, managed by a committee of the pupils.

In 1949, of twelve candidates who sat for the School Certificate Examination, all were successful. Since that year a number of pupils have gained the General Certificate of Education (two at the higher level). This year two pupils are proceeding to universities, one with a State scholarship. Not all pupils are expected to take the General Certificate. The aim of a wider culture is more important. Former pupils follow a wide range of occupations; for example, one, an assistant in the pathological laboratory of a hospital, is now studying for a university degree, and another is a quantity surveyor. All are working happily side by side with ordinary people, who accept them as fellow-workers. Eleven former pupils are continuing their studies by correspondence courses.

The number of schools for the deaf in Britain presenting candidates for admission has grown from ten, in 1946, to twenty-six in 1952. The existence of the Mary Hare Grammar School appears to be an incentive to teachers of the deaf elsewhere, and their pupils, to aim at higher standards.

In answers to questions, Mr. Askew said that the Mary Hare School is staffed by seven fully qualified teachers of the deaf and two teachers who are working for a special qualification. Incentives are used to encourage pupils to rely solely on speech and lip reading as a means of direct communication. The tendency of newcomers to resort to signs is "dying out".

Prof. Ewing's paper summarized developments in the educational treatment of deafness in children that have resulted from modern scientific research in Britain and the United States, and included references to investigations made in the Department of Education of the Deaf, University of Manchester, with financial support from the Medical Research Council and the Leverhulme Trustees. It has been found that the onset of dumbness, due to deafness, can be prevented in earliest infancy. Children of two years old have learnt to lip-read and begun to talk spontaneously, as a result of skilful training in their homes. This possibility was first discovered when the parents of a deaf girl, aged one year and two weeks, demonstrated that, under the guidance of Dr. I. R. Ewing, they had trained her to lip-read and respond by specific acts of behaviour to six different phrases spoken in a natural and conversational manner. She was one of more than thirty deaf children, whose ages ranged from twelve weeks to nearly three years, who had similar training during 1947. By the age of two and a half, some of them became able to understand, through lip-reading a vocabulary of up to 500 words and phrases.

It has been shown that deafness can be effectively ascertained during even the earliest weeks of life. Special tests for this purpose, based on the results of a study of the ways in which ordinary children develop capacity to respond to sound, have been evolved.

Of 781 children referred by medical officers and otologists to the Department of Education for the Deaf, University of Manchester, during 1948–51, for tests and educational guidance, those of two years old form the largest age-group. A majority of the pupils who at present are admitted to schools or classes for the deaf or partially deaf have had their handicap since before the age of two years; but many cases of partial deafness and some of severe deafness are not ascertained until after the children's admission to ordinary schools.

Great variations have been found in the stages of linguistic development which have been reached by deaf and partially deaf children when first seen. Of 430 children referred before the age of five years, almost all used their voices purposefully and some, especially of those who had become deaf after the age of one year, had a certain amount of imperfect speech. Of 351 boys and girls of school age, a majority were already talking, although very often imperfectly. Fewer than five per cent of pupils in schools for the deaf are unable to hear any sound. Experiments have shown that hearing-aid equipment can be designed and constructed to enable children who are very severely deaf to hear speech to an extent that stimulates their linguistic development and facilitates their general education. Children who, without this equipment, cannot hear any sound of conversational speech, unless uttered within a distance of two inches from their ears, have learnt to combine skill in the use of hearing aids with proficiency in lip-reading. Investigations are in progress to find ways that are economically practicable for making school rooms acoustically fit for the effective use of powerful hearing aids, and ways of modifying hearing aids to enable very young children who are severely deaf to benefit from continuous auditory experience.

During the course of a brief final discussion, Prof. Hallowell Davies, of Washington University, St. Louis, said that in the Central Institute for the Deaf, with which he is associated, it has been found that children who are admitted to the nursery unit, at an early age, are much less liable to linguistic retardation than those who enter school later. No 'signs' have ever been used in the Institute.

As a personal comment, the present writer regrets that the first paper at the meeting tended to focus attention on the use of 'signs' as a means of communication with the deaf, and to divert it from consideration of the outstanding success with which secondary education for the deaf has been established at the Mary Hare Grammar School, which is a unique institution of exceptional interest to educators and psychologists. A dictionary of organized signs, prepared by the Abbé Sicard, who published in 1823, still exists ; its use was long attempted in France but was abandoned many years ago.

MEASUREMENT AND IMPORTANCE OF ELASTIC PROPERTIES OF METALS

A CONFERENCE was held at the National Physical Laboratory, Teddington, during March 20–21 on the "Measurement and Importance of the Elastic Properties of Metals", to discuss the measurements of elastic constants which have been going on in the Laboratory and elsewhere, and to consider how the information obtained from them could be used by metallurgists. It was attended by between eighty and ninety representatives from universities, industrial concerns and government departments. The first day was devoted mainly to describing experimental techniques and the results which have been obtained from them, while on the second day the speakers considered how elastic constant measurements could contribute to new knowledge of the physics of solid states.

The first paper was by Mr. A. F. C. Brown (National Physical Laboratory), on the "Static Measurement of Very Small Strains". He pointed out that in order to measure strain to an accuracy of $\pm$ 1 per cent it is often necessary to measure changes of length of less than 10^{-6} in. Even higher precision is needed if a study is being made of small variations in elastic constants, and great difficulty is experienced in transferring the strain to the extensometer without introducing significant errors. Generally, the most suitable methods are those in which the extension of a standard length of a specimen is made to rotate a mirror ; but direct microscopic examination of length changes, and interferometer techniques, have also been used. It is very important to ensure that the desired type of loading is achieved, and this has been the subject of considerable research in the National Physical Laboratory.

In a paper on "Medium and High Frequency Measurements of Elasticity", Mr. G. Bradfield (National Physical Laboratory) described the methods in use at Teddington for the dynamic measurement of elastic constants, pointing out that, except at very high frequencies, the moduli vary somewhat with rate of straining. This was illustrated by results with polycrystalline aluminium from 0·4 c./s. to 50 kc./s. over a temperature range of 30°–700° K.

Methods using pulse-travel times and frequencies of 1–20 Mc./s. are very useful for measuring elastic constants of single crystals, and accuracies of a fraction of 1 per cent have been obtained with crystals of a few millimetres in size. On fine-grain polycrystalline bars about 10 cm. long, accuracies of 0·03 per cent are possible. Generally, the quartz crystal transducers used are mounted on steel or fused quartz blocks, which are applied to the specimen under test. Although separate transducers for transmitting and receiving have been most widely used at the National Physical Laboratory, many measurements with a single probe on both solid and liquid specimens have been made at high temperatures, and an attempt is being made to reach 1,550° C. in this way.

Of many alternative resonance methods, those using magnetostrictive transducers (which can produce both rotational and irrotational vibrations) are preferred, and have been used from near absolute zero to 500° C. ; 1,000° C. is the probable limit with the present equipment. Inductor methods have been used for specimens weighing as little as ¼ gm. The best accuracy obtained by resonance techniques is a few parts in 10^4 in the elastic moduli.

For bars, the lateral inertia effect on velocity enables Poisson's ratio to be determined very accurately, and deviation from ($\frac{1}{2}E/G - 1$) indicates anisotropy quantitatively, and thence the true constants for an isotropic material can be calculated, as described in the following paper.

Mr. H. Pursey and Mr. T. H. Schofield (National Physical Laboratory, Physics Division and Metallurgy Division, respectively) presented a paper on "Elastic Constant Measurements on Some Alloys". Measurements of the elastic moduli of a series of α-solid solutions of copper with elements of the first long period show principally a fall in modulus as the percentage of stranger atoms increases, and for a given atomic percentage of solute the higher the number of valency electrons the greater the depression in elastic moduli. They pointed out, nevertheless, that plotting elastic moduli against electron concentration does not bring the four curves together, and it is clear that they cannot be brought together by plotting against any power of electron concentration. Zener's theory of the misfit effect between solute and solvent atoms was outlined, but this too fails to explain the results satisfactorily. A further anomaly exists at very low atomic percentages, where it is found that the effect of introducing small amounts of stranger atoms is, in fact, to raise the moduli above those obtained for the pure metal. This may be due to the tendency of the foreign atoms to provide 'anchor points' for dislocations, thereby strengthening the material.

The remainder of the paper was devoted to an explanation of the mathematical technique whereby the elastic constants of an isotropic material may be derived from measurements on an anisotropic specimen of the same composition, assuming the anisotropy to be due to preferential orientation of grains, and that the lattice has cubic symmetry. The corrections are functions of the single-crystal constants, and proportional to the fractional difference between ($\frac{1}{2}E/G - 1$) and Poisson's ratio as determined from the lateral inertia effect on longitudinal vibrations.

Since the functions vary slowly with the single-crystal constants, these need only be known to a relatively low degree of accuracy.

A discussion followed these papers, and in reply to a question by Dr. E. Billig, of Associated Electrical Industries, Ltd., Mr. Bradfield said that although propagation of waves up to 3,000 Mc./s. in solids has been reported, serious difficulty is likely to arise from scatter in polycrystalline materials. Replying to an inquiry, Mr. Bradfield said that the strains used in the resonance method were of the order of 5×10^{-7}.

The next paper was by Dr. E. G. Stanford (Aluminium Laboratories, Ltd.), and was entitled "The Variation of Young's Modulus of Aluminium Alloys with Temperature". He described measurements of the Young's modulus of aluminium by the resonance technique, using the fundamental mode of longitudinal vibration. The materials used were super-purity aluminium (99·992 per cent), commercially pure aluminium (99·5 per cent), an aluminium–manganese alloy (1¼ per cent manganese) and an alloy of the duralumin type. The specimens were subjected to heating and cooling processes, the rate of change of temperature being about 2° C. per minute, and measurements of Young's modulus were taken at intervals of 10° C. between room temperature and the melting points.

The results show a discontinuity in the Young's modulus/temperature curves at the recrystallization temperature, accompanied by an increase in internal friction. Precipitation from solid solution also causes a slight discontinuity for alloys which show age-hardening characteristics. The modulus of both the pure material and the alloys is generally decreased by cold work, and cannot always be made to recover by annealing. Recovery did not occur, for example, in the case of annealed super-purity material which had been strained 10 per cent in tension; however, when recovery does take place, it is greater in the case of the super-pure than in the commercially pure material. At 10 kc./s., relaxation occurs at a temperature of about 500° C. in the super-pure material, accompanied by an increase in internal friction. No such effects were observed at any temperature up to the melting point in the case of the impure materials. Dr. Stanford hoped that further work on the behaviour of alloys near their melting points would enable improvements to be made in casting techniques.

The final paper of the first day was by Prof. N. F. Mott (University of Bristol). He discussed the effect of temperature on the elastic modulus. The drop in the shear modulus is due partly to thermal expansion, there being no first-order change of entropy with shear, and hence no change of temperature on shearing. Some theoretical calculations have been made by Prof. Max Born's school for solid rare gases, but none for metals. He also discussed the effect of cold-work on the elastic modulus. He considered that a drop in the shear modulus of five to ten per cent is to be expected, and that this is due to the screw dislocations trapped in the lattice and not to the edge dislocations, the latter probably forming sessile (immobile) groups, for example, in deformation bands. The partial recovery of the elastic moduli after a low-temperature anneal, observed recently by A. D. N. Smith, should be due (like cross slip) to the mutual annihilation of screw dislocations, and a similar dependence on temperature is to be expected.

The morning session of the second day opened with a paper entitled "Theory of the Elastic Constants of Metallic Crystals" by Prof. H. Jones (Imperial College of Science and Technology, London), who explained that on modern electron theory the cohesive energy of metals may be regarded as arising from (*a*) the exchange interaction between the ionic shells (*b*) the energy of the lowest state of the conduction electrons (spherical approximation), (*c*) a correction to (*b*), the electrostatic potential term, and (*d*) the Fermi energy of all the conduction electrons. Since in different metals these terms have differing relative importance and variation with strain, it is now becoming possible, by comparing theory and experiment to understand the dominant effects in the elastic constants of a particular metal or alloy. For example where the ion radius is considerably less than the atomic radius, as in sodium, the term (*a*) will be small and the electrostatic contributions predominate These are very anisotropic and hence in accord with the observed elastic constants of sodium.

The effect of strain on the Fermi energy can be illustrated by considering shearing distortion of the first Brillouin zone in the face-centred cubic case If there is only one electron per atom, the Fermi surface is well within the zone and is little altered by shear; but if there are 1·5 electrons per atom, the surface touches the zone, and shear causes a tendency of electrons to leave the zone. The larger the surface of contact the greater is the change in energy and hence the greater contribution to the elastic constants. Some results on β-brass in general accord with these ideas were then described. Prof. Jones pointed out that the treatment is most satisfactory for atoms where there are clearly marked closed shells and few valency electrons, such as copper, silver, gold, sodium, magnesium; in conclusion, he emphasized the need for experimental observations from single crystals.

In the subsequent discussion, Prof. Mott asked if there is any connexion between elastic constants and the diamagnetic effects at low temperature in aluminium and bismuth associated with small groups of electrons overlapping the zones. Prof. Jones replied that in any metal the Fermi surface is very complicated, and the diamagnetic effects are considered to arise from small parts of the surface of very high curvature, whereas the elastic constants are associated with large overlapping. In answer to a question by Prof. J. D. Bernal, Prof. Jones agreed that he would expect interesting differences between the hexagonal metals of long and short axial ratio, for example, magnesium and zinc, and would value some experimental observations. In particular, the measurements should be made at different temperatures in order to give an idea of the absolute zero values. This is important, since it enables some elimination of the influence of temperature and internal strain on the elastic constants, for internal strain has an effect decreasing with temperature. Dr. R. Street (University of Nottingham) mentioned that there is a considerable change in Young's modulus in passing through the Curie temperature, and in reply Prof. Jones said that he felt the present treatment could give no satisfactory explanation of this effect.

Dr. W. A. Wooster (University of Cambridge) spoke on "Diffuse X-ray Reflexions from Crystals in Relation to Elasticity and Structure". Dr. Wooster outlined the fundamental principle that perturbations in the atomic lattice produce additional diffuse reflexions between the normal spots on a Laue pattern. Alternatively, with monochromatic radiation the diffuse reflexions are observed when the crystal is rotated a small angle from the correct Bragg setting, that is to say, there is a spread of the reciprocal lattice points. By studying the diffuse reflexions near a particular point, attention is fixed on the thermal elastic waves of particular wave-length and wave-normal. From measurements of intensity the velocity of the waves can be derived and hence the elastic constants.

There are two main experimental methods: recording the reflexions on a photographic plate and using a microphotometer, or direct measurement of the intensities with a Geiger–Muller counter spectrometer. The former is less accurate, about ± 5 per cent, but has the advantage of showing the pattern of the reflexions. The Geiger–Muller method requires more elaborate equipment, namely, a highly stabilized X-ray source or a monitoring system, but can give an accuracy of about ± 3 per cent. Absolute measurements of the intensity of the X-ray beam, necessary if absolute values of the elastic constants are required, are less accurate (probably ± 10 per cent) owing to the difficulty of comparing the diffuse reflexions with a direct beam some 10^4 times stronger. The essential difference between this and all previous methods of measuring elastic constants is that the crystal is subjected to no external mechanical stress whatsoever. The constants, moreover, refer to very high frequencies, that is, wave-lengths in the region 0–200 A. There are few results yet obtained on metallic substances, the most important being those of Ohlmer on aluminium, who found marked dispersion for wave-lengths below about 10 A.

Dr. R. S. Leigh (Imperial College of Science and Technology, London) spoke on "Relations between Elastic Constants and Phase Boundaries in Alloys". Dr. Leigh explained that the free energy, F, of an alloy can be expressed as $F = E_0 + (E_v - TS_v) - TS_m$, where E_0 is the electronic energy at absolute zero; $(E_v - TS_v)$ is the lattice vibration term, E_v being the internal energy and S_v the entropy; and S_m is the mixing entropy in the case of a disordered solid solution. The equilibrium state of the alloy at a given temperature is, of course, that state which has the lowest free energy. An example of a theory based on the effect of lattice vibrations is that of Zener explaining the V-shaped phase boundaries of disordered body-centred cubic β-phases. This requires that the β-phase should have a lower Debye temperature than neighbouring phases. Zener has suggested that this is due to repulsive ion–ion interaction which in turn leads to a low value of $\frac{1}{2}(C_{11}-C_{12})$, a low cut-off frequency in the Debye treatment and hence a low characteristic temperature.

Considering the aluminium–zinc system, the solubility gap implies that here the mixture of the α- and α′-face-centred cubic structures has a lower free energy than an equivalent homogeneous phase. Thus the free-energy curve must be such as to have a common tangent at two points. The theory put forward to explain this is based on the idea of shearing the Brillouin zone, the overlapping electrons giving a negative contribution to the shear constant. The calculation leads to phase boundaries of the gap at 75° C. of 20 and 70 atomic per cent in comparison with observed values of 16 and 59 per cent. In conclusion, Dr. Leigh stressed the value of elastic constant measurements on single crystals, in particular in this field on solid solutions of aluminium with zinc, silver, lithium and magnesium.

The afternoon opened with a paper by Prof. C. S. Barrett (University of Birmingham), in which he discussed the after-effects in metals following plastic deformation and showed that they depend on the time occupied by the stress-cycle. He explained the after-effects in terms of anchoring and release of dislocations in the material. In discussion, it was pointed out that recent work at Bristol, in which care was taken to ensure that a homogeneous stress system was obtained, confirmed Prof. Barrett's views.

In the final paper, Mr. H. L. Cox (National Physical Laboratory) referred to the general issue of stability. He stated that failure by structural instability within the elastic range is always a possibility, and that it is quite easy to devise laboratory models which would collapse in this way under any prescribed form of loading; until the nature of the true forces of cohesion within a solid material is better understood, the possibility that the strength of the material is limited by elastic instability should not be overlooked.

After a short discussion, Dr. N. P. Allen, in closing the conference, expressed the hope that the National Physical Laboratory would have similar opportunities in the future for bringing the results of specialized research into closer relation with technological interests.

STANDARDS OF LIFE IN LESS-DEVELOPED AREAS

TWENTY years or so ago, the number of surveys of living conditions carried out each year in the 'less-developed' as well as in the 'more-developed' countries began to increase rapidly, reaching its peak just before the Second World War. This was, of course, due in the first instance to efforts on the part of administrative agencies to collect information on the basis of which action could be taken to combat the consequences of the economic depression—or sometimes, perhaps, to justify a reluctance to discharge responsibilities of this kind. A large amount of information has thus been made available as a by-product of government activity, rather than as a result of scientific research properly so called. The reports in which this information is presented have been collected by the United Nations Department of Social Affairs*, and an opportunity has now arisen to see what they amount to, and to evaluate their reliability.

The task is an important one, partly because of the urgent need for dealing with the problems of poverty and squalor in the less-developed countries, and partly because it is high time that administrative agencies so plan their work as to make available as much raw material as possible for scientific research. The range of social problems in the international field is so vast that it is unlikely that *ad hoc* researches can be undertaken to throw light on them. The proper planning of national and local surveys to secure comparability of the results is therefore an obvious necessity.

The first report which the Department of Social Affairs has published in the series dealing with inquiries into household standards of living in less-developed areas surveys the organization and geographic and demographic range of field-investigations of the income, expenditure and food consumption of households in Africa, Asia, the Caribbean, Latin America, and the Pacific. It is issued as the first part of a Survey of which the ultimate aim is "to provide a critical commentary on such information on standards of living in the less-developed areas of the world as is at present available". This is a task that is as ambitious as it is praiseworthy, for as the information available from the inquiries that are surveyed is narrow both in its range and its scope, the Survey will perforce "constitute a study of the limitations rather than of the extensiveness of the data now available".

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* United Nations. Enquiries into Household Standards of Living in Less-Developed Areas: a Survey of the Organization and Geographic and Demographic Range of Field Investigations of the Income, Expenditure and Food Consumption of Selected Households in Africa, Asia, the Caribbean, Latin America and the Pacific. Pp. viii+101. (New York: United Nations; London: H.M. Stationery Office, 1951.) 2 dollars; 16s.

This statement must be somewhat depressing to those whose interest in living conditions is administrative rather than scientific; something more might have been hoped from a study of twenty years of work in this field, because the aspects of the conditions which are dealt with by the Survey (consumer income and expenditure and domestic food consumption) are those concerning which it is most easy to produce quantitative data. The first volume of the Survey, however, makes it plain that the inquiries so far conducted are seriously defective in many respects. In the first place, the households which are the subjects of the investigations have almost invariably been selected from the members of social, economic or occupational population groups, the majority living in single localities. As a result, the geographical range of the strict applicability of the findings is narrow, often being confined to the locality concerned; few instances of comparability between inquiries conducted within the same territory have been found, and virtually no instances at all of direct comparability between inquiries conducted in different countries or territories. The general conclusion on this score is that, although the areas in which the inquiries were conducted are widely dispersed, they constitute "a relatively insignificant fraction of the total inhabited surface of the less-developed portion of the world", and, "in most cases, of particular less-developed countries or territories".

The inquiries are also defective in a rather more technical sense. Few, even of the relatively small number of inquiries which, it is claimed, deal with an adequate representative sample of the relevant statistical universe, appear to be free from faulty selection procedures, or from a failure to apply the sampling procedures originally decided on when a survey was being planned. "In many cases," it is said, "the methods applied to the choice of the units of investigation either deviated from the target standards of selection, or were not calculated to secure an unbiased choice." The final conclusion embodied in the first volume of the Survey is therefore that "both in respect of the less-developed countries and territories as a whole, and in respect of them individually, the total amount of information available on household income and expenditure and domestic food consumption is, if not negligible, at any rate meagre".

This is not to say, of course, that the work carried out hitherto has been a waste of time for administrative purposes. The statistician may be very sceptical about the results of numerous surveys of the condition of half a dozen or even single households. It is obviously dangerous to base sweeping generalizations on the circumstances, for example, of five families who are thought to be "more or less typical of the average run of Punjab cultivators working between seven and sixteen acres of land each", or on those of two families at San Antonio Huichimal, Mexico. Nevertheless, crude information such as this may be found to vary from case to case only within narrow margins, and to present a picture of basic poverty which is of great political and administrative significance. As is said in the first volume of the Survey, therefore, "in a socially and economically homogeneous environment, data on the living conditions of a small number of judiciously albeit not statistically, selected households, or even of a single typical household, cannot but be an expression of the domestic economies and material circumstances of life of the community as a whole".

In sum, then, even though the Survey demonstrates the need for greatly improved techniques in social surveys conducted in underdeveloped countries, the information elucidated in this way is of great interest, and the "critical commentary" on it which the Survey will produce will be received with gratitude both by social scientists and by administrators.

ELECTROMETRIC DETERMINATION OF OZONE AT HIGH DILUTIONS

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THE chemical reactions which were formerly mainly employed for the estimation of ozone were based on the liberation of iodine from a neutral potassium iodide solution[1]. In the absence of any more accurate or sensitive method, a check on the assumed reaction was lacking, and it is now apparent that this simple procedure is of value only for conducting comparative measurements. On the other hand, the precise spectrophotometric technique[2] which has now been developed and extensively employed in atmospheric tests is difficult to apply in isolated districts and is limited to the measurement of a column of air several kilometres in length.

Extended laboratory trials by us have shown that an electrometric technique provides a highly sensitive method which could be applied to the determination of local atmospheric concentrations by means of a readily portable apparatus. For this purpose a measurement is made of the E.M.F. of a suitable oxidation-reduction system which is determined by the well-known relation:

$$E = \frac{RT}{nF}\ln\left(k\,\frac{[\text{oxidant}]}{[\text{reductant}]}\right) = E_0 + \frac{RT}{nF}\ln\left(\frac{[\text{oxidant}]}{[\text{reductant}]}\right)$$

where k is the equilibrium constant of the reaction, E the potential with a given solution, and E_0 the potential with a solution containing equal concentrations of oxidant and reductant.

Of different reactions which were investigated, the one most suitable and specific for ozone was found to consist of the oxidation of hydrobromic acid with liberation of bromine in accordance with the reaction $O_3 + 2\,H^{\cdot} + 2\,Br' \rightarrow Br_2 + H_2O + O_2$. (At atmospheric pressure and a temperature of 18° C. the E.M.F. of ozone against hydrogen is estimated at 1·9 volts, and that of bromine in a normal solution of bromine ions at 1·066 V.)

The electromotive equation with this reaction takes the form:

$$E = E_0 + \frac{RT}{nF} \ln \left(\frac{[\mathrm{Br_2}]}{[\mathrm{Br'}]}\right) = E_0 + 0{\cdot}029 \log \left(\frac{[\mathrm{Br_2}]}{[\mathrm{Br'}]}\right)$$

at 18° C. The cell, employing the usual arrangement for this type of measurement, consisted of:

+ Pt wire	$3N$ H_2SO_4 $1N$ KBr	$3N$ H_2SO_4 saturated with Hg_2SO_4	— Hg

On passing ozonized air through the left-hand half-cell, the resulting potential is not proportional to the volume passed but approaches a limiting value depending on the concentration of ozone, due to the liberated bromine only accumulating until its rates of formation and vaporization are equal. With a stream of air free from ozone, the potential of the above system ranged, in different experiments, from 0·050 to 0·070 V., the variation arising from the response to the sensitive logarithmic effect of traces of free bromine.

For the standardization of this method, air with various contents of ozone was prepared by admixture with the anodic gas liberated from the electrolysis of sulphuric acid solution. The ozone contents were determined by passing a definite quantity through potassium iodide solution, acidifying and titrating the liberated iodine with $N/1,000$ sodium thiosulphate, a correction being applied for the amount of iodine liberated by oxygen in a blank experiment. The end-point of the titration was determined electrometrically from the oxidation potential. Air of ozone content as thus determined was then passed through the reagent surrounding the platinum wire until the E.M.F. attained an equilibrium value and became constant. The main precautions which it was found necessary to observe are: (1) to complete the purification of the sulphuric acid used by subjecting it to a stream of strongly ozonized air; (2) to introduce in the reagent initially a small amount of bromine by adding a little potassium bromate and then eliminating the bromine by heating on a water-bath to about 90° C.—alternatively a small amount of bromine can be allowed to remain so that the equilibrium value later given by the ozonized air can be approached from the higher value of the E.M.F. thus resulting; (3) the use of mercury to be avoided to make contact with the platinum wire electrode in its glass support; (4) to prevent access to the inner walls of the tube by the reagent into which the gas is led.

Typical laboratory measurements with this cell gave the following results:

Ozone (parts by volume per 10^6 of air)	Final E.M.F., corrected to 21° C.
18·3	0·237 V.
3·5	0·221
1·62	0·206
0·52	0·185
0·20	0·169
0·11	0·154
0·07	0·135
0·055	0·108
0·045	0·079

The circulation of oxygen or ozone-free air was found not to affect the E.M.F. values given, and nitrogen peroxide only caused a displacement if the concentration exceeded 10^{-6}. It is seen from these results that, when employing concentrations of ozone down to about 2 parts in 10^7 of air, the relationship between ozone concentration and potential was approximately in accordance with the following numerical values for the above equation, $E = 0{\cdot}1995 + 0{\cdot}0355 \log [O_3]$ (ozone concentration is in parts by volume per 10^6 of air), in place of the theoretical coefficient of 0·029. The discrepancy is probably due to the chemical method for estimating the ozone, which fails still further for concentrations below 10^{-7}. The results have shown the high degree of sensitiveness of this method, but no check on the applicability of the formula given has yet been possible. The instability of ozone prevents the preparation and maintenance of supplies of known very low concentrations for the purpose of calibration.

Further trials with this hitherto unpublished method have awaited the development of some alternative accurate procedure, and it is hoped that the present note may merit consideration by those engaged in this field.

[1] Cf. Pring, J. N., *Proc. Roy. Soc.*, A, 90, 204 (1914).

[2] Cf. Dobson, G. M. B., *et al.*, *Proc. Roy Soc*, A, 110, 600 (1926), *et seq*

ABDOMINAL MECHANO-RECEPTORS IN *DYTISCUS* AND *LOCUSTA*

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DURING an investigation of the nervous control of respiratory movements in the water beetle ***Dytiscus marginalis***, electrophysiological evidence has been obtained for the existence of sense organs responsive to these movements. The abdominal movements consist of an active expiratory phase in which the tergites are depressed by contraction of segmental sterno-tergal muscles, and a passive inspiratory phase in which these muscles relax. These movements normally occur 10–15 times per min., but the frequency may be only 6 per min. after dissection of the abdomen.

Electrical activity in the segmental nerves and abdominal ganglia has been recorded simultaneously with the dorso-ventral movements of the abdomen under various conditions. The normal response in the mixed nerves is composed of groups of large motor spikes and smaller sensory ones. The respiratory movements usually persist after severing a single nerve, and activity in sensory fibres can then be recorded from the distal section of the nerve. The activity in single afferent fibres has been studied and several responses similar to those recorded from the mammalian vagus[1] have been observed. These are apparently due to:

(1) End organs from which the frequency of impulses increases during inspiration. The discharge is usually irregular between successive ventilation movements but may become extremely regular (70 per sec.) at the onset of inspiration.

(2) End organs from which the frequency of impulses increases during both inspiration and expiration (Fig. 1). Expiration is commonly succeeded by a silent period before the resumption of an irregular resting discharge.

(3) End organs from which a persistent discharge of impulses is inhibited during inspiration. The resting discharge may cease completely and re-commence with a burst of high frequency at expiration.

Responses of the first two types may be found in nearly all preparations; but type (3) is of less frequent occurrence. No constant relationship has been observed between the nerve or segment and the type of response.

It was of considerable interest to find that responses to low-frequency vibrations could also be recorded from these nerves. Preparations are very sensitive to tapping of the substratum and to whistling in a low register. Such responses to ground and airborne vibrations are usually obtained from end organs that are not responding to the regular breathing movements, and many of the responses to the latter are not interrupted by these stimuli. When excited by pure tones in a sound-proof room, these receptors are found to be sharply tuned to frequencies of about 100 c./sec. The frequency of nerve impulses bears no relation to the frequency of the sound waves but increases as the intensity is raised (Fig. 2*a*). At a given intensity the frequency of discharge in a single fibre remains relatively constant (Fig. 2*b*). Similar observations led Pumphrey[2] to suppose that responses recorded from segmental abdominal nerves of the locust were probably from chordotonal organs and not from auditory hairs as suggested by Pumphrey and Rawdon-Smith[3]. The responses which they recorded were to sounds in the neighbourhood of 1,400 c./sec.

These auditory responses in the locust have been confirmed, and in addition bursts of impulses have been recorded from the segmental nerves during the inspiratory and expiratory movements. Some end organs respond to both the respiratory movements and auditory stimulation, while others are excited by either one or the other.

The precise nature of the receptors involved in these responses is not yet clear. The abdominal cuticle of *Dytiscus* is well supplied with sensory hairs and spines of several types[4], and there are also segmental chordotonal organs similar to those described in the larvæ by Graber[5]. Methylene blue staining has assisted in tracing the branches of nerves from which breathing responses had been recorded, and it has been found that these nerves contain fibres from the segmental chordotonal organs. The structure and position of chordotonal organs has long led morphologists to suppose that they have a proprioceptive function[6]; but little experimental evidence has been adduced for this view. It is generally accepted that chordotonal organs may have an auditory function[3]; and some of the evidence that responses to such stimulation are detected by segmental organs in *Dytiscus* and *Locusta* has been summarized above. There is no *a priori* reason why both sorts of response should not come from end organs of this type, as it has been generally recognised that from a functional point of view this class of sense organs is not as homogeneous as it is morphologically. It is not improbable that different types of chordotonal organs have become differentiated in a way analogous to the receptors of the vertebrate acoustico-lateralis system[7,8].

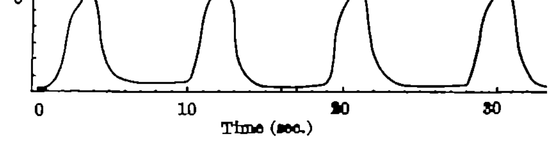

Fig. 1. *Dytiscus marginalis*. Changes in the frequency of impulses recorded from a single afferent fibre in a segmental abdominal nerve. The rhythm of ventilation movements is shown below (expiration upwards)

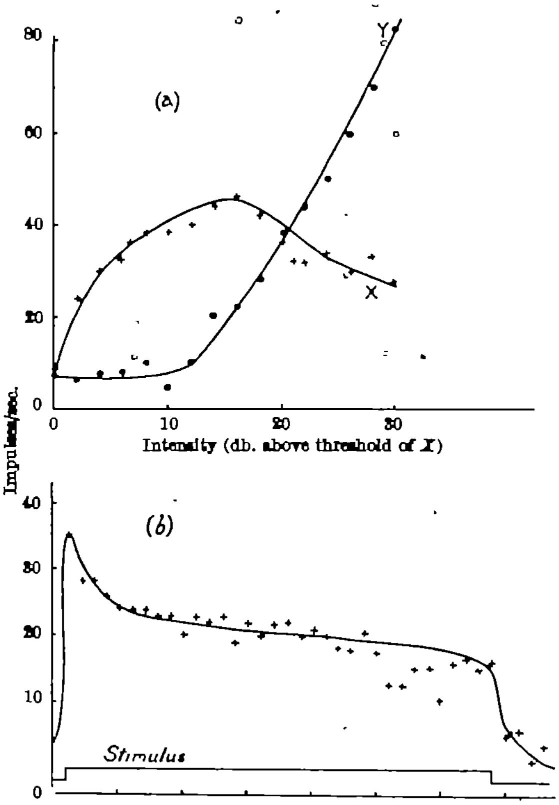

Fig. 2. (*a*) Frequency-intensity curves recorded in two afferent fibres of abdominal nerves in response to sine-wave stimulation at 100 c./sec. (*b*) Curve showing gradual decline in frequency of impulses in fibre *X* during continuous sine-wave stimulation at 100 c./sec.

Whatever the nature of the end organs involved, the responses from the abdominal nerves of *Dytiscus* demonstrate that this insect possesses the sensory equipment to detect sounds of frequencies about 100 c./sec. The flight of these insects in response to sounds and on the approach of footsteps is well known[5]. Furthermore, the responses to the ventilating movements may be of importance in the nervous co-ordination of these movements and may modify the activity of respiratory centres[9,10] which have been suggested in these insects. Such a function is in accord with Eggers's supposition that chordotonal organs may function as 'rhythmometers' which co-ordinate and regulate the rhythmical movements of respiration, circulation and locomotion.

Further results of this work will be published in more detail elsewhere. [March 17.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Internal Fissuring of Wheat due to Weathering

RADIOGRAPHIC technique developed at this Station or the determination of internal or hidden insect nfestation in stored grain[1] has proved to be useful or the detection of other physical anomalies in rains. Practical applications of this sort include the letection of cracked or broken kernels in rough rice paddy) prior to milling[2] as well as the extent of nternal fracturing of certain grains such as maize lue to uneven stresses arising from severe drying onditions. This communication deals with a conlition of internal fissuring occurring in wheat due to veathering of the ripened grain in the field.

Examination of radiographs of numerous samples f non-infested wheat disclosed that some had the ppearance shown in Fig. 1, indicative of sound, ormally matured grain, while others produced ine radiographic shadows indicating the existence f cracks or fissures oriented at right angles to the ongitudinal axis of the kernel (Fig. 2). (The pictures re projection prints of the original radiographs.) lose visual examination of both kinds of grain evealed that those samples which exhibited the issuring were weathered, whereas the sound grain was of normal colour and bright in appearance. Weathered grain loses this sheen and colour, and the kernels present a faded and roughened appearance. This condition is known to be caused by wetting of the mature grain by rain as it stands in the field prior to harvest.

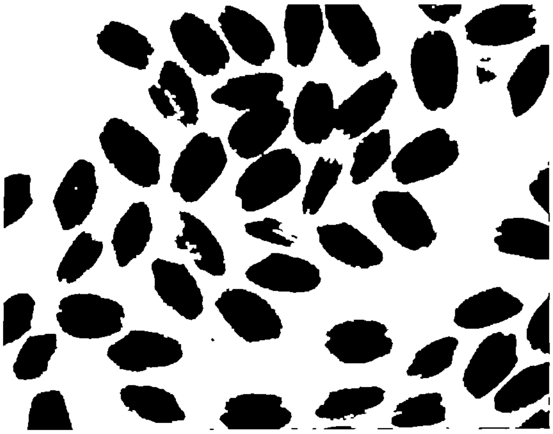

Fig. 1

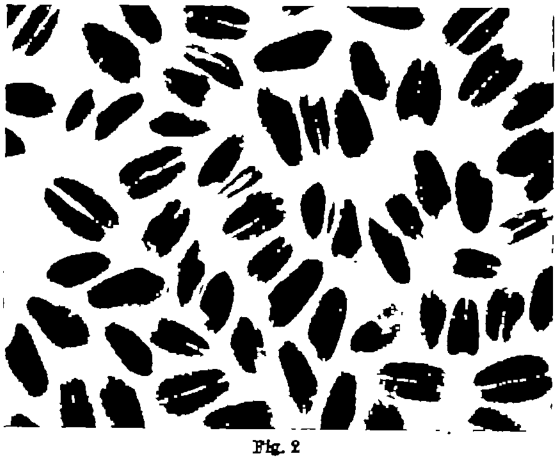

Fig. 2

It is well known that weathered or 'bleached' wheat kernels suffer a decrease in density associated with the swelling caused by wetting of the grain and that this change is not entirely reversible by subsequent drying in the field. This permanent loss in density is related also to the severity and frequency of wetting. It was at one time proposed[3] that this loss in density of grain, which has swelled by wetting and then has been re-dried, may be due to the formation of internal spaces in the endosperm of the grains. The present discovery confirms this hypothesis strikingly. The internally fissured condition has been noted not only in weathered hard red winter wheats from Kansas but also in spring wheats from North Dakota and western Canada.

These observations have prompted laboratory studies to determine precisely the conditions of wetting and drying which cause the fissuring of wheat to occur, as well as the effect of such fissuring on those physical characteristics of the grain which would affect its technological properties. The results of these studies will be published elsewhere.

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Rostral Extremities of the Sympathetic Trunks

THE older anatomists believed that the sympathetic trunks were attached to various cranial nerves; but nowadays the conception that they commence above in the superior cervical ganglia is apparently unquestioned, and the internal carotid nerves are described as branches of distribution of these ganglia. Is this modern view correct, or do the trunks really proceed farther in a rostral direction? They probably do, although not in the manner or position indicated by the classical authors. One suggests that the internal carotid nerves are cephalic portions of the sympathetic trunks, and the evidence in favour of this idea will be summarized here and given in detail elsewhere.

The internal carotid nerves, in man and other mammals, are often as thick as, or thicker than, the trunks uniting the superior and middle cervical ganglia, and appear to be direct upward continuations of the trunks into the carotid canals. A more significant feature is the occasional finding of macroscopic ganglia on these nerves, and the constant occurrence of discrete, microscopic collections of ganglion cells within them. These facts, and the morphological position of these nerves ventral to the costal vertebral elements, suggest that they are not purely branches of distribution of the superior cervical ganglia, but are cephalic continuations of the sympathetic trunks. The discrete collections of cells may represent the sympathetic trunk ganglia of the primitive head segments, which have become telescoped and fused in man in the chordal part of the skull base, although evidence of segmentation still persists in the myotomes, branchial arches and mode of innervation. If this conception is correct, the interconnexions between the internal carotid and various cranial nerves arise in part from cells within the former, and they are homologous with rami communicantes arising from other parts of the sympathetic trunks.

Attempts to determine the exact nature, origin and course of the fibres in the internal carotid nerves by histological methods produce equivocal results, because the calibre, staining reactions and degree of myelination are not absolute guides to their character, and attempts to trace fibres in serial sections through the ganglionic maze of axons and dendrites have so far been unsuccessful. For reasons given later, experimental attempts to discover the origin and course of the fibres are hedged around with unusual difficulties.

Theoretically, preganglionic fibres could reach the internal carotid ganglia either from the thoracolumbar or cranial autonomic outflows, the latter through known and unknown interconnexions with various cranial nerves. Or fibres from both sources could reach the ganglia, and then they would be mixed sympathetic and parasympathetic structures; this possibility should not be dismissed because it is novel or conflicts with current opinions. It is customary to repeat, for example, that the sympathetic outflow is entirely thoracolumbar and that all preganglionic sympathetic fibres for the head end travel upwards in the cervical sympathetic trunks. Although the argument will not be elaborated here, it is doubtful if either statement is correct. The sympathetic outflow is predominantly thoracolumbar, but smaller numbers of preganglionic fibres emerge through other spinal nerves, and some of these may reach the superior cervical or internal carotid ganglia via upper cervical rami communicantes. Moreover, there is little doubt that a proportion of the sympathetic fibres for the head end run in the vertebral and other paravascular nerves. Thus preganglionic fibres could reach the internal carotid ganglia through the sympathetic trunks, the upper cervical rami communicantes, in paravascular nerves (vertebral, ascending cervical and pharyngeal, etc.) or through interconnexions with various cranial nerves.

Bearing all these potential routes in mind, it is practically impossible to devise experimental procedures to eliminate every alternative and provide adequate controls, and many mistakes have been made because of the failure to appreciate the existence of the less obvious pathways mentioned. Unilateral section of the sympathetic trunk below the superior cervical ganglion, with subsequent comparison after an appropriate interval of the internal carotid nerves of both sides, will not prove conclusively whether preganglionic fibres pass into these nerves: such fibres reaching the superior cervical or internal carotid ganglia through other channels would persist unchanged after the experimental trunk section and would vitiate the results. However, the gradual diminution in size of the internal carotid nerves from below upwards does indicate that the majority of the fibres are flowing in a cephalic direction from the sympathetic outflow.

By analogy, one other feature lends support to the view that the internal carotid nerves are cephalic portions of the sympathetic trunks. A ganglion (of Ribes) has been described alongside the anterior communicating artery, and it is known that filaments from the opposite internal carotid nerves extend along this vessel. One has found only microscopic collections of ganglion cells in this situation in man, but a macroscopic nodule was detected in one rhesus monkey and was proved histologically to be a ganglion. Perhaps the rostral extremities of the sympathetic trunks coalesce in this region, the site of union being indicated by a cranial ganglion impar. The resemblance of this to the caudal arrangement of the sympathetic trunks needs no emphasis.

To summarize: the true rostral extremities of the sympathetic trunks may unite around the anterior communicating artery in a cranial ganglion impar, and the internal carotid nerves, with their discrete groups of ganglion cells, may be the cephalic portions of the sympathetic trunks and not merely branches of distribution of the superior cervical ganglia.

The expenses of this investigation were defrayed with the aid of a grant from the Nuffield Foundation.

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The Terms Homothallism and Heterothallism

F. L. Drayton and J. W. Groves have recently[1] presented a scholarly and eloquent plea for a return to the original definitions of the terms homo- and heterothallism as proposed by A. F. Blakeslee[2]. When their arguments are carried to their logical conclusion, the authors are forced to admit: "It is undoubtedly true that the fungus that originally suggested the idea to Blakeslee is not heterothallic in the sense in which he defined the term". I contend that an error in logic has escaped these authors in allowing them to arrive at such a conclusion.

Blakeslee wrote[2]: "According to their method of zygospore formation, the various species among the Mucorineae may be divided into two main categories, which may be designated as *homothallic* and *heterothallic*, and which correspond respectively to monoecious and dioecious forms among the higher plants". In his later attempts to homologize the mating reactions which he observed with sex in the higher plants, Blakeslee merely obscured what was, originally, a rather neat distinction. Monoecism and dioecism are, unquestionably, morphological terms, not physiological ones. The facts, however, are irrefutable: Blakeslee saw a physiological phenomenon, which he believed to be the analogue of the morphological phenomenon, sex, in higher plants. The terms homo- and heterothallism were coined to describe this physiological phenomenon, not a morphological one. To imply that the mucors do not fit the original definition taxes logic.

Two years later, Blakeslee[3] had already extended his definitions, in an attempt to further the homology of his mating types and 'sex'. It is in an attempt to follow this extension of the original definitions that, in my opinion, Drayton and Groves have gone astray.

Indeed, without differentiated male and female sex organs, Blakeslee could scarcely have made a definition on the basis of morphology, as Drayton and Groves would have one to believe.

The separation of morphological sex organs on separate plants (diœcism) is indeed, as stated by Drayton and Groves, "a phenomenon of fundamental biological importance". This is one means of ensuring cross-fertilization, as opposed to selfing. It is by no means the sole method of ensuring this result which Nature has evolved. Sterility factors, in particular, seem to have arisen in all groups in which the problem has been investigated. The various mechanisms are, in total, of even greater "fundamental biological importance".

As the terms homo- and heterothallism are used in the current mycological literature, they embrace that total concept. A homothallic fungus is one in which the sexual cycle can be completed starting from a single haploid nucleus; a heterothallic fungus is one in which the sexual cycle can only be completed by the union of two, physiologically different, haploid nuclei. Referring to Blakeslee's original paper[2], in the two paragraphs immediately following his definition are statements concerning whether zygospores can or cannot be obtained from a "single spore". The present concept differs from Blakeslee's only in that it substitutes the more precise term "haploid nucleus" for "single spore".

Unfortunately, homo- and heterothallic have been somewhat pre-empted by botanists for use as morphological terms. *Marchantia polymorpha*, for example, is often referred to as heterothallic rather than diœcious. Purists have objected to using monœcism and diœcism for both gametophyte and sporophyte generations, and Blakeslee's terms have been welcomed for such groups as the mosses and liverworts, where they are used in a morphological sense. Mycologists, however, have generally held to the physiological definition originally propounded by Blakeslee.

What would be the results if one were to follow Drayton and Groves, and certain botanists, and were to interpret homo- and heterothallism as morphological terms? With very few exceptions, the fungi would be universally homothallic; for example, all Basidiomycetes, including the rusts and smuts, nearly all Ascomycetes, including all the usual genetic tools, etc. The fundamentally significant biological (genetical) principle—the development of outbreeding mechanisms—would be obscured and would occur in two groups: a very few 'true' heterothallic (= diœcious) forms, and 'self-sterile homothallic forms. The vast and growing literature of microbial genetics would be filled with a misuse of the terms; and Blakeslee's classical mucors would have to be taught as homothallic (self-sterile) rather than as heterothallic.

What are the results if one adheres to established usage (and, I believe, to Blakeslee's original definitions) and interprets the terms as physiological ones? For the exceedingly few cases in the fungi in which male and female sex organs are differentiated and borne on separate thalli, a modifying word will have to be added: these fungi are diœcious as well as heterothallic. Examples are *Stromatinia narcissi*, special strains of *'Hypomyces' solani* f. *cucurbitae*, certain Laboulbeniales, and some water moulds. Nearly all the remaining heterothallic forms are monœcious. Whitehouse's[4] corresponding "morphological heterothallism" and "physiological heterothallism" are unnecessary in that all heterothallism is essentially physiological, and the morphological concept is better expressed with a morphological term, here diœcious or monœcious.

The purist objecting to monœcious and diœcious in gametophytes may prefer the alternative transliteration, monoicous and dioicous, now taking hold in the bryophyte literature, or could use Whitehouse's[4] haplo-monœcious and haplo-diœcious. Blakeslee's[3] terms homo- and heterophytic, offered as equivalents in the sporophyte of the terms monœcious and diœcious, have not come into general use but are available if needed. In my opinion, the terms homo- and heterothallic should be left for the mycologists' use in discussing the type of physiological phenomenon which Blakeslee observed.

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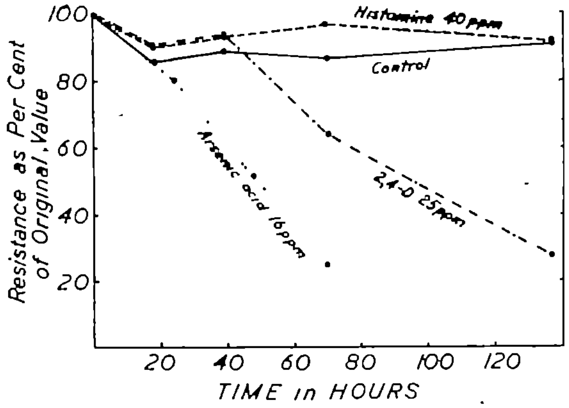
Phytotoxicity of Histamine, Arsenic Acid, and Dichlorophenoxyacetic Acid, and Methods of Testing

The recent paper by Allen and Skoog[1] on the phytotoxicity of imidazoline derivatives prompts this report on tests which have been made with the related β-imidazolyl-4-ethylamine (histamine). Some comments are added concerning the suitability of methods for measuring toxicity.

Tests were made with histamine because it is liberated in wounded animal tissues, is highly toxic to them, has been recorded as occurring in plant tissues[2], and because a phytotoxic substance is liberated when some plant tissues are macerated[3]. Tests were also made with 2,4-dichlorophenoxyacetic acid and arsenic acid to give a basis for comparison.

Tests with the method described below confirmed that the undiluted sap extracted from potato tubers was highly toxic to disks of such tubers. A chemical test also confirmed the presence of a substance reacting like histamine in the extracted sap, obtained from tubers macerated in a Waring blender. For this test, the conditions of diazotization recommended by Havinga *et al.*[4] were used. The procedure for preparing the sample to be diazotized was based on the methods devised by Koessler and Hanke[5], namely, add 2 vol. ethanol, adjust to pH 4, filter, chill overnight, filter, evaporate to original volume under reduced pressure, filter, add sodium hydroxide to 20 per cent concentration, filter, extract with amyl alcohol, extract with hydrochloric acid, evaporate to dryness on a water bath, dissolve in water and filter, add sodium hydroxide as before and repeat process to final filtration, then diazotize. The colour obtained indicated the equivalent of approximately 1 μgm. of histamine dihydrochloride per ml. of original sap macerate.

For testing toxicity, disks of potato tuber 19 mm. diam. × 1 mm. thick were used. After being cut, they were washed for five hours in an aerated isosmotic solution of sea salt (approx. N/10) and then transferred to 300 ml. of fresh salt solution to which the histamine or other substance had been added.



Graph showing effects of certain substances on the electrical resistance of slices of potato tuber (16 p.p.m. H_3AsO_4, 25 p.p.m. dichlorophenoxyacetic acid and 20 p.p.m histamine (dihydrochloride) are equimolar)

The solutions were constantly aerated and kept at 24° C., and toxicity was determined by the fall in resistance of the disk, determined between two electrodes at 1,000 c./s.[6] (the more potent the poison the more rapid is the fall in resistance). The disks were handled with forceps and rubber gloves.

As 1 p.p.m. and 5 p.p.m. of histamine dihydrochloride and 10 p.p.m. of dichlorophenoxyacetic acid had little if any effect on potato disks over a period of a few days, tests were made at higher concentration. The accompanying graph shows some results obtained, each point in the figure representing the mean value for two disks. For clarity the results with 20 p.p.m. of histamine dihydrochloride have been omitted, as they are similar to those obtained with 40 p.p.m., even to the rise at the 70-hr. measurement. It will be seen that at 20 and 40 p.p.m. histamine dihydrochloride has negligible if any toxic action. Accordingly, it is unlikely that histamine or histamine alone is the phytotoxic principle in expressed potato sap. In its negligible response to histamine, the central tissue of potato tubers differs from some animal tissues. In its negligible phytotoxicity histamine appears to resemble some of the imidazoline compounds with small substituted side-groups[1]; however, it must be remembered that these imidazoline compounds were tested by other methods.

The above method is a method for testing local toxicity, and shows that arsenic acid has greater local toxicity to potato tubers than dichlorophenoxyacetic acid. Arsenic acid also has greater remote toxicity than dichlorophenoxyacetic acid to mature roots of skeleton weed[7]. However, tests on young bean plants (growth-regulating tests) do not give similar results for remote toxicity, as shown by the following experiment made according to the general technique of Lucas and Hamner[8].

0·023 ml. of 0·1 per cent dichlorophenoxyacetic acid at *p*H 3·0, applied to one primary leaf per bean plant, reduced bud weight by more than 50 per cent (in eight days). On the other hand, 0·023 ml. of 1·0 per cent arsenic acid similarly applied had no effect whatever on bud weight, although one-third of each of the treated leaves was killed. The failure of this experiment to demonstrate the remote toxicity of arsenic acid is not necessarily attributable to the rapid death of tissues in the neighbourhood of the area of application. With skeleton weed it has often been possible to kill the roots to a depth of 18 in. or more by the application of 5–7½ per cent arsenic acid to the leaves, even though the leaves were discoloured and dead within 18 hours.

Certain tests for toxicity were recently reviewed by Blackman[9], who pointed out that techniques utilizing depression in growth or percentage mortality after spray application have the advantage that they are equally suitable for estimating the toxicity of compounds which do not come within the category of growth regulators. Nevertheless, the above electrical method should be considered eminently suitable for determining the local toxicity of poisons to mature tissues which are capable of little growth, which may be obtained in the form of thin slices, and in which death is not readily determined by visual observation. With micro-electrodes it is possible to work on smaller slices. Moreover, the method has the advantage that it may be used on root tissues as well as on stem tissues; this may be important, because root tissues do not necessarily respond to auxins and poisons in the same way as stem tissues. The saline solution can be buffered or otherwise modified.

Tests for remote toxicity to roots of perennials are at present difficult and laborious. Since remote toxicity depends on both effectiveness of translocation and on local toxicity, the above electrical method should be useful in screening tests of likely poisons for the roots of perennial plants. At present most screening tests are done on comparatively young tissues. However, it must be recognized that poisons will not necessarily behave similarly on young tissues and on mature tissues such as the roots of perennials.

Further work is being done on the identity of the toxic principle liberated on macerating plant tissues.

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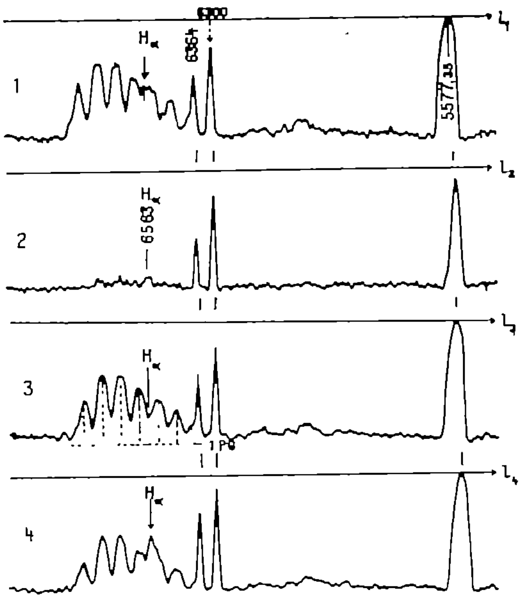
Great Intensity Variations of H_α and Effects in Auroral Spectrograms taken in Rapid Succession

BY means of a new spectrograph, constructed by J. Cojan at the Société Générale d'Optique, Paris combining the high light power $F : 0{\cdot}65$ with a fairly good dispersion, four spectrograms were taken at the Auroral Observatory, Tromsoe, on December 3, 1951 at about 23h. 00m. The spectrograms were taken on Kodak 103*a*-*T* plates and in rapid succession on the same plate with times of exposures from 4 to 10 min.

Photometer curves of the four spectrograms in the long-wave region from the green line towards the red part are shown herewith, in which the horizontal lines l_1, l_2, l_3, l_4 indicate the zero position of the registering galvanometer corresponding to an opaque plate. We notice that, in spite of the short exposures



the green line is greatly over-exposed, except in spectrogram (2). In addition to the green line, we notice the red O I doublet (6300, 6364), the H_α-line, and bands belonging to the first positive group of nitrogen (indicated by 1.P.G. on curve 3).

The great variations in the intensity distribution of these lines and bands must be co-ordinated with the way in which the exposures were made.

Spectrogram 1. Exposure 4 min. towards a band with ray structure appearing near the horizon towards the south and south-east.

Spectrogram 2. Exposure 5 min. towards auroral ray structures near the zenith.

Spectrogram 3. Exposure 7 min. on a homogeneous arc of moderate intensity towards the north.

Spectrogram 4. Exposure 10 min. towards auroral rays, where they appeared with the greatest intensity.

As spectrogram (2) mainly corresponds to auroral rays of great altitudes, and (3) to the low altitude of about 100 km. of an ordinary arc, they give a brilliant illustration of the two following well-known altitude effects: (*a*) enhancement of the red O I doublet with increasing altitude; (*b*) enhancement of the red bands of the first positive group of nitrogen towards smaller altitudes; this effect explains the red lower border sometimes observed on auroral arcs (red aurora of type *B*).

While H_α appears with considerable intensity on spectrograms (1) and (4), it is just noticeable on (2) and absent on (3). This great variability of the intensity of H_α can be explained in a simple way on the views I have proposed (for example, refs. 1, 3, 4, 8), that the auroras and magnetic disturbances are produced by solar electric ray-bundles composed of rays of electrons electrostatically neutralized by positive ions, preferably protons.

The correctness of this view was shown during 1939–40, when it was seen[8-10] that hydrogen lines occasionally appeared in the auroral luminescence and showed a Doppler effect corresponding to velocities of the protons towards the earth of the order of 1,000 km./sec. The Doppler effect of auroral H-lines has also recently been studied by Gartlein[11] and by Meinel[12].

As shown in previous papers[4,7,8], a bundle composed of protons and electrons has the following properties: the electric current density i is equal to $ne(V_e - V_p)$, where V_e and V_p are the velocities of the electrons and protons respectively, n is number of electrons and protons per unit volume. The number of protons entering the atmosphere in unit time relative to that of the electrons is equal to V_p/V_e, and the great variability of the intensity of the H-lines in the auroral luminescence is thus first of all due to a change of the relative proton velocity.

With increase of proton velocity, however, the magnetic stiffness of the bundle increases and consequently the distance of the aurora from the magnetic axis increases. This may explain why H_α appears strong on spectrogram (1), which corresponds to an aurora with ray-structure low down on the southern sky.

For the H-lines to be emitted the protons must be neutralized. At great altitudes the neutralized fraction is very small, but increases downwards. Further, if the energy of the protons is not greater than that of the electrons, the protons will be stopped at a considerably higher level than the electrons. In this way we explain the small intensity of H_α on spectrogram (2), which may correspond to an altitude so great that only a small fraction of protons is neutralized.

The absence of H_α from spectrogram (3) may result from two causes. The appearance of the arc on the northern sky indicates a small relative proton flux in the solar bundle. Small proton flux means small relative velocity and penetrating power of the protons. Consequently, they may be stopped before reaching to the lower part of the arc, from which the light through the slit has been emitted.

Spectrogram (4), showing a strong H_α-line, may correspond to altitudes where a considerable fraction of the protons is neutralized and not absorbed.

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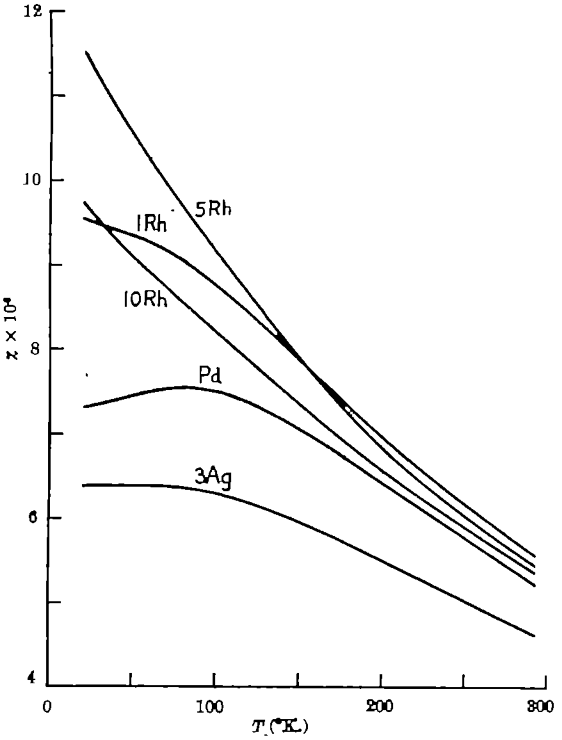
Magnetic Susceptibilities of Palladium–Rhodium Alloys from 20° to 300° K.

THE rapid, yet accurate, method of measurement and the results thereby obtained for the magnetic susceptibilities of platinum, rhodium and palladium between liquid hydrogen and room temperatures have been previously described by two of us[1]. The same measurement techniques were afterwards applied to a series of polycrystalline palladium-silver alloys; the specific heats of these alloys have also been investigated (both sets of results yet unpublished). The results, when interpreted through the collective electron theory, make possible an estimate of the size and shape of the normally unfilled portion of the d electronic energy-band of metallic palladium, on the assumption that the addition of small amounts of silver to palladium causes a reduction of the number of holes in the d-band without significantly modifying its shape. With the filling of the band, it would be expected that the magnetic susceptibility and its variation with temperature would be affected. It was actually found experimentally that both decreased monotonically with increased silver content.

It therefore became of interest to explore the possibilities of increasing the number of holes in the d-band by alloying small amounts of an appropriate metal with palladium, and to study the resultant effects on the magnetic susceptibility. Rhodium (atomic number 45), with one less electron per atom than palladium (atomic number 46), in contrast to silver (atomic number 47) with one more, appeared to be an obvious element to choose for this purpose. Moreover, the similarity in the size of the atoms of palladium and rhodium would favour extended solid metallic solubility; hence, although a phase diagram for palladium–rhodium alloys is not available at present, we can be fairly confident that at least over a small range of palladium-rich compositions there are no complicating phase changes.

We have now investigated the paramagnetic susceptibilities of a number of spectrographically pure palladium–rhodium polycrystalline specimens from room temperature down to that of liquid hydrogen, by the experimental method referred to above. The results for the three specimens (1, 5 and 10 per cent rhodium) that have been studied to date are presented in the accompanying graph along with those previously obtained for pure palladium and a 3 per cent silver palladium–silver alloy. Each curve represents approximately ninety experimental points evenly distributed over the entire temperature-range. The mean deviation of the points from the corresponding curve is about 0·2 per cent of the susceptibility. The substantial increase of the low-temperature susceptibilities, which accompanied the additions of rhodium up to the 5 per cent rhodium alloy, gives some support to the general type of interpretation suggested for the palladium–silver alloys. It is not surprising, however, to find that, for a further increase in rhodium content, the magnetic susceptibility began to decrease, the paramagnetic susceptibility of pure rhodium being only about 10^{-6} over the entire temperature-range in question. Undoubtedly, the dependence of the experimental susceptibility versus temperature curves on the composition of these alloys will provide valuable material for the elucidation of the electronic structure. At present, however, we merely present our initial experimental results. We are continuing our study of this and other related alloy series and will report more fully later.



Gram-susceptibility versus absolute temperature of pure palladium (Pd) of palladium–rhodium alloys of 1, 5 and 10 atomic per cent rhodium (1 Rh, 5 Rh, 10 Rh), and of a palladium–silver alloy of 3 atomic per cent silver (3 Ag)

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Acid Salts of Monobasic Organic Acids: a New Series of Primary Standards for Alkalimetry

It has long been known[1-3] that most monobasic acids HX are capable, in suitable circumstances, of combining with their metallic salts MX to form 'acid salts'; for example, of the type $(MX)_m(\mathrm{H}X)_n$.

The potassium compounds of this type derived from organic acids frequently have the stoichiometric composition of 1 mole acid : 1 mole salt, and are easily obtained and purified. Certain of these substances would probably prove highly suitable as primary standards in volumetric analysis; their use in the preparation of buffer solutions has already been noted[2,3]. In particular, the use of a new compound, potassium hydrogen *bis*-3 : 5-dinitrobenzoate (no definite melting-point, but explodes on strong heating), is proposed (found: K = 8·56, 8·58 per cent; equivalent weight = 461·7, 463 0; calculated for $C_{14}H_7O_{12}N_4K$, K = 8·46 per cent; equivalent weight = 462·3).

This substance is easily obtained by dissolving 21·2 gm. of 3 : 5-dinitrobenzoic acid (B.D.H.) (2 equiv.) in 60 ml. of acetone and adding a solution of 3·5 gm. A/R potassium carbonate (1 equiv.) in 20 ml. hot water. On cooling, small needles separate, and may be recrystallized from a 3 : 1 acetone–water mixture without alteration. After drying in a vacuum desiccator, the substance is non-hygroscopic, stable in air, and a sample has been kept for more than six years without a detectable change. As the dissociation constant of 3 : 5-dinitrobenzoic acid is $1 \cdot 57 \times 10^{-3}$ at 25° [4], a suitable indicator for its titration with 0·1 N sodium hydroxide is thymol blue (alkaline range). The solubility of 3 : 5-dinitrobenzoic acid in water is rather low (0·00635 mole per litre at 25° [5]) and the potassium hydrogen salt is only slightly more soluble than this, being decomposed by water into the free acid and a solution of the potassium salt together with a little of the acid.

No organic compounds of this type have been proposed previously as alkalimetric standards. Potassium bi-iodate, already in use for alkalimetry and iodimetry[4], is a similar acid salt of an inorganic monobasic acid. Alkali metal hydrogen salts of organic dibasic acids already used as standards suffer from several disadvantages not possessed by the substance now advocated. For example, potassium hydrogen phthalate must be recrystallized from water above 35° [7]; potassium tetroxalate must be kept under conditions of definite vapour pressure[8]; potassium hydrogen oxalate cannot be recrystallized from water without change[9]; potassium hydrogen tartrate has a low solubility in water and is difficult to obtain pure[10].

This investigation is being continued, and will be discussed in greater detail elsewhere.

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Thermal Transformations of the Aluminas and their Hydrates

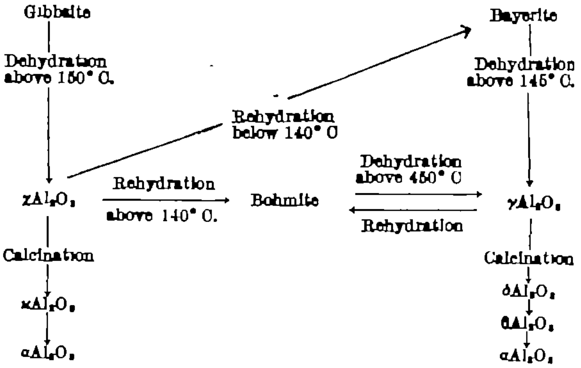
SEVERAL polymorphic forms of anhydrous alumina derived from the calcination of hydrated aluminas have been described by various authors[1-3]. The interpretations made of the relationships which exist between the hydrated and anhydrous forms presuppose that the dehydration of gibbsite and bayerite occur through bohmite, and that the dehydration of the bohmite derived from gibbsite can unaccountably yield one of two series of transformations before α-alumina is finally produced.

Work which we have carried out over a number of years and which will be published elsewhere has led us to believe that the böhmite which is encountered in the dehydration of both gibbsite and bayerite is produced by secondary reactions between the original dehydration products, which are virtually anhydrous aluminas, and the water which is released during the reaction, and our conclusions are illustrated in the accompanying diagram.

Bayerite gives rise on calcination to γ-alumina which is capable only of hydration to bohmite. Böhmite also yields only γ-alumina, so both these hydrates give rise to the γ—δ—θ [2] forms of anhydrous alumina.

Gibbsite, on the other hand, yields initially another form of alumina. This anhydrous alumina has a crystal form for which the lattice spacings of the two most intense lines have d values 2·11 and 1·39, the latter being identical with that of one of the major lines of γ-alumina. It is convenient to label this χ-alumina, and we have found that this is, in fact, only one of the components of the $(\gamma + \chi)$ mixture derived from gibbsite which had previously been designated χ [3]. True χ-alumina is capable of hydration to bayerite at temperatures below 140°, and above 140° to böhmite, and on further calcination yields true κ-alumina before final conversion to α. In practice, therefore, we find on dehydrating gibbsite a mixture of χ-alumina and böhmite, the latter being derived from the secondary reaction of χ with water. Subsequent calcination at higher temperatures therefore gives rise to mixtures of the two series of anhydrous forms, that is, γ—δ—θ—α, associated with the bohmite component, and χ—κ—α associated with the original dehydration product χ.

IDEALIZED ALUMINA-WATER SYSTEM



We are indebted to Mr. H. P. Rooksby of the Research Laboratories of the General Electric Company for his interest and helpful discussion.

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Chromatography of Rubber Accelerators and Anti-Oxidants on Silica Gel

THE chromatographic separation on alumina columns of certain constituents from the acetone extracts of vulcanized rubbers has been reported by Bellamy and co-workers[1] and by Mann[2]. As an adsorbent for such materials, alumina suffers from certain disadvantages, in particular, its tendency to favour chemical change in labile adsorbates. The successful use of silica gel/'Celite' for the chromatographic separation of a variety of ingredients from propellants and high explosives[3,4] suggested that this adsorbent might prove equally useful for the separation of the ingredients of vulcanized rubbers, and this has, in fact, been borne out by recent work in this laboratory. The procedure adopted for the qualitative examination of a rubber extract is as follows. A number of separate portions of the extract (each equivalent to 0·2–0·4 gm. of the rubber) are chromatographed on 1-cm. diameter columns using a series of different binary solvent mixtures as developers. When the extruded columns have been streaked with appropriate reagents, the positions of the zones, together with the colours of the streaks, give a reason-

Compound	Streak reagent	Developing solvents
Diphenylguanidine	30 per cent w/v Sodium hypochlorite solution	25 ml. of 20 per cent ethyl alcohol in light petroleum
Triphenylguanidine		
Thiocarbanilide		25 ml. of 1·5 per cent ethyl acetate in benzene
Tetramethylthiuram monosulphide	5 per cent w/v Aqueous $CuSO_4.5H_2O$	
Tetramethylthiuram disulphide		
Mercaptobenzthiazole (MBT)	5 per cent w/v $Bi(NO_3)_3$ in 0·5 N nitric acid	
Tetra ethylthiuram disulphide	5 per cent w/v Aqueous $CuSO_4.5H_2O$	25 ml. of 2 per cent ethyl acetate in carbon tetrachloride
Dibenzthiazolyl 2-disulphide (MBTS)	5 per cent w/v $SnCl_2.2H_2O$ in 2·5 N hydrochloric acid followed by 5 N sodium acetate followed by 5 per cent w/v $Bi(NO_3)_3$ in 0·5 N nitric acid	25 ml. of benzene
2-Benzthiazolyl N′-cyclohexyl sulphenamide		
Phenyl β-naphthylamine	1 per cent w/v $(NH_4)VO_3$ in 60 per cent sulphuric acid	25 ml. of 1 per cent ethyl ether in light petroleum
Phenyl α-naphthylamine		

ably unambiguous identification, which can be further confirmed by ultra-violet absorption measurements.

Using this method, it is possible to distinguish between the compounds named in the table even when present in admixture with one another and with other normal compounding ingredients, including pine tar. In most cases quantities as small as 0·05 mgm. can be detected on a column of 1 cm. diameter.

The same developers can be used for the detection of other accelerators and anti-oxidants, although complete separation from all other compounds cannot always be attained with a single chromatographic treatment. Thus it has been possible to detect *m*-toluylene diamine, *sym*-diphenyl-*p*-phenylene diamine, *sym*-dinaphthyl-*p*-phenylene diamine and some complex commercial materials containing, for example, aldehyde-amine condensation products or polymerized dihydroquinoline derivatives. The separation of more closely related compounds can also be attained. For example, derivatives of dimethyl-, diethyl- and dibutyl-dithiocarbamates can readily be distinguished from one another by chromatographing the brown copper complexes.

With minor modification, some of the methods can be adapted for quantitative determination. Good recovery of adsorbates has been obtained with the particular silica gel adsorbent in use. In this connexion, Bloomfield[5] has suggested that alumina may cause decomposition of labile accelerators during chromatography, and that such products may be mistaken for transformation products of the accelerator produced during the vulcanization process. Mann[2] has, in fact, observed the decomposition of dibenzthiazolyl 2-disulphide to mercaptobenzthiazole on alumina columns. In contrast, I have found that dibenzthiazolyl 2-disulphide can be chromatographed unchanged on our silica gel columns. Nevertheless, I have identified both mercaptobenzthiazole and dibenzthiazolyl 2-disulphide in the extracts of rubbers accelerated with either; this is in agreement with the findings of Dufraisse and Houpillart[6]. I have also observed mercaptobenzthiazole in the extract of a rubber accelerated with 2-benzthiazolyl N′-cyclohexyl sulphenamide. However, considerable care is required in the interpretation of the chromatograms, as there is evidence that labile accelerators can undergo further transformation during the process of acetone extraction of the rubber.

This investigation is continuing and will be reported in detail elsewhere.

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Translocation of Iron in Podzol Formation

SEVERAL mechanisms have been postulated to account for the translocation of iron and aluminium in the process of podzol formation. Thus Jones and Willcox[1] suggest that simple organic acids such as oxalic acid are responsible for the solution of the sesquioxides, while numerous workers[2] consider that the free oxides are peptized by the action of humus and move as sols.

It has been found in this laboratory that water extracts of the undecomposed leaves and bark of the New Zealand kauri (*Agathis australis*) and of Scots pine needles (*Pinus sylvestris*) are capable of causing rapid reduction of soluble ferric compounds to the extent of some 4–5 mgm. of iron per gram of air-dry Scots pine needles. Furthermore, over a wide range of *p*H values (4–7), the extracts are capable of causing non-biological solution of relatively large amounts of hydrous ferric and aluminium oxides. Ferrous iron, as determined by *αα*′-dipyridyl, accounts only for a part of the dissolved iron; but as the extracts are still capable of reducing considerably more iron than has already been dissolved, it is unlikely that the difference between the total and the dipyridyl-reactive iron represents iron in the ferric state. Experiments on the effect of the plant extracts on the recovery of ferrous iron by dipyridyl from solutions of ferrous sulphate show that complexing of the ferrous iron is, in part at least, the cause of the discrepancy between the total and the dipyridyl-reactive iron. It therefore seems probable that the whole of the dissolved ferric oxide is reduced to the ferrous state. Continuous aeration of the reaction mixture appears to have little or no effect on the solution and reduction of ferric oxide. These results resemble very closely those previously obtained with anaerobically fermented grass[3].

It can be seen from these results that the percolation of rainwater through undecomposed coniferous litter provides all the necessary conditions for the leaching of sesquioxides from the surface layers of the soil. In view of the capacity of the aqueous extracts for reducing ferric iron, it seems most probable that translocation of the iron takes place in the form of a ferrous organic complex.

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Relief of Hypoglycæmic Convulsions with Butyric Acid

THE lower volatile acids, acetic, propionic and utyric, have been widely studied in relation to termediary metabolism[1,2]. Propionic acid is known o be glucogenic, and sodium propionate has been ound to relieve severe hypoglycæmic symptoms in n adrenalectomized ewe; but sodium acetate was ithout effect[3]. Butyric acid has usually been studied n relation to the metabolism of fat and the pro-uction of ketone bodies[4]; but there are some uggestions that it may also be implicated in carbo-ydrate metabolism[5]. Moreover, Jarrett, Potter and ilsell[6] have found that the concentration of blood ugar and of pyruvic acid was increased after sodium utyrate had been injected into the blood-stream of heep.

In view of the possible association of the meta-olism of butyric acid with that of carbohydrate, the ffect of sodium butyrate administration on an nimal in convulsions was studied.

Eight young merino lambs aged between 1 and 8 days were fasted for 24 hr. and then given an travenous injection of insulin in the manner em-loyed by Comline *et al.*[7]. The subsequent hypo-lycæmic convulsions were found to be relieved by n intrajugular injection of 10 ml. sodium butyrate, ontaining 2·5 m*M* butyric acid/kgm. neutralized o *p*H 7·0 with sodium hydroxide. Sodium propionate 2·5 m*M* propionic acid/kgm.) had a similar effect, ut there was no response to sodium acetate (2·5 m*M* cetic acid/kgm.).

Convulsions which supervened in two adult ewes n which the splanchnic nerves had been sectioned[8] ere similarly relieved by 30 ml. of either butyrate r propionate but not by acetate.

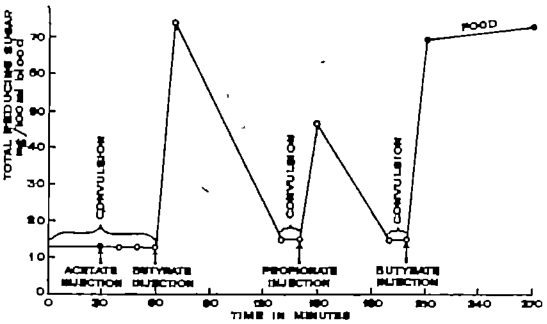
Insulin-induced hypoglycæmic convulsions in rab-its were also relieved by 5 ml. of intravenous sodium utyrate (2·5 m*M* butyric acid/kgm.) and by pro-ionate but not by acetate.

Total reducing sugar in the blood[9] estimated in amples taken prior to the insulin injection, during onvulsion, and ten minutes after the injection of e volatile acids, showed that the relief of the con-ulsions was accompanied by a considerable rise in lood sugar.

Convulsions in lambs ceased immediately after he injection of butyrate: the coma which super-ened for 1–2 min. gradually subsided and within -10 min. the animals had regained their feet. An pparently normal state was maintained for about 0–40 min.: the animals then became lethargic and fter 50–60 min. again convulsed. This second onvulsion could be relieved with butyrate and if, n recovery, the animals were allowed to suck from eir dams no further convulsions ensued.

Butyrate, when administered to the adult ewes, owever, relieved hypoglycæmic convulsions but with ss spectacular effect. Acetate was found to be effective and propionate gave no more relief than utyrate.

Rabbits were observed to respond to butyrate jection in much the same manner as lambs and wes. On some occasions the coma that followed the jection persisted for as long as 20 min., after which e animals recovered rapidly and began to eat if lowed access to food. If prevented from feeding, ey became convulsed again 60–90 min. later, and nder these conditions were relieved by another jection of butyrate. Acetate was again ineffective and propionate did not relieve the symptoms as effectively in the rabbits as in the lambs and sheep.



Blood sugar curves of lamb *F* (aged 28 days) after sodium acetate, propionate or butyrate (2·5 m*M*/kgm.)

The concentration of sugar in the bloods of the lambs was raised from the low level of 10–15 mgm./100 ml. to which it fell during the convulsions, to 50–80 mgm./100 ml. ten minutes after the injection of butyrate. Injection of propionate led to a rise of only 30–40 mgm./100 ml., while acetate produced no alteration in the blood-sugar level (see graph).

Similar results were obtained with adult sheep and rabbits: the butyrate in all cases led to a greater increase in blood sugar than the propionate. The sugar in the blood of rabbits, however, was not increased as much as that of the lambs and sheep, but it remained elevated for a longer period.

Sodium propionate is known to be glucogenic and therefore might be expected to relieve hypoglycæmic convulsions: the greater efficiency with which sodium butyrate can also relieve them suggests that butyric acid may readily be converted to glucose *in vivo*. The mechanism of this conversion is obscure.

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'Lipochondria' and the Golgi Substance in Epithelial Cells of the Epididymis

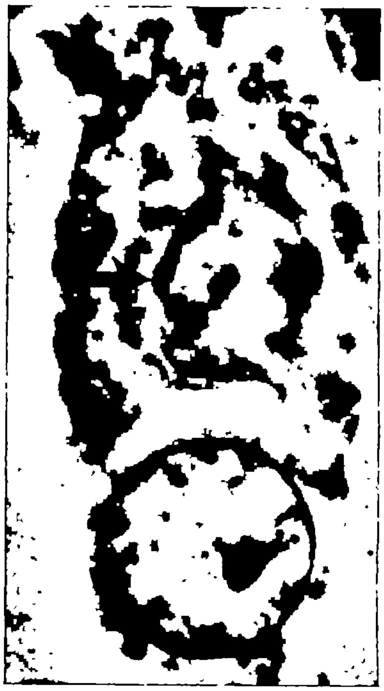
BOTH J. R. Baker[1] and O. L. Thomas[2] have expressed the view that 'lipochondria' (discrete sudanophilic droplets supravitally stainable with methylene blue and neutral red) are transformed into the classical Golgi network during the processes of fixation and impregnation with silver and osmic acid techniques. Thomas[2] also considers that mitochondria are involved in the development of the classical Golgi network during fixation.

In epithelial cells of the duodenum of the mouse we have not been able to demonstrate to our complete satisfaction that the droplets stainable supravitally with methylene blue and neutral red ('lipochondria'[1]) are identical with the substance stainable with sudan black in fixed material. The Golgi zone in this cell type is surrounded by numerous mitochondria as well as droplets of various size having different optical properties, so that for us it was impossible to determine accurately which bodies actually were within the Golgi zone and which were not. We decided, therefore, to turn to a study of the epithelial cells of the head of the epididymis of the mouse. These cells are relatively large compared with the epithelial cells of the duodenum and possess a large, clearly defined Golgi zone. Mitochondria and droplets are few in number in the immediate vicinity of the Golgi zone, and do not interfere noticeably with observations on this region of the cell.

We found that in this particular cell a classical Golgi network with filaments, lamellæ and vacuoles was strikingly demonstrable with phase contrast and less clearly but nevertheless definitely demonstrable with the ordinary light microscope in fresh unstained material. (A typical Golgi network may also be seen with phase contrast in some of the cells in fresh preparations of the seminal vesicles and ventral prostate gland of the mouse.) We also found that none of the substance of the Golgi zone stains supravitally with either methylene blue or neutral red. Droplets in the region between the nucleus and the Golgi zone took up these dyes avidly, but even after long intervals, when the nucleus became stained, there was still no evidence of staining within the Golgi zone. In fact, this zone was the one area of the cell which remained completely refractory to staining with these dyes. The strands of the network which appeared dark with the phase contrast and light microscopes stained diffusely with sudan black in fixed material. With the Kolatchev–Nassonov method these strands were impregnated with reduced osmic acid. Comparison of electron micrographs of positive and negative images of the Golgi material indicated that the substance responsible for the reduction of osmic acid (the osmiophilic component) is situated in the cytoplasm adjacent to the vacuoles and canals of the osmiophobic component. This suggests that the osmiophobic component represents the negative image of the Golgi substance frequently seen in routinely prepared and stained specimens, and that the osmiophilic component, being intimately associated with protein materials in the cytoplasm, does not contribute materially to this negative image.

Thus it may be stated that in this cell type the Golgi substance is clearly visible in the living cell as a definite network, classical in its form, which so far as we were able to determine is not modified by fixation with suitable fixatives. Further, it may be stated that in this instance the 'lipochrondria' of Baker have no structural or obvious chemical relationship to the Golgi substance, since by definition the 'lipochondria' are stainable supravitally with methylene blue and neutral red while the Golgi substance is not.

These results are comparable to those of O'Leary[4] who, following the lead of Bensley[5], demonstrated the negative image of the Golgi substance in living cells of the islets of Langerhans of the mouse ar determined that in this case also the Golgi substan was not stainable supravitally with either methyle blue or neutral red.



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We would like to add that we are in agreement wi Baker[1] and Thomas[2] to the extent that, whenev feasible, living tissues should be studied experimen ally in preference to fixed tissues, and that, whenev possible, studies on fixed tissues should be suppl mented by studies on living cells. We feel justifi in pointing out at this juncture, however, that the are uncertainties inherent in conclusions drawn fro comparisons made between living and fixed ce when the size of the structures under investigatio in these cells are at the border line of, or beyond, t resolving power of the optical equipment used make the comparison. We cannot agree with eith Baker or Thomas that studies with the electr microscope have no place in the elucidation the enigma of the Golgi substance. Rathe we believe with Beams *et al.*[6] that every availab means of analysis should be used. The resul reported above and those reported previously[7] a to us adequate demonstrations of the usefulne of the electron microscope in this area investigation.

The results of this study will be reported in det elsewhere.

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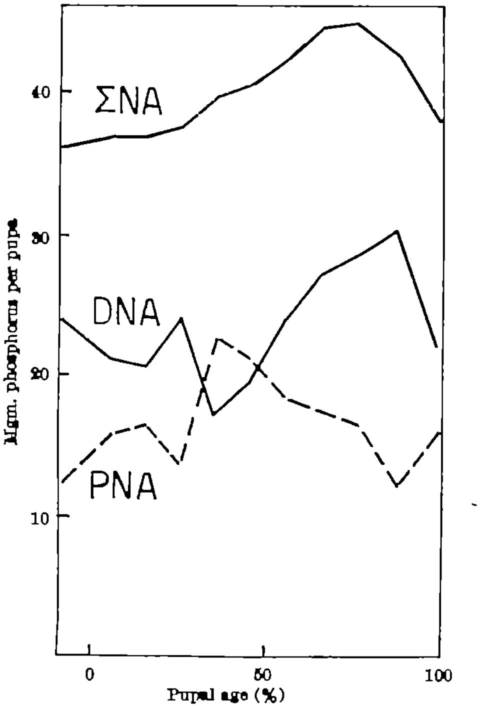
Nucleic Acid Metabolism during Insect Metamorphosis

THE transformation of the two nucleic acids, eoxyribonucleic acid and ribonucleic acid, one ito the other has been postulated by Brachet[1], sing developing sea urchin embryos as material for e investigation. Ribonucleic acid should be the recursor of deoxyribonucleic acid. These results ave been questioned by Villee *et al.*[2] and Abrams[3], mong others, who show that the amount of total ucleic acid phosphorus is not constant during deelopment. Further, with the aid of phosphorus-32 nd carbon-14 respectively, these investigators have emonstrated that the specific activity of deoxybonucleic acid is much higher, up to fifteen times, han of ribonucleic acid. These results indicate hat most of the deoxyribonucleic acid should rise from an endogenous precursor, which is not ibonucleic acid.

The insect pupa is a closed system in respect of ucleic acid metabolism. Moreover, metamorphosis characterized by a profound histolysis of the larval ssues and a corresponding histogenesis of the naginal organs. If there were any mutual interependence of the two nucleic acids, this would be een in such an organism. Therefore, investigations ere carried out on the fly *Calliphora erythrocephala* Meig.). As analytical method the phosphate fractiontion devised by Ogur and Rosen[4] was used. The hosphorus determinations were checked by spectrohotometric readings at 2500 A.

As is clear from the graph, there is an obvious nverse relationship between the amounts of deoxybonucleic acid and ribonucleic acid. Naturally his does not prove transformation from one acid o the other. However, it strongly suggests a mutual nterdependence of the two nucleic acids as regards heir synthesis.



Change in amount of deoxyribonucleic acid (*DNA*), ribonucleic acid (*PNA*) and total nucleic acids (*ΣNA*) during the metamorphosis period of *Calliphora*

There is an increase in total content of nucleic acid of about 25 per cent up to the point when histogenesis is almost finished. The phosphorus used seems to arise from the alcohol-soluble fraction. The final decrease is principally due to an increased decomposition of deoxyribonucleic acid during lysis of nuclei in the abdominal larval fat-body. The increase in amount of deoxyribonucleic acid during histogenesis is not only concerned with the growth of muscles in the thorax (cf. Agrell[5]). In the abdomen also there is an identical increase in deoxyribonucleic acid content, in spite of the fact that histogenesis processes are only very limited and consequently no increase in Feulgen-positive substance can be seen in this part of the body. It seems possible that deoxyribonucleic acid is synthesized in the cytoplasm of the abdominal fat-body cells in a form not detectable by the Feulgen reaction. The large cell granules of complex build could be the site of this process. The existence of cytoplasmic deoxyribonucleic acid has recently been shown to be probable by Zeuthen[6].

The inverse relationship in the amount of ribonucleic acid and deoxyribonucleic acid always shows the same course. However, the ratio of the two is remarkably different in different cultures of *Calliphora*; it varied from about 1·0 down to 0·4 in four experimental series of pupæ, all of which gave rise to normal imaginal flies.

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Progesterone in Body Fluids

A METHOD has been developed for the assay of progesterone by which as little as 4 μgm. of the hormone can be detected. It is based on the technique of extraction and partition between organic solvents[1] and subsequent separation and semi-quantitative estimation by chromatographic partition on filter paper[2]. The method has been used for the detection and semi-quantitative determination of progesterone in biological material. The results are summarized as follows.

Blood withdrawn directly from the ovarian vein of ewes contained progesterone in concentrations ranging from 0·5 to 2 μgm. per ml. (see table). On the other hand, all attempts to detect progesterone in peripheral blood were consistently negative, both in pregnant and non-pregnant animals, in mare, cow, ewe and sow, although the quantities of blood used for analysis ranged from 10 to 160 ml.; the blood analysed came mostly from the jugular vein (mare, cow, ewe and sow), occasionally also from the middle uterine artery and vein (ewe). No progesterone could be detected in blood from the caudal vena cava of a female rabbit seven days after ovulation.

In cases where progesterone was detected in blood, the residue left after extraction of the hormone was analysed for 'bound' or conjugated progesterone[3].

PROGESTERONE IN BLOOD FROM THE OVARIAN VEIN OF EWES

Animals examined	Condition of ewe	Condition of ovary	Quantity of blood (ml.)	Progesterone found (μgm.)	Approximate concentration (μgm./ml.)
1	98 days pregnant	1 Corpus luteum	31	60	2
1	8 months pregnant	2 Corpora lutea	15	8	0·5
1	3½ months pregnant	1 Corpus luteum (left ovary) 2 Graafian follicles (right ovary)	35 41	55 40	1·6 1
1	8 days post œstrum	2 Corpora lutea	22	12	0·5
1	28 days post partum	Quiescent	40	nil	less than 0·1
5					

'Bound' progesterone did not exceed 15 per cent of the total. Blood samples in which no free progesterone was found gave consistently negative results when analysed for 'bound' progesterone.

The effect of intramuscular injections of progesterone on the level of progesterone in blood was studied on rabbits. Blood withdrawn from the caudal vena cava of a doe 25 min. after an injection of 25 mgm. pure hormone (in oil) showed a content of 0·2 μgm. per ml. No progesterone could be detected in rabbit blood 3 hr. and 8 hr. after injection.

Fluid obtained from Graafian follicles of a sow nearly at ovulation contained 8 μgm. progesterone per ml.

Cow's follicular fluid near ovulation contained 3 μgm./ml.; no progesterone was found in developing follicles, nor, three and four days after heat, in follicles which had failed to ovulate.

Fluid obtained from ovarian cysts of nine sows contained 1–5 μgm. progesterone per ml.

Luteal tissue from an elephant ovary, which had been preserved in formalin for 23 months, contained 2 μgm. progesterone per gram.

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Cell Surface Constituents and Yeast Flocculation

THE cell wall of *Saccharomyces cerevisiae* holds nitrogen-containing complex polysaccharides. By a gradual extraction method I have obtained compounds which were homogeneous at sedimentation analysis and electrophoresis.

An aqueous suspension of fresh brewer's yeast was agitated with a laboratory stirrer for two hours at room temperature. A high-molecular mannan was thereby extracted, apparently being detached from the cell surface by friction. Analyses of the purified substance showed 1 per cent nitrogen and 0·2 per cent phosphorus. The molecular weight was calculated from sedimentation and diffusion measurements to be 340,000. The compound was of anodic migration in the *p*H range 3–10. At complete extraction 0·3 per cent was obtained from dry yeast. The substance was called 'cebrosan'.

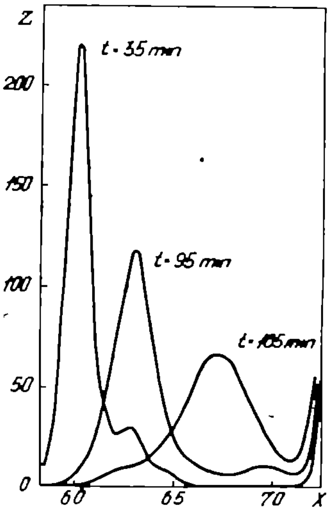
When the agitation was continued at a temperature of 30–45° C. a mucopolysaccharide with higher contents of nitrogen and phosphorus was extracted, of $s^0_{20} = 8 \cdot 1\ S$, and the isoelectric point 5·1. About 1 per cent from dry yeast was isolated. The substance was called 'mycetin'.

At subsequent high-speed agitation in a 'Turm blender about the same amount of yeast nucleic ac was extracted ($s^0_{20} = 2 \cdot 55\ S$). The preparatic were often accompanied by two high-molecular carl hydrates ($s_{20} \sim 13$ and $16\ S$, respectively) in mn quantities. No cell proteins were extracted by tl treatment.

When yeast of 25 per cent dryness was stor at 30–40° C. for two days, in the extracellu solution were found macromolecular carbohydrat in considerable amounts (6 per cent from d yeast), at nitrogen contents of 5–7 per cent up dry substance. Sedimentation analysis made evide four main compounds, of $s_{20} = 2 \cdot 8, 4 \cdot 0, 6 \cdot 5$ and $7 \cdot 2$ respectively, as well as a carbohydrate of bas properties, of $s^0_{20} = 3 \cdot 6\ S$. The latter was isolat by precipitation with alcoholic ammonia. It ga Ehrlich's reaction for glucosamine, and contain 5 per cent nitrogen. It was of cathodic migration the *p*H interval 4–11. A sedimentation diagra for the substance is given in the accompanyi illustration.

From top fermentation brewing yeast were obtain the same compounds as from bottom fermentati yeast. An essential difference was the extraction 1–2 per cent proteins on agitation of a top yea suspension at 30–45° C., which was not observ with bottom yeast.

Electrophoretical investigations upon isolated ce wall constituents made evident compounds of positi as well as negative charge. The flocculation mec anism is essentially explainable by the mutu attraction of oppositely charged groups on t surfaces of different cells, whereby large c



Sedimentation diagram for the basic compound extracted from the cell wall glomerations are rapidly modified. A coating ch proteins hinders the flocculation of top yeast, ess the pH of the medium is lower than their electric point, and favours adherence to carbon xide bubbles during fermentation, by which the ast rises.

The investigations were carried out at the titute of Physical Chemistry, University of psala, during 1948–51, with financial assistance m A. B. Stockholms Bryggerier, Stockholm. tailed results will be published elsewhere.

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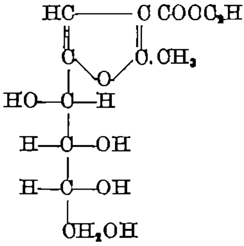
Biosynthesis of Vitamin C and a New Precursor

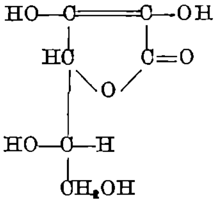
IEXOSE sugars and sugar acids have long been own to be concerned in the biosynthesis of vitamin [3], and it was also reported by Nath *et al.*[4,5] that ection of acetoacetate causes an immediate rise blood sugar in the rabbit and accelerates the biothesis of vitamin C in the animal system; although a higher dose of 180 mgm./kgm. causes about per cent decrease in vitamin C in the blood of bits in half an hour, an increase to the extent of per cent is observed in rats under identical conons, thus indicating the enormous capacity of s for the biosynthesis of vitamin C in their bodies, showing at the same time the possibility of toacetate being concerned in the process too.

Vith the view of gaining some insight into the mechsm, glucose and acetoacetate (sodium salt), both arately and combined, were added to the medium d for germination of a legume—green gram *aseolus mungo*). The seeds were first soaked in s-distilled water for about three hours prior to ping them in the presence of various aqueous lia containing these different substances at pH 7·4. each experiment, 500 seeds were taken and cted in such a way that each group had almost al weight.

ecause glucose has been found to condense with oacetate *in vitro*[6,7] to give rise to a product— tra hydroxy butyl 5-methyl 4-carbethoxy furan the structure of which resembles to a great ınt that of ascorbic acid (II), and because both constituents of (I) were found to be concerned he biosynthesis of (II), it was also decided to ly its effect in the process of biosynthesis of min C. This condensation product (I) was pared according to the method of West[6], with it modification, as follows.



(I)

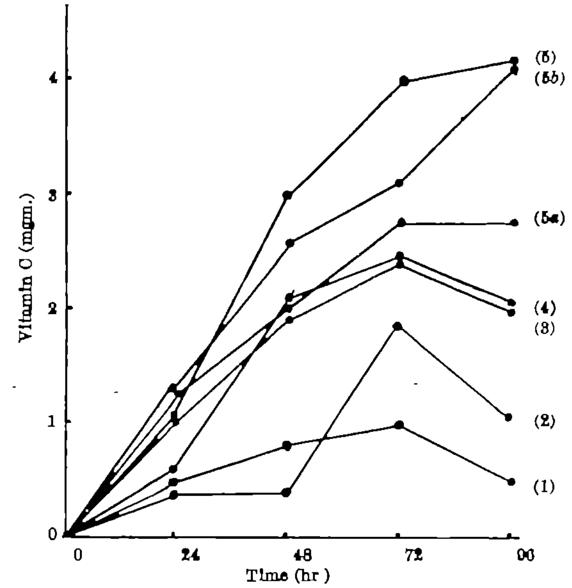


(II)

)0 gm. of glucose finely powdered was mixed oughly with 100 gm. of fused zinc chloride; this ture was then introduced in a round-bottomed 'ex' flask, which was immersed in boiling water, 50 gm. of ethyl acetoacetate and 50 c.c. of lute alcohol were added. The mixture was then rously stirred continuously until a heavy yellow p was obtained, approximately in about 25 min. ing this period of reaction, absolute alcohol (50 was again added for the second time. The syrupy s was then poured into about 150 c.c. of water kept overnight in the refrigerator, when fine ening needle-shaped crystals of the condensation luct of glucose and acetoacetate were found to separated out. The crystals were then separated from the mother liquor and washed repeatedly with ice-cold water. The substance was freed from adhering glucose and other impurities by repeated crystallization from hot water. The yield was about 25 gm. The substance melts sharply at 153° C. (corrected) and $[\alpha]^{20}_{D}$, as found by West[6], is $-19{\cdot}00°$ in water.

In order to prevent the ascorbic acid formed from being auto-oxidized during the process of germination, potassium *meta*-bisulphite, concentration 300 p.p.m., was added to all the different media, as recommended by Kendrick and Downer[8]. After the specified periods of germination in the dark, 100 seeds were removed from the dish, the testa removed and extracted repeatedly (thrice) with meta-phosphoric (3 per cent)–acetic acid (8 per cent) mixture, and vitamin C estimated according to the modified titrimetric method of Bessey[9].

All the experiments were repeated three times, and their average values, obtained with each type of substance in the germinating media after 24, 48, 72 and 96 hr., respectively, are shown graphically in the figure. The mean deviation in no case exceeded ± 0·18 up to 72 hr. This experiment was repeated several times, and the direct method of Roe and Kuether[10] (that is, by coupling the dehydroascorbic acid, formed by oxidation, with 2-4 dinitro phenyl hydrazine), which is much more specific for vitamin C, was used. Almost similar results were obtained by



Effect of various substances (in equimolecular quantity) on the amount of vitamin C formed during germination of 100 seeds (green gram): (1) acetoacetate (sodium salt) (72 mgm. per 100 seeds); (2) glucose (100 mgm.) and acetoacetate (72 mgm.) mixture per 100 seeds; (3) water, (4) glucose (100 mgm. per 100 seeds); (5) condensation product of glucose and acetoacetate (152 mgm. per 100 seeds); (5a) condensation product of glucose and acetoacetate (5 mgm. per 100 seeds), (5b) condensation product of glucose and acetoacetate (25 mgm. per 100 seeds) this method also, thus confirming that the substance responsible for the decolorization of the indophenol dye in Bessey's method is nothing else but the ascorbic acid.

It is quite evident from the graph that, although glucose alone (100 mgm. per 100 seeds) has but slight effect in increasing the concentration of vitamin C, sodium acetoacetate alone (equimolecular quantity) decreases the same considerably, while a combination of the two in equimolecular proportion shows sudden acceleration after 48 hr.; and it is interesting to note that the freshly prepared crystalline condensation product (I) shows gradual increase in the quantity of vitamin C even from the very beginning, and the result after 96 hr. is more than 100 per cent higher than that with glucose alone, thus showing the possibility of its playing the part of a precursor of ascorbic acid and of doing away with the possibility of acting as a catalyst only.

It is worth noting also that even a very low concentration of the condensation product (5 mgm. per 100 seeds) is much more effective than a much higher concentration of glucose (100 mgm. per 100 seeds), and the result with 25 mgm. per 100 seeds is as high as with 152 mgm. after 96 hr.

A sudden rise in vitamin C in case of glucose plus acetoacetate after 48 hr. may also be the result of formation of the condensation product through enzymatic processes during the course of germination.

Further details will be published elsewhere.

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Feb. 28.

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Permeability of Yolk of the Hen's Egg to Bromine-82

To investigate the resistance to diffusion between the two phases of the egg, the 34-hr. isotope of bromine (^{82}Br) as bromide was injected into the white in many eggs and its penetration into the yolk measured after various periods of time. About 5 ml. of the white of the egg to be injected was mixed with ¼ ml. of the radioactive bromide in isotonic solution, and injected as uniformly as possible throughout that remaining in the shell. The egg was maintained during the experimental period at 1° C., and, at its conclusion, frozen in a mixture of ether and dry ice. The yolk and white could then be separated cleanly with a sharp blow, and were conveniently diluted and their activities measured with a Geiger–Muller counter dipping into the liquids.

While the white was frozen, it was possible to scrape its entire inner surface, to collect the scrapings, and to analyse them separately. This showed that the activity of the layer in contact with the yolk was half that in the main mass of the white aft 5–10 min., and that after 1 hr. there were no long significant differences.

The rate of entry of the bromine-82 into the yc was found to be constant between 5 and 200 h the longest experimental time which was practicab when the activity reached, in the mean, 2·5 per ce of that in the white. This suggested that the penetr tion was across a single resistant barrier surroundi the yolk. That this was not the only obstacle w made evident when the distribution of the pen trating material within the yolk was studied. T superficial layer of the frozen yolk was sliced c weighed, and analysed separately, and it was fou that, even after 100 hr., one-third of the bromine- remained in the outermost 0·4 gm., correspondi to a thickness of about 0·1 mm. It is clear th after having passed the external resistant barrier, t ion still encounters an obstacle to its penetration in the yolk, and one is led to postulate a second barr some tenths of a millimetre below the first; it is be presumed that this system of spaced-out barri would be repeated towards the centre of the yolk.

Before the fifth hour, the amount of bromine- found in the yolk is greater than that expected fr the constant rate of entry found later. This exc of bromine-82 relative to its concentration in t layer of white in contact with the yolk, is marked lower in the shortest experimental times, suggesti that it is not due to contamination of the yolk the white during or after freezing, but rather the penetration of the ion into an outer layer yolk before the first resistant barrier is reache As the vitelline membrane in the frozen egg variably remained attached to the white, it wou seem that this cannot be the resistant barrier question.

A full account of the work will appear elsewhere.

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May 8.

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Single-spore Cultures of Heterothallic *Saccharomyces cerevisiae* which mate wit both the Tester Strains

Lindegren and Lindegren[1] observed that ra single-spore cultures produce abundant copulati tubes when the culture reaches full growth, and th the cells from these cultures can conjugate with t cells of any other culture irrespective of its bei (+) or (−). They regarded this as a loss of d criminatory power due to a mutation of the ge producing copulation tubes.

During an investigation of the mating system Danish baking yeast, *Saccharomyces cerevisiae*, thı such 'highly fertile' cultures were found. Each them showed the formation of copulation tubes wi both the tester strains. When original cultures we examined, abundant copulation tubes and zygo were seen in each of them.

It was decided to isolate single cells and gr single-cell progenies, in order to see whether ea cell belonging to these 'highly fertile' cultures h lost the power of discrimination and could mate wi both the tester strains or not. Five cells with copu tubes and six ordinary vegetative cells were ated from one of these cultures. Single-cell tures were grown from them and tested for their ting capacity. As seen from the table, out of cells with copulation tubes, four gave a (+) ting reaction and one a (—) reaction; likewise, the six vegetative cells, one gave a (+) mating ction and five a (—) reaction.

Nature of cells isolated	No of cells isolated	No of single cells showing a (+) mating reaction	No. of single cells showing a (—) mating reaction
lls with opulation ubes	5	4	1
egetative ells	6	1	5

The facts that each of the single-cell progenies m the single-spore culture gives mating reaction h only one of the two tester strains, and that genies from some cells prove to be (+) and from ers (—), show that the mating responses of these cks with both the tester strains were due, not to s of mating discrimination, but to the creation of ls of opposite mating type within the culture ough mutation[2]. The simultaneous existence of h types of cells in the culture results in the pro- ction of copulation tubes and zygotes in these cks; and when they are tested with the tester ains, (+) cells in the culture produce copulation es on crossing with (—), and (—) cells on crossing h (+). This explanation seems more plausible n to assume the same cell on different occasions l respond to both as a result of loss of discrim- tory power.

M. AHMAD

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Feb. 26.

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Edmond About and the Technique of Freezing and Drying Tissues

THE procedure of freezing and drying tissues for purposes of histology is commonly known as Altmann or Altmann–Gersh method. Altmann blished his method in 1890[1], and Gersh, in 1932[2], scribed fundamental improvements in the tech- ue. It is curious that in 1862 the basic principles the method were described in "L'homme à l'oreille sée", a scientific romance by Edmond About, an glish translation of which was available in 1867.

About describes how the frozen body of a French soner was carefully dehydrated *in vacuo* over phuric acid and calcium chloride and preserved a German man of science during the Napoleonic ars. The technical detail given by About is very usible; he describes how the quality of the ezing was checked by observing the perfect servation of the red blood cells. This is a test t I personally used before reading the book.

have not been able to discover any information to the extent of About's scientific training, and suggestions as to the source of his ideas can only speculation. The discovery of the technique of frozen sectioning is given by Mann[3] as 1842, and it is possible that About knew of this technique and improved on it for his story. It is also possible that he was elaborating the legends of bodies being recovered from glaciers.

It is a pleasing speculation to suggest that a German histologist may possibly have obtained the idea for a fundamental technique from reading a scientific romance.

I am indebted to Dr. Henri Firket for bringing the book to my notice.

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Terminology applied to Computing Machines

MAY I suggest that a protest is overdue against the anthropomorphic character of the terminology that is being applied to electronic digital computors? To the layman the use of such a terminology seems to ascribe human or near-human properties to these machines. Not only is it undesirable to use such terms, but also it is quite unnecessary, as alternative engineering terms are well established.

Those who describe electronic digital computors often use the term 'instruction', for example, when speaking of what is done to the machine by the operator. The word 'teaching' has even crept in. In engineering, the words 'setting' or 'adjustment' have exactly the same meaning. Why not use them? Numbers associated with these devices are given the name 'information' where the established term is 'readings'. Enthusiasts for electronic digital computors speak of the 'memory' of these machines; engineers would, instead, speak of 'records' or 'stores'. For the symbols that represent numbers in the mechanism, again, these enthusiasts have introduced the term 'machine language' where an engineer would say 'code'. Perhaps worst of all, a predetermined sequence of events in a digital electronic computor has been spoken of as a 'decision' of the machine.

Biologists and other men of science are careful to warn against anthropomorphic interpretations of animal behaviour. They avoid the word 'decision' when speaking of animals lest it convey to the lay public the suggestion that the animal's powers of volition resemble those rightly or wrongly assumed when the word is applied to human affairs. They are right, for many fallacies are rooted in anthropomorphic habits of thought. Is it wise, then, to encourage the lay public to believe that electronic digital computors possess rudimentary powers of scholarship, reasoning and volition, and that they may be thought about in a way that would be deprecated if applied to lower animals? There is abundant evidence that, aided by the new unfortunate terminology, such a notion is being spread. Hence this protest.

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FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Wednesday, October 1

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Scientific Papers.

BRITISH KINEMATOGRAPH SOCIETY (joint meeting with the TELEVISION SOCIETY, at the Gaumont-British Theatre, Film House, Wardour Street, London, W.1), at 7.15 p.m.—Dr. W. D. Wright: "The Viewing of Moving Pictures (Film and Television)".

Wednesday, October 1—Saturday, October 4

INTERNATIONAL UNION OF NUTRITIONAL SCIENCES (at Basle, Switzerland).—Symposium on "Present Problems in Nutritional Research".

Thursday, October 2

ASLIB, NORTHERN BRANCH (in the Council Chamber, Guildhall, Kingston-upon-Hull), at 11 a.m.—Conference.

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. R. E. Hardingham: "Maintaining Airworthiness in Operation" (Eighth British Commonwealth and Empire Lecture).

Friday, October 3

ASSOCIATION OF APPLIED BIOLOGISTS (in the Mining Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 11 a.m.—Papers on "Forestry Problems".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SCIENTIFIC OFFICER and an ASSISTANT EXPERIMENTAL OFFICER—The Secretary, The Hannah Dairy Research Institute, Kirkhill, Ayr (October 6).

ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY (knowledge of cartography is desirable)—The Registrar, Queen Mary College, Mile End Road, London, E.1 (October 7).

LECTURER and an ASSISTANT LECTURER IN THE FACULTY OF EDUCATION at Makerere College, University College of East Africa—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 10).

SENIOR RESEARCH OFFICER (with honours degree in physics or engineering, proven research ability, experience of length measurement and in handling of staff) IN THE DIVISION OF METROLOGY, National Standards Laboratory, New South Wales, to undertake research work in a well-equipped laboratory and to supervise work of the Length Section—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3984 (October 15).

DEPUTY DIRECTOR OF RESEARCH—The Director of Research, British Leather Manufacturers' Research Association, Milton Park, Egham, Surrey (October 2[illegible]).

LECTURER IN PHYSICS (with an honours degree and experience in research), and an ASSISTANT LECTURER IN PHYSICS (with an honours degree: research experience would be an advantage), at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 20).

ASSISTANT LECTURER IN MATHEMATICS at the University College of the West Indies—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 25).

ASSISTANT LIBRARIAN and LIBRARY ASSISTANTS at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (October 30).

LECTURER (qualified either in mathematical statistics, or in pure or applied mathematics, but preferably with special knowledge of statistics) IN THE DEPARTMENT OF MATHEMATICS, University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

LECTURER IN THE DEPARTMENTS OF MATHEMATICS AND APPLIED MATHEMATICS, University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (October 31).

RESEARCH FELLOW (with a science degree of at least second-class honours and experience of ecological work in the field) to engage in fundamental research to determine the carrying capacity of the Hluhluwe Game Reserve, Zululand, in respect of certain animals, notably zebra and blue wildebeeste—The Secretary, Natal Parks, Game and Fish Preservation Board, P.O. Box 662, Pietermaritzburg, Natal, South Africa (October 31).

DIRECTOR OF STUDIES (with good academic qualifications and educational experience; university teaching experience would be an advantage) for the Royal Air Force College, Cranwell, to be responsible, under the Commandant, for directing and supervising the educational course in scientific, technical and humanistic subjects—The Air Ministry, S.2(c), Cornwall House, London, S.E.1.

HEAD OF THE MATHEMATICS DEPARTMENT (with a good honours degree and good experience in teaching mathematics to advanced students of technical and university colleges)—The Registrar, Technical College, Sunderland, Co. Durham.

JUNIOR SCIENTIFIC OFFICER (male or female, with an honou degree in general science, pharmacy or biology) to undertake tec nical work in the Blood Transfusion Service Laboratory—The Direct Regional Transfusion Centre, Roby Street, Manchester 1.

PHYSICIST (with honours degree) for work in Technological Depa ment involving investigations into friction and measurement a control of yarn tension—The Secretary, British Rayon Resear Association, Barton Dock Road, Urmston, Manchester.

SCIENTIFIC OFFICER and an ASSISTANT (Scientific) IN THE ME POLITAN POLICE LABORATORY—The Secretary, Room 163, N Scotland Yard, London, S.W.1.

REPORTS and other PUBLICATION

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Philosophical Transactions of the Royal Society of London. Ser A: Mathematical and Physical Sciences. No. 889, Vol. 244: Grav Measurements in the Eastern Mediterranean. By R. I. B. Coop J. C. Harrison and P. L. Willmore. Pp. 533–559. 6s. 6d. No. 8 Vol. 244: Seismic Refraction Shooting in an Area of the Easte Atlantic. By Dr. M. N. Hill. Pp. 561–596. 7s. 6d. (London: Ca bridge University Press, 1952.) [1

Colonial Office. The Colonial Territories, 1951–52. (Cmd. 8553.) P x+140. (London: H.M. Stationery Office, 1952.) 4s. 6d. net. [2

Ministry of Agriculture and Fisheries. American Agriculture: Background and its Lessons. By A. N. Duckham. Pp. iv+78 4 plates. (London: H.M. Stationery Office, 1952.) 2s. 6d. net. [2

Council for the Preservation of Rural England, Sheffield and Pe District Branch. Annual Report, 1952. Pp. 28. (Sheffield: Ho Sec., Mrs. Gerald Haythornthwaite, Endcliffe Vale House, 1952.) [2

Lister Institute of Preventive Medicine. Report of the Govern Body, 1952. Pp. 20. (London: Lister Institute, 1952.) [2

Iodine Pharmaceuticals: a Checklist of Iodine Compounds a Preparations used in Human Medicine. Pp. vi+78. (London: Chile Iodine Educational Bureau, 1952.) 2s. 6d. [2

Lectures, Monographs and Reports 1952. No. 2: Studies in t Chemotherapy of Tuberculosis. By Dr. Vincent C. Barry. Pp. 1 (London: Royal Institute of Chemistry, 1952). 3s. net. [2

Philosophical Transactions of the Royal Society of London. Seri B: Biological Sciences. No. 636, Vol. 236: Nuclear Division in Ni Species of small Free-living Amoebae and its Bearing on the Classific tion of the Order Amoebida. By B. N. Singh. Pp. 405–461. 1 No. 637, Vol. 236: A Study of the Plasma Cell and Lymphocy Reaction in Rabbit Tissue Homografts. By D. O. Darcy. Pp. 463–50 9s. 6d. (London: Cambridge University Press, 1952.) [2

Colonial Office. British Dependencies in the Caribbean and Nor Atlantic, 1939–1952. (Cmd. 8575.) Pp. xi+98. (London: H. Stationery Office, 1952.) 3s. 6d. net. [2

Fitzwilliam Museum. Annual Report for the Year ending December 1951. Pp. 9+4 plates. Friends of the Fitzwilliam Museu Forty-third Annual Report for the Year 1951. Pp. 8. (Cambridg Fitzwilliam Museum, 1952.) [2

Boulton, Watt and the Soho Undertakings. By W. K. V. Gal with an Appendix by W. A. Seaby. Pp. v+40+10 plates. (Birmin ham: Museum and Art Gallery, 1952.) 2s. 6d. [3

Other Countries

Classified List of Smithsonian Publications available for Distrib tion, May 1, 1952. Compiled by Lester E. Commerford. (Publicati 4084.) Pp. vi+61. (Washington, D.C.: Smithsonian Institut 1952.) [1

Smithsonian Miscellaneous Collections. Vol. 117, No. 10: Peri icities in the Solar-Constant Measures. By C. G. Abbot. (Publicati 4088.) Pp. ii+31. Vol. 117, No. 11: Important Interferences wi Normals in Weather Records, associated with Sunspot Frequen By C. G. Abbot. (Publication 4090.) Pp. ii+3. (Washington, D.C Smithsonian Institution, 1952.) [1

East African Tsetse and Trypanosomiasis Research and Reclam tion Organization. Annual Report 1951. Pp. 56. (Nairobi: Ea African Tsetse and Trypanosomiasis Research and Reclamat Organization, 1952.) [1

Fiskeridirektoratets Skrifter, Serie Havundersøkelser. Vol. 9, N 16: The Annual Phytoplankton Cycle of a Landlocked Fjord ne Bergen (Nordåsvatn). By Trygve Braarud and Brigt Hope. Pp. Vol. 10, No. 1: Faktorer av betydning for fiskeeggenes og fiskeyngele oppvekst. Av Alf Dannevig og Sigurd Hansen. Pp. 36. (Berge A/S John Griegs Boktrykkeri, 1952.) [1

Chimiothérapie du cancer considéré comme maladie à virus. Les aldéhydes. Par J. Solomidès en collaboration avec H. Ronal (Monographies d'oléothérapie expérimentale, Vol. 1.) Pp. 56. (Pari Libr. Le François, 1952.) [1

Astrophysica Norvegica. Vol. 5, No. 2: Slow Thermally Frictionally Controlled Meridional Circulations in a Circular Vort By Arnt Eliassen. Pp. 19–60. (Oslo: Jacob Dybwad, 1952.) [1

Coryndon Memorial Museum. Annual Report for 1951. Pp. 2 (Nairobi: Coryndon Memorial Museum, 1952.) 1s. [1

United States Department of Commerce: Weather Bureau. Tec nical Paper No. 15. Maximum Station Precipitation for 1, 2, 3, 6, and 24 Hours. Part 3: Florida. Pp. ii+92. (Washington, D.C Government Printing Office, 1952.) [1

A Demographic Study of the Eurasian Population in Rangoon 1949. By John Clement Koop. Pp. iv+56. (Rangoon: Ang Burman Union, 1952.) [1

Publikace Ústředního Ústavu Astronomického, Číslo 22 (Publi tions de l'Institut Central d'Astronomie, No. 22): Katalog Chrom Chromosférických Erupcí, Část První (Catalogue d'activité d éruptions chromosphériques, Première partie). Napsal Josip Klec Pp. 104. (Praha: Přírodovědecké vydavatelství, 1952.) 90 Kčs. [1

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AN AUSTRALIAN ACADEMY OF SCIENCE

IN 1951 the Australian National University organized a seminar on "Science in Australia" as part of the jubilee celebrations of the Federation of the Australian States. This gathering, generally representative of Australian science, was aided greatly in its discussions by the presence of Sir Edward Mellanby, from Great Britain, and of Dr. J. B. Conant, president of Harvard University. Scientific activity in Australia was reviewed in an endeavour to find how best it should develop in the future. It had become clear that in a country of such large size, with a scattered scientific community, where responsibility for scientific work is divided between the universities and institutions of the various States, on one hand, and those of the Commonwealth Government on the other, it is extremely difficult to preserve unity and to ensure that achievement is recognized and fostered. The relative isolation of Australian scientists, not only from scientists abroad, but also from their colleagues within Australia, is a major hardship. Much has been achieved and science has made a great contribution to the welfare of Australia; but it is felt that the development of an integrated scientific community will stimulate greater progress. For these reasons the proposal by Prof. M. L. Oliphant that active steps be taken to found an Australian Academy of Sciences received strong support.

The idea of a national scientific body in Australia is not new. Several attempts have been made in the past to establish an institution to encourage the pursuit of natural knowledge as do the Royal Society in Great Britain and the various national academies of science in Europe and America. These attempts were frustrated by the time and expense involved in bringing even a small number of men of science together for regular meetings in the days before air travel virtually eliminated time consumed in movement about Australia, or a rapidly growing public appreciation of science, and the part played by science in the development of the country, made it easier to obtain financial support for scientific activities. Inter-State jealousies, and the fear by the States of encroachment by the Commonwealth upon their rights and privileges, added to the difficulties encountered.

The only effective scientific body which covered the continent was the Australian and New Zealand Association for the Advancement of Science (A.N.Z.A.A.S.), closely resembling the British Association in the United Kingdom. The periodic meetings of the Association became the natural means of personal contact between scientists. The sectional sessions became serious scientific discussions, and the habit grew of holding meetings and congresses of scientific societies during the gatherings of A.N.Z.A.A.S. It was natural, therefore, that the endeavour after the First World War to form international scientific bodies should result in the formation of a National Research Council (A.N.R.C.), at first as an independent body, but later composed of the Australian Fellows of A.N.Z.A.A.S.

Within the limitations imposed by lack of funds and its diffuse membership, A.N.R.C. has done a great deal for Australian science. In particular, it has fostered national and international congresses, encouraged the pursuit of anthropology, urged the development within the universities and government institutions of necessary scientific activities, and has given advice to State and Commonwealth governments upon matters affecting research and teaching in science. Its members have been informed of its activities through the publication of the *Australian Journal of Science*; it has established and maintained responsibility for the anthropological journal *Oceania*, and more recently has collaborated with the Commonwealth Scientific and Industrial Research Organization in the general supervision of the *Australian Journal of Scientific Research*. However, because of its very restricted resources, the A.N.R.C. has been entirely dependent upon a few devoted officers in Sydney and Melbourne, between which cities the Executive Council has alternated every few years; members of this Council from other States have been unable to attend its meetings and have had to nominate proxies, while lack of contact between the ordinary members has led to growing apathy on the part of the majority.

For these and other reasons, including the relationship with A.N.Z.A.A.S., it became the general feeling of members that there was little prospect of reforming A.N.R.C. from within so that it could discharge effectively the functions of a national body representative of science in Australia.

Dr. D. F. Martyn and Prof. M. L. Oliphant decided to make a fresh approach to the problem by inviting the Fellows of the Royal Society resident in Australia to become the foundation members of a new organization. This group of thirteen chose eleven other Australian scientists, who it was unanimously agreed should be potential members of an Academy, to sit with them as founders of the new body. The A.N.R.C. was kept fully informed at all stages of the discussions, and joint meetings with its Executive Committee were held in Sydney and in Canberra. At the annual meeting of A.N.R.C. on August 19, unanimous approval was given to the proposals for an Academy, and it was decided that when in active operation it will take over the present functions and responsibilities of A.N.R.C. It is a tribute to the spirit of Australian science that, in the common cause, some 150 scientists should, by this action, have withdrawn voluntarily from immediate participation in the government of the principal scientific society in the country.

At an early stage in the discussions representatives of the embryonic Academy were received by the Prime Minister, who expressed keen interest in the proposed institution and said that his Government would give sympathetic consideration and support to a national body which was adequately representative of Australian science and which had ensured that it would maintain high standards.

The task before the foundation group of the Academy is now to draw up a constitution, statutes and rules and to apply for a Royal Charter. Th Commonwealth Solicitor-General and his Office hav agreed to give guidance upon procedures.

Since the pursuit of science is now a major activit in a developing Australia, it is probable that th Fellows of the Academy will number eighty in th course of time. This would be approximately th same proportion, on a population basis, as th Fellowship of the Royal Society in Great Britair However, it is not anticipated that the number c Fellows in the early years will rise rapidly abov about fifty.

In order that the wide representation of scientifi men provided by A.N.R.C. should not be destroyec and to foster regional interest in the Academy, it ı contemplated that a number of regional committee will be established consisting of Fellows of th Academy resident in a region together with a numbe of local scientists who are not Fellows. These regiona committees will have no part in the government c the Academy, but will advise the parent body upo the scientific problems and needs of the widel dispersed parts of the continent.

The headquarters of the Academy will be in th Federal Capital, Canberra, where it is hoped tha suitable accommodation will be provided. Th government of the Academy will be modelled upo that of the Royal Society, with modifications to su Australian conditions.

The foundation group of the new body consists c the following Fellows of the Royal Society: Si Douglas Mawson, Antarctic explorer and professo of geology in the University of Adelaide; Sir Davi Rivett, formerly chairman and chief executive office of C.S.I.R.O. and formerly professor of chemistry ı the University of Melbourne; Sir Macfarlane Burne director of the Walter and Eliza Hall Institute c Medical Research in Melbourne; Prof. J. C. Eccle professor of physiology in the John Curtin School c Medical Research, Australian National University Prof. O. Tiegs, professor of zoology in the Universit of Melbourne; H. R. Marston, chief of the Divisio of Nutrition and General Biochemistry, C.S.I.R.O. Adelaide; Prof. T. G. Room, professor of math matics (pure), University of Sydney; Dr. D. F Martyn, chief scientist of the Radio Research Boarc Canberra; Prof. J. A. Prescott, director of the Wait Agricultural Institute, Adelaide, and professor c agricultural chemistry in the University of Adelaide Prof. K. E. Bullen, professor of mathematics (applied University of Sydney; Prof. D. G. Catcheside, pro fessor of genetics in the University of Adelaid (Waite Institute); Dr. R. Lemberg, Institut of Medical Research, Royal North Shore Hospita Sydney; and Prof. M. L. Oliphant, director of th Research School of Physical Sciences, Australia National University; together with the following Prof. R. v. d. R. Woolley, Commonwealth astronome and professor of astronomy in the Australian Nation University, Commonwealth Observatory, Canberra J. Pawsey, assistant chief of the Division of Radio physics, C.S.I.R.O., Sydney; Prof. R. J. W. LeFevre professor of chemistry, University of Sydney; Prof S. Sunderland, professor of anatomy in the Universit

Melbourne; L. Clunies-Ross, chairman of C.S.I.R.O., elbourne; Prof. T. M. Cherry, professor of mathe- atics, University of Melbourne; Prof. L. G. Huxley, ofessor of physics in the University of Adelaide; rof. E. S. Hills, professor of geology in the University Melbourne; A. J. Nicholson, chief of the Division Entomology, C.S.I.R.O., Canberra; Prof. L. H. artin, professor of physics in the University of elbourne; with Prof. H. K. Ward, chairman of .N.R.C., as an observer. Dr. D. F. Martyn is acting secretary *pro tem.*

THE AMERICAN FARMER AND HIS WOODLANDS

orestry in Farm Management

y R. H. Westveld and the late Ralph H. Peck. econd edition, revised by R. H. Westveld. Pp. i+340. (New York: John Wiley and Sons, ıc.; London: Chapman and Hall, Ltd., 1951.) 0s. net.

ALTHOUGH I have not had the good fortune to visit the United States and its forest areas, I el that an intimate knowledge of American forestry ractice is not necessary in order to recognize the erits of this admirable book. If there was a British ersion (and how valuable it would be), it could well e renamed "Forestry in *Estate* Management", since is book would appear to have more in common with state forestry in Great Britain than with farm oodlands as we know them over here.

Judging from the advice offered to American eaders, it would seem that there are many aspects f private woodland management which are common both countries. The effect of the Second World Var, the need for efficient utilization, the absorption f certain types of woodland produce (such as fencing aterial) by the grower on his own property, the hristmas tree market, and the need for proper ecords and accounting, are only a few examples.

The first chapter deals with the relationship etween agriculture and forestry, the contribution hich forestry can make to food production, and the eason why forestry fails to do so in some cases. The gures quoted are, of course, in respect of the United tates. The next two chapters are concerned with hat may be described as the elements of forestry, he choice of species, site requirements, how a tree rows, even-aged and uneven-aged woods, and ensity and methods of propagation, being some of he points which are considered.

The problem of damage by natural and artificial auses, and the steps to be taken in combating them, re covered by parts of the third and fourth chapters. he greater portion of the fourth chapter deals, owever, with forest management. Under this eading, particular attention is directed to the need or improving immature and partially stocked areas; oth these matters are often the concern of foresters n Great Britain to-day. Thinning and pruning are lso considered in this chapter. It is interesting to bserve that, although natural regeneration and election cutting', 'group-selection cutting' and helterwood cutting' are dealt with, no reference is ade to sylvicultural systems as such. Doubtless the uthors thought that it was unnecessary for their eaders to delve too deeply into these matters.

Chapter 5 is devoted to planting and refers, *inter alia*, to planting compared to direct seeding, to pure and mixed stands, to the choice of young stock and to spacing. On the subject of methods of planting it is interesting to see that the method known in Britain as 'pit-planting' is referred to as 'hole-planting', and 'notch-planting' as 'slit-planting'. The remarks on planting machines are particularly interesting, since this equipment has not yet appeared in Britain to any general extent. The type described has a planting capacity of approximately ten thousand trees per eight-hour day with a crew of two. If a man plants by hand 500–700 trees per day under 'average' conditions, a planting machine will show an eight- or nine-fold increase, which is a very substantial amount. The cost of the machines varies from 200 to 750 dollars (approximately £70–250). As regards planting costs, a formula for ascertaining these is given, and it is added that costs vary from 6 to 30 dollars per acre (£2–10) including the trees. Even allowing for wide spacing, cheap trees, and without rabbit netting, such as we have to erect in Britain, these figures seem very low. Without netting, costs in Britain are seldom less than £25 per acre, and with netting may well be £40 per acre for small areas.

The following four chapters deal with measurement and utilization, including felling and extraction, marketing, conversion and preservation. Chapter 11 covers three special forest products: Christmas trees, rosin and turpentine (known in the United States as 'naval stores'), and maple sugar. This is followed by a chapter on the preservation of wild-life in forestry. Finally, two chapters are added covering 'forest plans' and records, and State aid to woodland owners. There are eight valuable appendixes on various subjects.

The book is well illustrated, with some excellent line drawings; but the quality of the photographs is not up to the standard one would expect. The text includes adequate headings, and is well tabulated. This book should be of great value in the United States, and is bound to be of much interest to anyone in Britain who wishes to increase and broaden his knowledge of forestry. N. D. G. JAMES

A STUDY IN CULTURE CONTACT

From Black to White in South Australia

By Ronald and Catherine Berndt. Pp. 313+5 plates. (Melbourne: F. W. Cheshire Pty., Ltd.; London: Angus and Robertson, Ltd., 1951.) 37*s.* 6*d.*

WITH few exceptions, the effects of European domination on any of the simpler native societies are fairly predictable—a period of mutual hostility, distrust and misunderstanding, the break-down of the traditions, ties and sanctions that held the indigenous culture together, a further period of 'drifting' and general social maladjustment, and, finally, the very gradual absorption of the sub-ordinate people into the lower strata of European society. Depending mainly on the cultures involved, this process may be accomplished with varying degrees of difficulty; but the history of Colonial development shows that it never has been, and perhaps never can be, entirely painless for the native peoples concerned.

In Australia, the difficulty experienced by the Aborigines in making the required transition was intensified by three factors. First, their small numbers; it has been estimated that the Aboriginal population has never been large, probably at no time exceeding half a million, scattered over the entire continent and living in small groups which were not accustomed to act in any organized unity. Second, although their religious and social structure was highly complex, technologically these people were among the most backward known. Finally, besides being, by European standards, physically unprepossessing, the Aborigines had an outlook and ideology which was, to the first settlers, foreign and 'barbarous' beyond any hope of understanding. The effect of these factors was that the Aborigines were able to offer no resistance to European settlement, which might have given them a 'breathing-space', however temporary; their absence of technology inspired the Europeans with a supreme and lasting contempt for their 'primitiveness', an attitude reflected in subsequent dealings with them; and, finally, the complexity and uniqueness of their social system not only made native adaptation to the new order excessively difficult, but also nullified most attempts at compromise made by the new-comers, so that humane intentions were often changed to exasperated bewilderment.

In their treatment of this problem, Mr. and Mrs. Berndt have restricted their discussion to South Australia, where they have selected four areas which typify four successive stages of the general Australian contact situation.

The first, Ooldea, is an 'outback' area. The natives of this district still retain, in modified form, much of their old nomadic tribal life, although they are becoming increasingly dependent on 'hand-outs' of government rations. The main source of contact here, however, is the United Aborigines' Mission, whose activities attract some extremely caustic criticism. With an earnest *naïveté* and a sense of values it were kindest to describe as 'misplaced', this body has made it a deliberate policy to condemn every aspect of native life, and, more seriously, to alienate, by every means in its power, the children under its control from their families and their tribal background. In return, it offers the Word; that the Word might Itself have meaning only in a particular cultural context does not seem to have occurred to them. The result of this disruptive policy is that the products of this Mission's training are left in a sort of cultural hiatus, severed from their traditional culture, yet not prepared for or admitted to European society.

The second district, Oodnadatta, is also an undeveloped area, but without mission influence. Here we see the process of acculturation beginning to take effect. The natives fall into three fairly distinct groups: labourers living in a squalid camp outside the town, disliked and despised by the Europeans; those living in the town (mainly women married to non-Aboriginal husbands) who form an amorphous section with no affiliations to either cultural group; and (the smallest section) women married to respected members of the town who enjoy an uneasy acceptance by the white community.

The third area carries the process a step further. The native population here is almost entirely mixed-blood and has attained the general living standard of 'poor whites'. The men are casual labourers, the women mostly prostitutes, and only traces survive of the old culture. The gradual infiltration to highe social levels continues.

In the fourth area, the city of Adelaide, accu turation is almost complete. Most of the people a scattered through a large slum area where they liv on equal terms with their white neighbours.

The authors' treatment of this theme, while exce lent so far as it goes, seems most suitable for the la reader. The anthropologist who has not specialize in this area would like to know, for example, mor about the nature of the native's ties to his 'ow country' and why separation from it means degene ation and collapse; and more precise details of th modifications in the kinship structure, which, th authors inform us, is one of the last features of th old culture to survive. The book is a fairly adequat account of a situation, but the characters of th protagonists, which give the conflict its specifi flavour, are insufficiently analysed.

The book is nicely presented, but contains a numbe of misprints, including two in section-heading (contents page and p. 125)—regrettable carelessne in a book published at this price. D'ARCY RYAN

FOOD FOR THE URBAN MASSES

Townsman's Food

By Dr. Magnus Pyke. Pp. 212. (London: Turnstil Press, Ltd., 1952.) 15s. net.

THIS is a readable little book, but whether i fulfils its objective "to try to describe for a intelligent and non-scientific reader some of th technical problems of modern food industry, and t examine the aims and purposes of its technique an policy" will be dependent on the degree of understanding of the non-scientific reader.

I am of the opinion that in describing some of th problems the author has achieved his object, that i his examination of the "aims and purposes" he i slightly less successful, and that in considering "policy" his contact with the Ministry of Food ha biased his mind and that far too much space i devoted to war-time rules and regulations.

Whether such books are essential, whether or no they do any good, is a moot point. Certainly thi publication has enabled both 'special correspondents and learned academic people to write startling (and absolutely ill-informed) reviews in which the cunning methods of sophistication adopted by the moder food-manufacturer and the possible danger to th public are stressed out of all proportion.

To gibe at the food-manufacturer is popular these days, and in many places in the book there is a 'sting in the tail' of a sentence. For example, the author, on commenting on the colouring of margarine by th British manufacturer, says (p. 19), "is he then no contributing to the national nutrition if the colourin artifices he adopts to make his product resembl butter, succeeds in persuading people to eat it—even though these manœuvres were originally adopted t increase his sales, and hence his profits ?" Artifices, manœuvres, sales and profits !

The use of glyceryl monostearate as an emulsifying agent is mentioned (p. 123): ". . . its employment in the food industry has been viewed with a certain element of thoughtfulness. Its development is closely related to progress in the field of soapless detergents". One feels that the author enjoyed writing such aragraphs ; he perhaps did it with his tongue in is cheek.

The chapters dealing with various groupings of od are well balanced ; perhaps the section on bread slightly too long, and in the section on milk the ferences to the unpasteurized versus pasteurized ontroversy would appear, in these days, to be rchaic.

The author repeatedly stresses the difficulty of eding a population such as that of the British les, with its congested urban districts, and gives ll credit to the food technologist for making it ossible to supply the people with food.

It is probable that the population in Great Britain as the purest food in the world, not excluding the nited States, and one can agree with the author at the motives which stimulate the large food-anufacturer are (p. 203) "firstly honesty, and condly enlightened self-interest".

The book is worth reading, if only to decide hether the reviewer is right or wrong.

L. H. LAMPITT

THE GLASS-POLISHER'S ART

rism and Lens Making

Textbook for Optical Glassworkers. By F. Twyman. econd edition. Pp. viii+629. (London : Hilger and Vatts, Ltd., 1952.) 58s. net.

THE earlier edition of Mr. F. Twyman's book was one of the first important works in English to ppear on the subject. Its value derived from the cord of his wide experience ; its weakness was that was almost entirely confined to the methods of one ctory. In the second edition the author has taken dvantage of the co-operation he has received to tend its scope ; in addition, there are a number of apters (more or less connected with the subject-atter) contributed by experts. The size (and cost) ave increased nearly fourfold.

Since the first edition the industry has become creasingly mechanized, and to this the diamond-nded tool has largely contributed. The applications this are well covered. The work of W. Taylor has en recognized, and the production and working of w materials have received adequate attention.

There are still a few (perhaps unavoidable) defects the presentation of other manufacturers' methods. little more information would be welcomed on the und-stroke polishing machine (only one type is ustrated) and the method of controlling figure, as done for the straight-stroke machine. There is ill rather much on the largely academic question air-conditioning; though most firms find this un-cessary, and even in the working of the 200-in. irror the elaborate plant devised was eventually andoned.

There is much valuable discussion on grinding and lishing materials, and the author has endeavoured introduce scientific precision. It would have been en more valuable if information about the sizes of rasive powders of other manufacturers had been ven. A new section deals with aspherical work, ough this again is not quite complete as to range work or methods of testing.

Two statements call for remark. One is that the thor does not know of any machine on the market ecifically designed for trepanning. Such a machine f British make) was on sale between the two World Wars ; the second is that an American surface generator has been constructed in which the whole sequence of operation is automatic. A British machine has also appeared (possibly while the book was in the press).

There are a few misprints and some omissions from the bibliography ; the rather scanty section on tool-making could have been enriched by reference to the machines for milling optical tools, illustrated in W. Ewald's "Das Optische Werkstatt" (a work mentioned in the text). Surprisingly, no mention is made of the trichlorethylene degreasing plant for cleaning lenses, nor of the method of supporting lenses in recessed tools.

These are all minor matters in comparison with the wealth of information made available. The book is throughout delightfully seasoned by the author's personality, and he will be forgiven for riding his hobby-horses so hard.

H. W. LEE

THE AVIAN PITUITARY

The Structure and Development of the Avian Pituitary from a Comparative and Functional Viewpoint

By Karl Georg Wingstrand. Pp. viii+316. (Lund : C. W. K. Gleerup, 1951.) 18 kr.

DURING the past three decades there have appeared hundreds of papers dealing with the microscopic structure and the functions of the pituitary in various Chordates; but, comparatively speaking, little attention has been paid to the pituitary of birds despite its fundamental role in the evergreen study of migration and the timing of breeding seasons. This most acceptable volume from Sweden will be the standard work on the subject for many years to come, for Dr. K. G. Wingstrand has been at great pains to attain a comprehensive view of the class—from Rattites to Passerines—as a whole rather than draw conclusions from a single species: that is, the atypical, non-seasonal egg-laying machine, the common fowl, which is usually put forward as an adequate representation for 'The Bird' in biological literature.

The work comprises fourteen chapters and covers the anatomy and embryology of the adenohypophysis and neurohypophysis and compares them, in various aspects, with those of reptiles and mammals. The innervation, and blood vascular relationships, of the pituitary are considered at length, including the hypophyseal portal system which, though studied intensively in various groups during the past few years, has been curiously neglected in birds prior to the contemporary publications of Benoit, Walter and Assenmacher.

Dr. Wingstrand has seemingly confirmed the validity of the 'avian pituitary pattern' of Rahn and Painter and has, in fact, found the caudal and cephalic lobes of the pars distalis to be recognizably different in representatives of no less than fifty genera. He adopts a most conservative attitude in regard to the distribution of the various α and β cell-types and, it follows, to their probable functions. It is further noteworthy that although the subject of neurosecretion is briefly dealt with, the Golgi 'network' (whatever, precisely, it is) is not considered, nor is it dealt with in Dr. Wingstrand's lengthy cytological discussions.

A. J. MARSHALL

SIR WILLIAM RAMSAY (1852–1916)

By Prof. J. R. PARTINGTON, M.B.E.

THE present week marks the centenary of the birth on October 2, 1852, in Glasgow, of one of the most distinguished of the many famous British chemists, William Ramsay. Both his parents came from families of notable people ; his paternal grandfather had been a chemical manufacturer in Glasgow, and his uncle on the father's side was Sir Andrew Crombie Ramsay the geologist. As a boy he showed already musical and linguistic talents ; in later life, at scientific meetings abroad he spoke in several languages to suit the nationalities of those whose papers he was discussing, and in proposing toasts at more convivial gatherings he followed the same practice.

Ramsay's interest in chemistry developed in his student days at the University of Glasgow, but extra-murally, since he had been educated for the ministry. In 1871 he went to Tübingen, where he took his doctorate, and on his return to Glasgow he became assistant in the chemistry departments of Anderson's College and then the University. His research work in this period was in organic chemistry, especially in relation to pyridine, an evil-smelling constituent of bone oil, stocks of which had been left in the cellar by a former professor, Thomas Anderson. His interest in physical chemistry (or, as he liked to call it, general chemistry) seems to have been aroused by E. J. Mills, then professor in Anderson's College (later the Royal Technical College). It was not until 1880 that Ramsay obtained his first professorial chair, at University College, Bristol. Here he showed another of his outstanding qualities, that of being an energetic and capable administrator, becoming principal of the College as well as professor of chemistry. His single demonstrator was Sydney Young, who later succeeded him as professor. Young was a very able experimenter and there is no doubt that he exerted a steadying and beneficial influence on Ramsay. Together they carried out work of outstanding importance on the vapour pressures and critical properties of liquids, which is still regarded as authoritative.

By now, Ramsay had become a chemist of international reputation. Always interested in teaching, he wrote in Bristol a small book, "Experimental Proofs of Chemical Theory for Beginners", on a very original plan. Another of Ramsay's traits was his open-mindedness towards modern theories ; his early adoption of the Periodic Law as a basis of classification of the elements (which he adopted in his larger "System of Inorganic Chemistry", published in 1891), and of the theory of electrolytic dissociation at a time when it was bitterly criticized by most other chemists, are both good examples of his receptiveness and judgment. He also participated in the earlier developments of the electronic theory of valency.

In 1887 Ramsay succeeded Williamson as professor of chemistry at University College, London. At that time the College had become part of the University of London, but the latter was purely an examining body, having no concern with teaching or research. The conditions at University College were not so good as those in Bristol when he left it, and accommodation for research was practically non-existen To some men such conditions are more stimulatin and beneficial than succession to an 'institut elaborately equipped and with a strong tradition research in a special direction. Towards the end Ramsay's life new laboratories, which in their tim were models of what a university chemistry depar ment should be, were erected ; but all his importa work was done in the old and modest accommodatio In 1888 he was elected a Fellow of the Royal Societ and in later life he accumulated a series of honorar degrees and memberships of learned societies whic must be without parallel. He was a well-know personality both on the Continent and in the Unite States, numbering among his friends practically a the notable chemists of his time. His friendship wit Ostwald, who did so much to further the cause physical chemistry at a time when the preponderatin interest was in organic chemistry, brought Ramsa into touch with a current of thought and of researc which was changing the face of classical chemistr and must have influenced his own work.

Up to 1894 Ramsay's work was in the field inorganic chemistry, in which he investigated oxide of nitrogen, and in physical chemistry, in which h investigated with Shields the effect of temperatur on the surface tension of liquids, leading to the wel known equation of Ramsay and Shields and to relation between surface tension and molecul weight. At University College also was carried ou the work of Linder and Picton on colloidal solution which is one of the foundation stones of moder colloid chemistry. It was in 1894, however, th Ramsay's great chance came. Lord Rayleigh w measuring the densities of gases and had found th nitrogen obtained from the atmosphere was apprec ably denser than that obtained from chemic compounds. He suspected that the lighter nitroge contained an unknown light gas, while Ramsa thought that the heavier nitrogen contained a unknown heavier gas. In 1894 he had a conversatio with Rayleigh, who so far back as 1892 had aske chemists if they could solve the mystery, and in very short time Ramsay was able to tell Rayleig that by heating atmospheric nitrogen with ma nesium, which combines with nitrogen, the residu gas was even heavier, suggesting that the heavi impurity in atmospheric nitrogen was a chemicall inert gas. Even at that time Ramsay had realize that there was a possibility that the Periodic Tab might be extended by a new group of gaseo elements, an event which he and his collaborato afterwards brought into being by the discovery these elements.

Rayleigh was working on lines suggested by forgotten experiment of Cavendish in 1785, who ha found that on sparking a mixture of air and oxyge over potash solution the gas slowly disappeared a a solution of saltpetre was formed from the alka and the oxides of nitrogen produced by the sparking but always a small residue of gas was left, about a p cent of the original volume of the nitrogen. By h magnesium method Ramsay also obtained this ine gas, and at the meeting of the British Association

894 the two announced to an incredulous audience hat the atmosphere contained a new gaseous element. Working independently, the two had reached the ame result and the discovery was announced by hem jointly. The full account of the work was given o a meeting of the Royal Society in January 1895. By then the density of the gas was found; it had been hown to be monatomic from the ratio c_p/c_v of its pecific heats as approximately 1·66, and its atomic weight was 39·9. The new gas was given the name argon'.

The day after the paper was read, Henry Miers, he mineralogist, directed Ramsay's attention to a gas evolved on heating uranium minerals and thought o be nitrogen. It might, he said, be argon. Ramsay prepared this gas, found that it gave a bright yellow line in the spectrum, and was inert. Crookes, with a sample of the gas sent him by Ramsay, identified the spectrum line with one which had been observed in he solar spectrum during the eclipse of 1868 by Lockyer, and supposed by him to belong to an element present in the sun to which he gave the name helium'. The new gas had, therefore, already been named. By the end of 1898 Ramsay, working with Travers, had discovered three more inert gases, neon, krypton and xenon, and with one exception the new group in the Periodic Table was filled. The remaining element linked this work with another field in which Ramsay made notable discoveries.

The year 1898, when the tale of the atmospheric inert gases had been told, saw the beginning of an epoch of scientific discovery without parallel in anything which had gone before. Radium was discovered by Mme. Curie. It was soon shown that radium emitted a radioactive gas called the emanation of radium (now radon). This was of great interest to Ramsay, who began work on the subject. His splendid manipulative skill, highly developed by having to deal with minute volumes of rare gases, was needed in handling extremely small quantities of radioactive emanation. In collaboration with Soddy, Ramsay soon showed that radon is an inert gas and that on standing it slowly changes into helium. In 1912 Ramsay and Whytlaw-Gray published the results of a determination of the density of radon in which only about a tenth of a cubic millimetre of gas was weighed on a micro-balance sensitive to two-millionths of a milligram. The atomic weight of radon found agreed with the assumption that it was formed from radium, atomic weight 226, by the emission of an alpha-particle which was chemically the same as a helium atom of weight 4; hence the atomic weight of radon should be 222, while the value 223 was found from the density on the assumption that it was monatomic. Radon then took its place as the last element in the inert gas group.

Ramsay's later work in the field of radioactivity was less successful and he was led astray by supposed transformations of elements, such as copper into lithium, under the influence of radioactivity. He realized, however, that the great concentration of energy made available in radioactivity was likely to lead to such transformations, a prediction achieved by later workers in this field. Ramsay took a great interest in the earlier applications of radioactive materials in medicine.

Ramsay was knighted in 1902 and his work on the inert gases gained for him the Nobel Prize in 1904. His administrative talent has already been mentioned, and during his tenure of the professorship at University College he was a president of the Society of Chemical Industry, of the Chemical Society, and of the British Association. He also took a keen interest in the character of the University of London, as a result of which and of the efforts of others, the University changed its former character of being a purely examining body and incorporated the constituent colleges as teaching institutions, at the same time giving their teachers a share in the examinations and the determination of the places of the candidates. Since then, the internal side of the University has greatly increased in importance and influence.

Ramsay had the keenest interest in research, inspiring his students and encouraging them by his example. Many of them have filled positions of distinction. At the end of the session of 1912 Ramsay retired from the professorship at University College. He was looking forward to the continuation of research; but this was not to be. He died on July 23, 1916, after a painful illness.

Kindly and sympathetic towards his students, friendly and courteous to his colleagues, enthusiastic and active in his work, Ramsay left memories of a great man, which he undoubtedly was. After his death, funds raised by public subscription were partly devoted to the building of a Chemical Engineering Laboratory at University College and partly to the foundation of a Ramsay Memorial Fellowship for advanced students of chemistry. At present, owing to monetary depreciation, the number of fellowships has had to be reduced to half the original number, and the University College Committee and the Ramsay Memorial Fellowships Trustees decided that the centenary of the birth of Sir William Ramsay should be made the occasion of a joint appeal for a total of £100,000, partly to restore the number of fellowships and partly to extend the chemical laboratories at University College. Both these objects, it is believed, would further the interests of the extension of scientific knowledge which were Ramsay's interests, and also, since the fellowships are international in principle, are in harmony with his constant desire to advance friendship and helpful collaboration among all scientific men. The Appeals Secretary, Ramsay Centenary Appeal, University College, Gower Street, London, W.C.1, will receive contributions from all who wish to help this cause and will give further information about the appeal. The Science Museum, South Kensington, has also organized a Ramsay Centenary Exhibition in collaboration with University College, which was opened on October 2 by Lord Woolton, Lord President of the Council, and will remain open to the public for three months (see p. 562).

FACTORS AFFECTING CHOICE AND JUDGMENT

It had been the intention to take advantage of the meeting of the British Association at Belfast to follow up the work of the informal conference on "Subjective Judgments" held in London in October 1950. It proved, however, to be difficult to realize this object within the present framework of the British Association, so that instead a series of papers were given which were not directly related to the work of the previous conference, the general title of the papers being "Some Factors affecting Choice and Judgment". Two of the papers, from the Road

Research Laboratory, Harmondsworth, dealt with social factors which affect the actions of road users; the other papers were of a more theoretical nature and dealt with factors affecting perceiving and judging under experimental, rather than everyday, conditions.

The attitude of the general science graduate to experiments involving subjective judgments is curious and illogical, even if understandable. He is taught throughout his study period to believe that those things which he measures during the course of his 'practical work' are facts, inviolable and true. His faith in them transcends the faith of religion. Above all, he believes in the dogma of Kelvin, that we must measure to be able to understand. He rarely succeeds in grasping the principles of uncertainty in physical measurement, and many years may pass before he realizes that all measurement demands a judgment on the compromise between accuracy and expediency. As a result, he dismisses all experiments which involve direct subjective judgments as being 'vague and inaccurate'. This dogmatic attitude is not confined to the young graduate. It finds its way into higher levels, where great efforts are made to develop physical analogues to supplant the human observer in a perceptual situation. Consequently, it happens that the experimenter who uses human subjects as indicators finds it necessary to go to unusual lengths to explain his means as well as his ends. Modern statistical methods have assisted greatly in the discipline of subjective judgment experiments. They serve in three ways: to enable the experiments to be designed on sound lines; to enable the results to be interpreted by a logical procedure rather than by inspection and induction alone; and to enable the results to be presented in a way which carries some conviction with the worker who believes that physical instruments alone can be used as indicators in experiments.

Statistical technique is a good servant, but an exacting master; it is appalling to contemplate the amount of observational and analytical work necessary to demonstrate statistically a factor the existence of which common sense has never had any reason to doubt. This must have struck forcibly those who participated in the Belfast symposium; but little improvement is likely to result until there is a change of heart in favour of a greater faith in the very real ability of human observers to give reliable judgments of their environment. The nature of this ability was demonstrated by Dr. R. G. Hopkinson, of the Building Research Station, Garston, who reported assessments of glare discomfort made under controlled conditions over a period of more than three years. With nothing to guide them but their sensations of glare discomfort, subjects had made settings of the physical variable controlling the sensation; the results showed only a very small variation in the mean values. Subjects who had passed through an initial 'sensitization period' could be relied upon to reproduce their findings to a useful order of repetition accuracy.

These findings apply to the conditions of a laboratory experiment. The work reported by the Road Research Laboratory was done under more natural conditions, records being made of the behaviour of road users, both drivers and pedestrians, to determine how this behaviour could be improved. The findings must be of interest to sociologists as well as to those concerned only with road safety problems. The work on driver behaviour suggests that improvement cannot result from legal restrictions alone unles there is a very great certainty of enforcement. Leg restrictions must be combined with clear evidence o the inevitability of enforcement, such as the presenc of a policeman in a strategic position, or with cle evidence of the inevitability of physical retribution— drivers will stop at a "Halt, major road ahead" sig if there is clear evidence of the existence of fa traffic on the major road. The same effects ar observable on pedestrians; a policeman at a crossin has a significant effect on those (chiefly men, it woul appear) whose normal behaviour at crossings i irregular.

The effect of propaganda on the behaviour of bot drivers and pedestrians could be demonstrate clearly; but propaganda alone is insufficient t maintain any permanent improvement. An exampl is that of the behaviour of both drivers and pedestrians on crossings. Propaganda alone improve behaviour at ordinary crossings, but not for long But propaganda added to the striping of crossings i the zebra pattern produced a more marked effect and one which remained, not indeed at the pea level attained during the initial stages, but nevertheless substantial.

These findings can be interpreted charitably on th assumption that the driver and pedestrian ar sensible adults. A driver will not obey legal restrictions unless there are manifest reasons why h should. In the absence of visible evidence o retribution, he will behave as common sense dictates He will not obey a speed restriction if there are n obvious hazards, nor will he stop at a road ahead i it is not likely to require such action. A pedestria will not use a crossing unless it is clearly beyond hi ability to get across the road without its aid. Bu equally the findings can be interpreted on th assumption that he is little more than a juvenil delinquent. This was the interpretation made in th paper by Mr. B. M. Foss, of Birkbeck College, London with especial reference to the personality of th 'car-plus-driver'. On this interpretation the roa user is anti-social, and will do any un-neighbourl action which he thinks he can 'get away with'. Th car driver can be expected to enlarge his 'body-image in relation to the size and horse-power of his car just as a man with a hat allows for his increase height in going under a low doorway. The body-image governs behaviour in a social as well as a physical sense. The driver with a large car find himself in a position of power, and his tendency i to exercise it to his own advantage, unless he i warned, say by the presence of a policeman, of the inevitable retribution which such behaviour wil bring.

There is a good reason for believing that much can be explained by the faith which the human subject has in his own abilities to make accurate judgments —a faith which, as has been suggested, is not shared by scientists nurtured in the nineteenth-century tradition. The pedestrian crosses the road without troubling to find a crossing, because he is sure that he can judge the distance and the speed of an oncoming vehicle, and hence is certain that he will be across before the vehicle can hit him. On the average his faith is justified, as the estimates given by the Road Research Laboratory show. But of course it is not the average man who gets knocked over. The distribution and variance of the speed estimates given by the work of the Laboratory show that there are occasions when the speed of an oncoming vehicle is rossly underestimated. Mr. Foss directed attention the fact that these lapses are more frequent in the eurotic and the fatigued; but many experiments, cluding those of the long series of judgments ported by Dr. Hopkinson, show that even the xperienced subject will on occasions show a wide eparture from his average judgment. If the 'average an' appreciated that his errors of judgment ight on, say, one occasion in fifty involve him a potentially fatal situation, he might exercise ore caution—but equally he might still take the sk.

In any experiment or situation involving subjective dgments, the apparent inevitability of big random rors must not be neglected. If a large number of bservers can make the judgment, these errors can e expected to cancel out. In practice it is often ifficult or impossible to obtain sufficient observers, e work has to be done with a small team, and Dr. opkinson's paper dealt with some of the problems hich arise in such a case. Experience of the experi- ental situation clearly has an effect. In the case f glare discomfort, there is a demonstrable increase sensitivity from day to day, apart from the random rors. After this 'sensitization period' is passed, e subject appears to maintain his criterion of nsation over a very long period, with a fairly onstant variance. It is therefore possible to decide e number of observations necessary from this bserver in order to eliminate, to a predetermined egree of probability, the random errors in his bservations. Consequently, an experiment employ- g a team of observers can be designed with a certain ecision. It remains to link the results with those hich would be expected to be obtained from a presentative selection of the population under the me conditions. This has been done for a few of e important situations, and it has been found that bout four-fifths of the general population are tisfied, or more than satisfied, with the average pinion of the team of experienced subjects. This plies, of course, to the particular problem of glare lighting, but the same procedure is applicable to her perceptual situations.

The exact reason for this 'experience effect' in bjective judgments did not emerge from the dis- ssion. It may be some form of accumulative emory-trace effect which should be capable of planation. It might well link up with studies of odern information theory. The techniques of the uilding Research Station experiments, which demand e control and variation by the subject of the ysical variable governing the sensation, involve e feed-back of information of the situation, which ust necessarily influence the judgment. These ctors need study and explanation. The judgment certainly influenced by the environment. This has en shown to be true in the judgment of spatial rection, as was demonstrated in the paper by Miss A. Phemister, of the Psychology Department, ueen's University, Belfast. There are preferred ames of reference, which assist judgment. If the dy is vertical, the subject can judge position and rection accurately, but if it is tilted, this facility to some extent lost. The apparent size of an object pends not only on the angular subtense of the ject at the eye, but also on its position in the me of reference. The moon near the horizon looks gger than when well up, to such an extent that all nds of explanations of the effect are made in terms refraction distortions—another example of the inclination of some trained scientists to search for an objective rather than a subjective explanation of a phenomenon.

One would have hoped that some discussion would have arisen on the training of subjects to make judgments: whether such training is advisable, and if so, what form it should take. This important point was unfortunately not taken up. Mr. Foss, in his paper, gave a clear lead in his suggestion that 'intuition' is a facility that should be recognized as a valuable ability in clinicians and interviewers, for example, and that persons of good intuition should be found and trained, over and above the need, already recognized, for the training of subjects to make finer discriminations of a situation with greater accuracy. Dr. Hopkinson suggested that observers should have certain valuable personal characteristics. They should have a social conscience, and give of their best, without needing to be encouraged by a knowledge of the trend of their results—indeed, they must not have any preconceived theory about the experiment on which they are asked to make judgments; otherwise their 'coefficient of involuntary mendacity' may cause deviations or over-compensation. Their social conscience should extend only to a desire for the success of the experiment, and not to an interest in its result. Personal characteristics may also influence the kind of criteria which form the basis of the judgment. Mr. Foss suggested that some subjects may work better with broad categories; others may prefer to exercise their abilities to make fine discriminations within narrow categories, and hence these people may be suitable for different experiments from the former. This is a valuable and interesting suggestion which may merit close attention by those engaged on the development of the discipline of subjective judgment experiments.

R. G. HOPKINSON

BOTANY OF FLAX

In introducing a meeting on the "Botany of Flax", held in Belfast on September 8 by Section K (Botany) of the British Association, Major G. O. Searle, of H.M. Norfolk Flax Establishment, referred to the importance of the flax plant as a major factor in building up the prosperity of Belfast and Northern Ireland in general. Although in Ernst Schilling's "Die Faserstoffe" more than nineteen hundred plant species are listed as being capable of yielding fibre of industrial use, the best of all—that is, *Linum* spp.—were utilized in the Middle East seven thousand years or more ago. It has been suggested by some that *Linum angustifolium* Huds. was the species first used for the manufacture of linen; but it is clear that for many centuries *Linum usitatissimum* L. has held the field; the taller fine-stemmed varieties are used for the production of fibre, and the shorter branching-varieties for linseed. The chief interest of linen flax lies in its fibre system and in the attempt to produce improved types by breeding, the quantity and quality of the fibre being the salient factors concerned. From 1880 onwards, flax growing in the British Isles has been mostly centred in Northern Ireland where, owing to the practice of 'dam retting', the seed is lost. Consequently, all sowing seed was imported from Russia and the Baltic countries or from Holland. Distinctive varieties as such were not available, and the brands of seed largely used were known as Riga or Pernau Crown. Often the seed was first imported into Holland, where it was grown once, and the produce exported to Northern Ireland as Riga Child or as Dutch seed under a merchant's brand. Some of these brands were exceptionally good; but they are not now obtainable owing to the changed conditions of flax culture in Russia and the Baltic countries since the Revolution of 1917.

Planned flax breeding was commenced in or about 1911 by the Department of Agriculture in Dublin and by Vargas Eyre at Wye College, Kent. Eyre had visited Russia and the Baltic countries in that year and had brought back seed from some of the best flax districts. These stocks were maintained in England until 1920, when they were taken to Northern Ireland and made available for the flax breeding programme commenced by the Linen Industry Research Association at Lambeg. It was then known that taller varieties of flax could be isolated by single-plant selection from existing commercial strains, and the early work was based on this knowledge. In order to short-circuit the lengthy procedure of bulking large numbers of pure line selections for field and mill trials, Searle and Davin developed a section-cutting, staining and fibre-measuring technique for assessing the likely value of selected plants. As a result of this work, the well-known series of Liral varieties of fibre flax were produced. Liral Monarch and Liral Crown were single-plant selections from a Dutch brand of seed; Liral Prince was a hybrid between a Dutch selection and one of the original Russian strains produced in 1911; Liral Dominion, a selection from imported Riga seed, has been extensively grown in Canada, while a short but more resistant variety, Liral Duke, has given satisfaction in Egypt when grown on irrigated land. Similar success attended the work carried out at the Plant Breeding Station of the Northern Ireland Ministry of Agriculture, where such popular varieties as Stormont Gossamer, Stormont Cirus and Stormont Motley have been produced. Some promising varieties have appeared on the Continent of Europe in recent years, but with the exception of Concurrent, a white-flowered flax which has been favoured by Continental growers for its standing and crop-yielding qualities, their popularity has not tended to be lasting.

Thus, during the past thirty years pure-line strains of flax have been produced which, according to the official trials, yield up to 50 per cent or more fibre per acre than the older commercial brands. Yet it is generally agreed both in Britain and on the Continent that the yields and grades of fibre are not so high as they were fifty years ago. The true explanation for this may lie in the inevitable decline in standards as fibre flax production slowly changed from a peasant handicraft to a semi-mechanized mill industry, and the outstanding problem is to devise ways and means for reversing this decline.

The future of flax breeding may be influenced by a study of yarn quality made in recent years by the Linen Industry Research Association. Here a significant correlation has been shown to exist between diameter and length of straw and spinning quality, indicating a relationship between fineness of straw and fineness of fibre. If it be assumed that fibre strands with fine ultimate fibres having thick walls and a small lumen are stronger than those having large ultimate fibres and a large lumen, then it would seem as if the search for strength may be linked with the search for fine quality, since the taller fine-stemmed varieties tend to have mor
and finer fibres and the thick-stemmed varietie
coarser fibres with a tendency to a large lumen
These findings may be put to the test in trials wit
the three new purple-flowered varieties, Norfolk Ear
Norfolk Prince and Norfolk Mandarin, which appea
to possess the characters required in the search fo
both quality and quantity of fibre.

In dealing with the question of seed health i
relation to flax, Prof. A. E. Muskett, of Queen'
University, Belfast, outlined the work carried out i
Northern Ireland for the purpose of providing tech
niques for the examination of seed for contaminatio
with fungal parasites. In the case of flax, this wor
culminated in the Ulster method for seed examinatio
as a routine procedure, and in proving the effective
ness of tetramethylthiuram disulphide as a flax-see
disinfectant. The disinfection of all sowing fibre fla
seed produced in the United Kingdom has no
become routine practice. The availability of th
Ulster method allowed a health survey to be made fo
flax seed produced throughout the United Kingdom
and the survey has now been carried out for a perio
of ten consecutive years, three to four thousand see
samples being examined each year. The results ma
be expressed as follows.

(1) (*a*) The incidence of the fungal seed-born
parasites *Colletotrichum linicola* Pethybr. and Laff
Polyspora lini Laff. and *Phoma* sp. is highly sig
nificant in the northern and western areas of th
United Kingdom. It is insignificant in the souther
and eastern areas. (*b*) The incidence of the fung
seed-borne parasite *Botrytis cinerea* Fr. may b
significant in flax seed produced in all areas of th
United Kingdom. Its incidence tends to be highe
in seed produced in some coastal areas.

(2) The results show clearly that seed contamina
tion occurs much more readily in the wetter an
cooler northern and western areas than in the dri
and warmer areas of the south and east, where
build-up of parasitic fungi, with the exception
Botrytis, has been observed over a period of ten year
Rainfall, in so far as it may encourage a continuous
humid atmosphere, is probably the major fact
leading up to seed contamination, with temperatu
conditions playing their part.

(3) Investigations over a ten-year period show th
the area to the south and east is well suited for t
production of supplies of healthy flax seed of goo
quality. The remainder of the country is not suitab
for seed production.

The results emerging from this survey show t
possibilities which might emerge from similar surve
carried out not only in the United Kingdom but al
on a world-wide basis with seeds of other agricultur
and horticultural crops, with the object of ensurin
supplies of seeds and planting stocks of proved go
health. Such work might be of very great benefit
the more backward regions where so much st
remains to be done to ensure more bountiful suppli
of food and raw materials.

In presenting a paper on the physiological specia
ization of *Melampsora lini* (Ehrenb.) Lev. by D
A. G. Arif (formerly a research student of Quee
University, Belfast, and now in India), Dr.
Colhoun, of Queen's University, said that studies
the reactions of sixteen differential flax varieties
pure cultures of *Melampsora lini*, the causal organis
of flax rust, collected in various parts of the Unit
Kingdom had resulted in the recognition of sixte

hysiological races of the parasite. Six of these races ave already been recorded in North America or urope; but the others are believed to have been itherto unrecorded. One new race was also isolated rom diseased flax sent from Pakistan. All the races ound occurring in England, Scotland or Wales have een recorded as occurring in Northern Ireland. All he fibre varieties of flax commonly grown in the ritish Isles are susceptible to all the British races f the fungus. The fibre varieties, Textilshchik, .S.S.R. No. 2, 1288/12 and Stakhanovets, developed or rust resistance in the U.S.S.R., as well as the rust-esistant variety Wada, bred in Australia, proved nmune to all the British races. These results show ubstantial agreement with those previously obtained 1 Northern Ireland for the reaction of these varieties 1 the field, with the exception that 1288/12 was usceptible in field trials in certain years. It is sug-osted that the difference between the results of field rials and those where known races of the fungus ere used for inoculation purposes may be attributed o more races being involved under field conditions han have yet been differentiated. These studies emonstrate that resistant varieties exist to provide he basis for the production of varieties which will ombine the quality of rust resistance to British races f the parasite and high yield of good-quality fibre.

The important problem of weed control in the flax rop was dealt with by Mr. K. Holly, of the Oxford Jnit of Experimental Agronomy, who emphasized he fact that flax cannot compete effectively with ggressive or perennial weeds. As it is the fibre in 1e stem of the flax plant which is the economic roduct, the use of selective herbicides for flax must e carefully studied for adverse effect on the straw s well as for effectiveness of weed control. In the ourse of experimental work with weedicides on rops in south and east England, sulphuric acid, mmonium sulphamate and ammonium thiocyanate ere quickly discarded because of the excessive amage caused. Although, at equivalent dosages, upric chloride had more adverse effect on flax than upric sulphate, from three to five times as much upric sulphate was needed to give a comparable egree of weed control. Dosages of cupric chloride f 10–20 lb./acre in 100 gallons of water had no dverse effect upon the yield of deseeded straw or cutched fibre at the 4–6-in. growth stage. Sodium initro-*o*-cresylate could be used at 6 lb./acre before 1e flax is 10 in. high without undue risk, and pproximately the same finding held for the sodium alt of 2-methyl-4-chlorophenoxyacetic acid used at lb./acre. Experiments on weed-free crops showed 1at the safety limits for cupric chloride and sodium initro-*o*-cresylate were small, whereas they appeared be greater for sodium methyl-chlorophenoxy-cetate. Since 1945 the work has been confined to comparison of the effectiveness of commercial rmulations of the sodium salts of 2-methyl-4-hlorophenoxyacetic acid and 2.4-dichlorophenoxy-cetic acid. The use of the sodium salt of the ethyl-choro compound at 1 lb./acre or less, with maximum resistance when the crop was 4–6 in. igh, was found to be safest for the variety Liral rince. With the advent of low-volume spraying, rther experiments showed that this method entailed greater risk of damage than medium- or high-volume pplications. The results of the work considered as whole suggest the recommendation of the use of dium methyl-chlorophenoxyacetate for weed con-ol in the flax crop in England. A dosage-rate of ¾ lb./acre should not be exceeded, and it should be applied between the cotyledon stage and the attainment of a crop height of 6 in. Low-volume spraying is probably undesirable. These findings are not altogether in keeping with those for other countries, and, although the reason for this is not clear, it may be concerned with the flax variety grown. Apart from weed control, the effect of synthetic growth regulators upon the anatomy of the flax straw and the consequent effect upon the yield of fibre suggests a most interesting field of study.

In opening the discussion, Mr. E. V. B. Wilson, of the Plant Breeding Division of the Ministry of Agriculture, Northern Ireland, suggested that selection in flax is not aided by any known correlation of desirable economic characters with any constant and easily observable morphological characters, and that none of the nine standard Russian flax varieties is satisfactory for all economic requirements. Unfortunately, this also holds for the United Kingdom, where work by plant pathologists in Northern Ireland has shown that the popular modern varieties of fibre flax are very susceptible to disease generally and probably more so than the older brands referred to by Major Searle. Mr. Wilson was of the opinion that breeding for disease resistance in flax and other crops is most essential and that the closest co-operation between the breeder and plant pathologist is highly desirable. Dr. J. Ramsbottom emphasized the sudden character changes liable to occur, particularly in the parasite, which may render a resistant host-plant susceptible. A good example of this, he said, is presented by the cereal rusts; but it is a problem which has to be faced. Prof. Muskett said that one hopeful aspect of the work on flax rust in Northern Ireland is the fact that one or more of the Russian flax varieties used has shown immunity to all the physiological strains of the parasite employed. With regard to resistance to flax wilt, Major Searle pointed out that tests made in Northern Ireland show the variety Norfolk Queen to be highly resistant to this disease.

Further discussion was debarred owing to the shortage of available time, but it is clear that the meeting did much to bring to light the difficulties facing the breeder of improved flax varieties, especially in view of the changing methods adopted in the linen industry. It also showed the desirability of producing seed in areas where the seed-borne disease factor is relatively unimportant, and for disease resistance to be taken into account by the breeder. Although a considerable advance has been made in the investigation of spraying with selective herbicides for weed control, the solution of this problem still awaits completion.

OBITUARIES

The Right Hon. Lord Robinson, O.B.E.

By the sudden death in Canada on September 5 of Lord Robinson of Kielder Forest and Adelaide, Great Britain has lost its foremost forester. An Australian by birth and early upbringing, he was one of the first of the Rhodes Scholars and seldom, indeed, can the Rhodes Foundation have made a better choice. His academic forestry knowledge was acquired under that wise old forester, Sir William Schlich, then professor at Oxford, of whom Robinson often spoke in later days with affection and respect.

A public servant since 1909, the whole of Robinson's long career was devoted to the cause of British forestry. The Forestry Commission, of which he was successively technical commissioner and chairman, owed its existence and policy very largely to his initiative and organizing ability.

Made a peer in 1947 in recognition of his outstanding services, he was the first forester to receive that honour. Characteristically, he took his title in part from the Border Forest of Kielder. The largest of the new forest blocks of his creating, it was also the one of which he was the most proud, partly perhaps because it exemplified the wisdom of his policy of proceeding step by step from the known to the unknown. It was not until the success of the pioneer afforestation at Smales in the Kielder area was reasonably assured that he agreed to the acquisition of the further large blocks which now comprise Kielder and the adjoining forests in the Border country.

Robinson's extensive tours of the forests in Great Britain and throughout the Commonwealth, as well as in many parts of Europe, reinforced by a remarkably retentive memory, gave him a uniquely wide experience of all branches of forestry. It was this wealth of experience which made him such a stimulating guide in the forest.

Robinson's approach to sylvicultural problems was essentially scientific, and although administrative work took up a large part of his time, his own contributions to our forestry knowledge were of no mean order. We owe to his fertile mind the highly original basis of the construction of our British yield tables which were built up from the measurements of 1,000 sample plots recorded in woodlands in the process of being felled during the First World War. Had it not been, too, for his foresight, all record of the rate of growth of these woods would have been irretrievably lost. Moreover, he was probably the first forester in any country to realize the importance of statistical lay-outs and analysis in field experimentation: in the early 1920's, he enlisted the aid of R. A. Fisher, then at Rothamsted, in order to ensure that the techniques being developed there for agricultural experiments were applied also to appropriate problems in forestry.

Lord Robinson's fine physique and handsome presence made him a conspicuous figure in any gathering. Inclined to be austere in the office, his reserve melted almost magically as soon as he got among his trees, when he was extremely good company. It was not until about two years ago, when an accident on one of his inspections of the Border country led to a serious illness, that he was obliged to curtail his outdoor activities to some extent; though even then he continued to cover an astonishing amount of ground, using a 'land rover' to get about over the forest tracks.

His many-sided gifts showed perhaps to the greatest advantage when he was presiding over a large meeting. Those who attended the Empire Forestry Conference held in South Africa in 1935 will long remember the tact and imperturbable good humour with which he conducted its affairs. It was while attending, as head of the British delegation, the Sixth Commonwealth Forestry Conference in Canada, that a sudden attack of pneumonia proved fatal. So at the height of his fame and almost at the end of his long and honourable career in the public service, a great man has departed; the nation is the poorer for his loss.

W. H. GUILLEBAUD

Sir Frederic Kenyon, G.B.E., K.C.B.

SIR FREDERIC KENYON, who died on August 23 gave forty-one of his eighty-nine years to the servic of the British Museum. For the last twenty-one o them he was director and principal librarian. Bor in 1863, the seventh of the fifteen children of Joh Robert Kenyon, Q.C., he laid the foundations of hi classical learning as a scholar of Winchester an of New College, Oxford. First-classes in Moderation and in *Literæ Humaniores* led to a fellowship a Magdalen in 1888, and a year later he won th Chancellor's English Essay prize. In 1889 he entere the Department of Manuscripts of the Britis Museum, where he devoted himself to the cataloguin of the extensive and increasing collection of papyri It was virtually an unworked field and a particular attractive one for a brilliant young scholar. He mad his name two years later by the discovery, publication and translation of Aristotle's lost treatise on th Athenian Constitution. The text of this was edite for the Berlin Academy in 1904 and for the Clarendo Press in 1920. Other discoveries among the literar papyri were the Mimes of Herodas, an unknow speech of Hyperides, and twenty odes of Bacchylides the latter from a roll acquired by the Museum i 1896. In 1899 appeared his well-known "Palæography of Greek Papyri". Other fruits of his scholarshi were the "Catalogue of Greek Papyri in the Britis Museum" (vol. 1, 1893; vol. 2, 1898; vol. 3, 1907 and "Facsimiles of Biblical Manuscripts in the Britis Museum", published in 1900. In addition to thes official labours, he published in 1895 "Our Bible an the Ancient Manuscripts", a classic in this field an many times reprinted.

In 1909 he was chosen to be director of the Britis Museum at an unprecedentedly early age and i preference to not a few colleagues of senior rank an of great eminence in their different fields. It was difficult situation calling for exceptional tact an wisdom. These qualities Kenyon possessed to th full, and with them urbanity, fairness, and administrative ability of the highest order. Never was th Museum more wisely and fairly governed; never ha its prestige been raised to a higher level. Classica studies had sharpened his critical faculties, enablin him to lay bare with penetrating clarity the essential of the most difficult problem. His capacity fo business, coupled with firmness and courtesy, mad him a model chairman, and he was at various period president of the British Academy, of the Helleni Society, of the Society of Antiquaries, and warde of Winchester College. In 1918 he was selected a adviser to the Imperial War Graves Commission.

After his retirement in 1930, Kenyon gave himsel largely to biblical studies, an early love, and t textual criticism in particular. He edited a series o biblical papyri which Mr. Chester Beatty had brough from Egypt, publishing the fruits of his labours i "Recent Developments in the Textual Criticism o the Greek Bible". To this work, produced in 1933 he added in 1948 "The Bible and Modern Scholarship", small in size, but weighty in content. A wor of more popular appeal but not less scholarly was hi "Books and Readers in Ancient Greece and Rome" which had appeared in 1932.

He was an honorary graduate of many universitie Many honours and decorations had fallen to him; bu it is probable that he prized none more highly tha the T.D. which marked his long connexion with th Territorial Army and with the Inns of Court Regimen in particular. Beginning the First World War as a company commander, he ended it as a lieutenant-colonel. Had he not chosen the path of scholarship, Kenyon might have been a soldier of distinction. He touched nothing which he did not adorn.

He married in 1891 Amy, daughter of Rowland Hunt. She died in 1938. Of his two daughters the elder is a well-known archæologist.

F. G. RENDALL

Dr. William McRae, C.I.E.

WILLIAM MCRAE was born in Scotland in 1878 and graduated in the University of Edinburgh, from which he later received the degree of D.Sc. He arrived in India on March 28, 1908, and joined the Agricultural Service as a mycologist at the Imperial Institute of Agricultural Research, Pusa, now the Indian Agricultural Research Institute, New Delhi. Dr. McRae's services were placed at the disposal of the Government of Madras with effect from January 1, 1910, for employment in the local Agricultural Department, where he served for nine years as Government mycologist and as the principal of the Agricultural College. During the period of his tenure in Madras he developed both mycological research and teaching. He successfully conducted campaigns against the serious disease of palms which is responsible for bud-rot. Earlier he also investigated the blister blight of tea which was responsible for heavy losses in tea plantations in Darjeeling, and published an extremely valuable bulletin on the subject, in which he described the control measures of this serious disease.

In 1920 Dr. McRae returned to Pusa as head of the Mycological Section of the Imperial Institute for Agricultural Research, a post which he held until the end of his service, except for intervals when he acted as agricultural adviser to the Government of India or as agricultural expert to the Indian Council of Agricultural Research. He was responsible for valuable investigations on the wilt disease of pigeon-pea, the mosaic disease of sugar-cane and also foot-rot of betel vine. He held the posts of joint director and that of director of the Imperial Institute of Agricultural Research, Pusa, in addition to his own duties, for short periods.

Dr. McRae made valuable contributions to the investigation of plant diseases and published more than twenty-one scientific papers. In recognition of his work he was appointed C.I.E. in 1934. He was placed on the retired list after more than twenty-five years service on June 23, 1934. He was one of the most energetic men in the Indian Agricultural Service, and besides being an able scientist he also had the reputation of a good administrator and a great disciplinarian, who spared no pains in the development of mycological research and kept up the standards so well established by Dr. E. J. (later Sir Edwin) Butler, whom he succeeded. In Dr. McRae's death on July 8, India has lost not only an outstanding scientist, but also a friend who will be held in esteem for a long time to come.

R. S. VASUDEVA

The Right Hon. Lord Macmillan, G.C.V.O.

MR. W. D. STURCH, secretary to the Royal Commission for the Exhibition of 1851, writes: "Lord Macmillan, who died on September 5, was chairman of the Board of Management of the Royal Commission for the Exhibition of 1851. He took a close personal interest in the Commissioners' scheme of science research scholarships, and those who were present at the 1851 Scholars' Centenary Dinner in 1951 will surely remember him with affectionate respect. His great humanity enabled him to see scientific achievement in a true perspective, and he was not afraid to remind a gathering of distinguished scientists that they were first and foremost human beings. He was intensely proud of the scientific record of the Commissioners' research scholars, and maintained his active interest in the work of the Royal Commission until the day of his death. Scientists may well join with those in many other walks of life in mourning the loss of a great friend".

WE regret to announce the following deaths:

Prof. C. B. Fawcett, emeritus professor of geography in the University of London (University College), on September 21, aged sixty-nine.

Mr. E. H. Godfrey, formerly chief of the Agricultural Branch, Dominion Bureau of Statistics, Canada, on September 22, aged ninety.

Prof. C. H. Lees, F.R.S., emeritus professor of physics in the University of London, formerly vice-principal of Queen Mary College, on September 25, aged eighty-eight.

NEWS and VIEWS

Emil Fischer (1852–1919)

EMIL FISCHER, who in his life-time exerted a profound influence on chemistry and chemists of his generation and whose discoveries in biochemistry are still yielding rich harvests, was born a century ago, on October 9, 1852, at Euskirchen in Rhenish Prussia. The son of a prosperous merchant, he was apprenticed for two years to his brother-in-law, a timber-merchant, on leaving school in 1869. His interest in experimental science led to his becoming a pupil of Friedrich August Kekulé at Bonn. After working as assistant to Adolf von Baeyer at Strasbourg and Munich, he held the chairs of chemistry at Erlangen and Wurzburg, and in 1892 succeeded August Wilhelm von Hofmann as professor of chemistry at Berlin. As early as 1875 he discovered phenylhydrazine, "the path-finder of carbohydrate chemistry", and described its reaction with the sugars to form osazones. He synthesized and formulated caffeine, xanthine, theobromine, glucose, fructose and veronal—the first of the barbiturates; developed a 'family tree' of gout, based on the purine nucleus; devised quantitative methods for isolating amino-acids, with which he prepared polypeptides; and, with Emil Abderhalden, did fundamental research on the specific action of enzymes. Keenly interested in the requirements of the chemical industry, he was instrumental in founding the Kaiser-Wilhelm Institut fur Chemie in 1912 and in the First World War organized Germany's chemical resources. A tremendous worker with a splendid memory, Fischer was idolized by his pupils and assistants, once they had accustomed themselves to his austere manner and to his exacting and critical methods. Elected a foreign member of the Royal Society in 1899 (he had been awarded the Davy Medal in 1890) and recipient of the Nobel Prize for Chemistry in 1902, he died during the night of July 14, 1919.

An Elizabethan Lodestone

THE National Maritime Museum, Greenwich, has recently been lent a lodestone reputed to have belonged to Sir Francis Drake and to have been given by him to Lawrence Kemeys. The lodestone is mentioned in an inventory of the possessions of the Kemeys family so far back as 1630, and has been handed down in the family to Lord Wharton, its present representative, by whose permission it is being exhibited in the Museum. It is approximately 1 in. by 1 in. by ¼ in. and is believed to have been reset in silver about 1700. The lodestone is of the type formerly carried by sea-captains when on long voyages in order to 'retouch' the compass needles when they became demagnetized. This one is extremely strong, having a magnetic moment of 1,900 c.g.s. units. Lawrence Kemeys came of the Kemeys, or Kemmeys, family of Cefn Mably House, Michaelstone, near Cardiff, and the earliest record usually quoted of him is his command of the *Gallego* under Sir Walter Raleigh during his voyage to Trinidad and up the Orinoco in 1595. He seems to have shared for a time Raleigh's imprisonment in the Tower of London in 1603, and was foremost in urging the undertaking of the latter's ill-fated expedition to the Orinoco of 1617.

Ramsay Centenary Exhibition

AN exhibition at the Science Museum, organized in collaboration with University College, London, marks the centenary of the birth of Sir William Ramsay (see p. 554); it will be open for three months. The Exhibition is divided into three main sections: the first will include books, documents, portraits and general biographical material. A large oil painting of Ramsay, made by Mark Milbanke in 1913, will form a fitting centre-piece. In the second group will be seen some of the original apparatus used by Ramsay and his collaborators. One of the earliest machines for obtaining liquid air, which was installed for Ramsay in 1898, has been re-erected for the exhibition. The third group illustrates the way in which the inert gases now serve our needs.

Incubation and Hatchery Practice

EVERY year in England and Wales about 100,000,000 poultry eggs are used for hatching purposes; of these, about 30 per cent fail to hatch. Failure to hatch may be due to unsatisfactory nutrition of the breeding flock or it may be due to some fault of the hatchery incubating the eggs. Whatever the cause, a 30 per cent loss represents a heavy charge on the poultry industry of Britain. Of equal or greater importance may be the effect of unsatisfactory hatching conditions on chicks which do survive any mismanagement at the hatchery. They may be affected to a degree which may adversely influence their ability as egg producers, and these poor-quality birds will remain an additional handicap on the poultry industry. To help poultry farmers the Ministry of Agriculture and Fisheries has produced a booklet which deals with the hatchery industry in considerable detail. The opening section describes the structure of the egg and the development of the embryo chick. Natural hatching and artificial incubation are then dealt with, and hatchery design, construction, hygiene and management are also described. A chart summarizes all the possible causes of hatching failure and how to avoid them, while the special requirements of turkey, duck and goose eggs are listed in an appendix. Copies of the bulletin may be obtained from H.M.S.O., price 1*s.* 10½*d.*

Detection of Insects in Grain

To reveal the extent to which a sample of grain is infested by insects and the nature of the insects concerned, a prolonged investigation in the laboratory which may take several weeks is required. But there is frequent need for some rapid method by which the presence or absence of living insects can be recognized, so that an immediate decision may be reached as to whether the grain in question is suitable for prolonged storage. Similarly, in stores receiving supplies from various sources, testing of incoming batches will prevent the addition of infested samples to the main stocks. The 'heating' of stored grain is a well-known sign of infestation, but a much more sensitive method for the detection of insects in grain is their production of carbon dioxide. At or below 15 per cent water content, the metabolism of the grain itself or of any micro-organisms it may contain is negligible in comparison with that found even with a minimal amount of insect infestation. R. W. Howe and T. A. Oxley, of the Pest Infestation Research Laboratory, Department of Scientific and Industrial Research, have written a concise statement of the principles and applications of the carbon dioxide method in a pamphlet entitled "Detection of Insects by their Carbon Dioxide Production" (pp. 20; London: H.M.S.O., 1952; 1*s.* net). This describes the apparatus required, the test procedure and the interpretation of results, and includes all the tables needed for the analysis.

Agriculture and Forestry

A STUDY of alluvial soils in north-west Germany from the point of view of combining alternate forestry and agriculture in a periodic or temporary agricultural use of forest land has been made by W. Wittich, and his conclusions have now been published in a brochure entitled "Landwirtschaftliche Zwischennutzung im Walde als Meliorationsmittel und Hilfe für die Ernährung" (temporary agricultural cropping on forest land as a means of soil improvement and as a supplementary source of foodstuffs) (Hannover: M. and H. Schaper, 1948) (see *Forestry Abstracts*, 13, No. 3; 1952. From the Commonwealth Forestry Bureau, Oxford). He reviews German, Austrian and Swiss literature on the subject, considering the varying characteristics of forest soils, the types of soil suitable for this purpose, the requirements of the agricultural crop plants that could be used, the practical management of such crops and the prospects for agricultural cropping on individual soil types, with main reference to the diluvial and alluvial soils of north-west Germany. He concludes that the widespread prejudice against this practice, one of the earliest practised by man, in part at least, is untenable; and he maintains that there are few soils on which agricultural use need be detrimental and many in which definite improvements could be achieved under proper treatment—for example, by the more intensive cultivation and fertilizing made economically possible by agricultural crops. This investigation, which is of great value, is really only a throw-back to the method of 'shifting cultivation' and should have a far wider application than north-west Germany. The old-type shifting cultivation is being utilized in India and Burma, under its Burmese name *taungya*, by the forest officer to produce new crops of some of the more valuable species of timber trees; the practice is applicable to Africa and elsewhere in the tropics. But Wittich's work introduces a further most promising step to the problem of a world shortage of food. For the permanent forest areas of the world, which for various reasons it is imperative to conserve, can nevertheless be used for the growing of food crops for a pre-arranged number of years at the end of a forest rotation, and then the land can be returned to permanent forest. Such a system should substantially increase the amount of land available at any one time for agriculture.

West African Gold Coast Timbers

A SMALL handbook of Gold Coast timbers was first published in 1941; it proved of great utility to officers of the Forest Department and others concerned and was soon out of print. Since then, considerable progress has been made both in the assessment of the forest resources of the country and in the development of the timber trade. To meet a growing demand, it was decided to publish a new edition, a work undertaken by D. Kinloch and W. A. Miller, of the Gold Coast Forest Department ("Gold Coast Timbers." Revised Edition. Pp. xii+39; Takaradi: Government Printing Department; 1*s*. 6*d*.). Thanks are accorded to the Director of the Princes Risborough Forest Products Laboratory for assistance. The closed-forest zone of the Gold Coast occupies approximately one-third of the entire territory and has an area of some 30,000 square miles. The remaining northern two-thirds consists of the savanna-forest zone, the forest resources of which are of purely domestic interest. The timber wealth of the country is concentrated in the closed-forest zone, of which it is estimated that some 16,000 square miles are still under forest; the remainder has been converted to agriculture, which continues to destroy an estimated 300 square miles of forest every year. The forest is not uniform in type throughout, there being a gradual transition from the south-west corner in a general north-easterly direction, and this transition is intimately connected with rainfall, though other local factors occur. Two types occur: the tropical semi-evergreen rain forest of the south-west corner, and the tropical mixed deciduous forest covering some ninety per cent or more of the whole zone. Sub-types are proposed, and a number of species described for which the booklet should be consulted. The information given in this new edition is almost entirely the work of the Forest Department and includes considerable additional data provided by enumeration surveys and records of the Forest Products Research Laboratory, Princes Risborough. War-time departmental experience in milling and utilization has also proved of great assistance.

Proceedings of the Bihar Academy of Agricultural Sciences

THE first number of the *Proceedings of the Bihar Academy of Agricultural Sciences* has now been published. In view of the importance of agriculture in India to-day, this new journal should be a great asset, for research results, particularly those relating to local crops and climatic conditions, must be available to all concerned if progress is to be made on sound scientific lines. The subjects discussed in the first number are very varied, but in each case the emphasis is laid on the practical aspect of the problem. Among the biological papers are those on inter-varietal hybridization in *Luffa acutangula* and its economic significance, and studies in the production of carbon dioxide in stored wheat infested by *Sitophilus granaria* L. and *S. oryzae* L. Soil and manurial problems are represented by a description of the Bihar soils, followed by an account of the results from a large number of field experiments carried out on cultivators' plots throughout the State. The benefit from the application of nitrogenous and phosphatic manures has been clearly demonstrated, and interest in their use so stimulated that appreciable increases in yields may be expected in many districts. The importance of statistics is evidently recognized, for the accuracy of field experiments is discussed in a further paper on the size and shape of plots in wheat trials. Three numbers of the journal will be published annually and those will be available free to members of the Academy; to others the annual subscription is Rs. 10. All communications should be addressed to the Secretary of the Academy, Agricultural Research Institute, P.O. Sabour (Bihar), India.

Newspaper Libraries in Great Britain

THE Library Association has published a pamphlet, entitled "Newspaper Libraries", by J. Lewis (No. 11 in the series; pp. 76; 1952. 7*s*., or 5*s*. to members), which outlines first the functions of such libraries in Great Britain and then describes the types of material contained in a newspaper library and the arrangement, classification and filing of such material. Some account is given of the news indexes maintained and indexing practice in newspaper libraries, of the methods used for the care and preservation of general and special material, and of the formal and informal co-operation which exists with other libraries. The pamphlet includes both a bibliography and index, and these facilitate reference to much information which may assist the technical or scientific librarian on occasion, as well as those whose needs are more general.

Manchester Museum: Annual Report for 1950–51

THE annual report of the Manchester Museum for the year ending July 1951 (pp. 28; from the Museum, Manchester; 1952) gives an account of continued progress in all departments. The housing of study and reserve collections has presented many problems, though by extensive movement of cupboards and cases a more orderly arrangement has been attained. The proper storage of collections involves classification, which is also an essential preliminary to cataloguing. One essential function of museums is research, and in this connexion it is interesting to note the large number of papers written by members of the staff during the year.

Fifth Empire Mining and Metallurgical Congress

THE fifth Empire Mining and Metallurgical Congress will be held in Australia during April 12–May 23, 1953, and afterwards in New Zealand. The Congress will afford an opportunity for mining engineers, metallurgists, scientific workers, engineers and others concerned with the mining and metallurgical industries to meet and discuss technical progress and problems, including the development of the mineral resources of the British Commonwealth of Nations. The programme will be divided into five parts: pre-sessional visit in Tasmania (April 12–19); inaugural meeting and other official functions, together with technical sessions, in Melbourne (April 20–25); visit to Canberra (April 26–27); further technical sessions in Sydney and tours in New South Wales, South Australia and, if desired, Queensland or Western Australia (April 28–May 23); journey to New Zealand inspecting coal and mineral fields in South Island, followed by a conference in Dunedin and then visits to North Island. The main section of the technical proceedings will consist of a series of volumes dealing in an analytical and comparative manner with Australian deposits and practices, as follows: (1) geology of Australian ore deposits; (2) mining methods; (3) milling methods; (4) extraction metallurgy—(*a*) ferrous, (*b*) non-ferrous; (5) miscellaneous and general; (6) coal; and (7) general handbook. In addition, literature describing equipment and practices in the various important mining centres will be available. Further information about the Congress can be obtained from the Secretary, Fifth Empire Mining and Metallurgical Congress, Osborne House, 399 Little Collins Street, Melbourne, Victoria.

International Fertility Association

In Rio de Janeiro last year, delegates from twelve nations founded a new medical society to be known as the International Fertility Association. The aims of this organization are fourfold: to study the problems of fertility and sterility in their broad implications; to stimulate scientific investigation and social awareness in the field of fertility and sterility; to standardize nomenclature, terminology, tests and evaluation of diagnostic methods and therapy throughout the world; and to hold regular international congresses in different parts of the world. The first World Congress on Fertility and Sterility, sponsored by the Association, will be held in conjunction with the American Society for the Study of Sterility, in New York City in May 1953. Further information can be obtained from the secretary-general of the Association, Dr. Carlos D. Guerrero, Miguel E. Schulz No. 19, Mexico, D. F., or from the associate secretary-general, Dr. Abner I. Weisman, 1160 Fifth Avenue, New York, N.Y.

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have recently been announced: C. A. Collins (inspector of plants and produce, Gold Coast), agricultural officer, Gold Coast; R. G. Heath (chief field officer, Federation of Malaya), deputy director of agriculture, Federation of Malaya; J. D. Jameson (senior botanist, Uganda), senior research officer, Uganda; R. G. Sangster (senior assistant conservator of forests, Uganda), conservator of forests, Tanganyika; Sir James Kirkpatrick (game ranger, Kenya), senior game ranger, Kenya; Z. Wolak (assistant livestock officer, Nyasaland), livestock officer, Nyasaland; W. R. Asfour, agricultural superintendent, British Guiana; D. R. Goodrich, agricultural officer, Nigeria; K. W. Barker, pasture agronomist, Agricultural Department, Uganda; T. E. F. Neavind, agricultural officer, Uganda; J. E. Huddart and C. Walker, veterinary officers, Kenya; D. A. B. Llewelyn, scientific officer, East Africa High Commission.

Announcements

Mr. Harold James Page, principal of the Imperial College of Tropical Agriculture at Trinidad since January 1947 (see *Nature*, 158, 410; 1946), is resigning that appointment at the end of October in order to join the staff of the Food and Agriculture Organization of the United Nations.

The Lord President of the Council has appointed Sir Wallace Akers, a director of Imperial Chemical Industries, Ltd., and Sir Philip Johnson, a director of Hawthorn Leslie and Co., Ltd., and chairman of the Parsons and Marine Engineering Turbine Research and Development Association, to be members of the Advisory Council for Scientific and Industrial Research. Prof. P. I. Dee has retired from the Council on completion of his term of office. Sir Hugh Warren has resigned his membership of the Council because of the pressure of other duties.

The Council of the Institute of Metal Finishing announces that the Westinghouse Brake and Signal Co., Ltd., Prize is to be awarded to Mr. W. A. Marshall for his paper on "Non-Electrolytic Smoothing Treatment for Steel". The Johnson Matthey Silver Medal has not been awarded this year, no paper in the field covered by the terms of the award having been received. The Medal is offered for a paper dealing with any aspect of electrodeposition of precious metals.

Sir Frank Whittle has been awarded the Churchill Gold Medal of the Society of Engineers. The award has been approved by Mr. Winston Churchill, who is an honorary fellow of the Society, and is made "for the most noteworthy development in engineering or contribution to contemporary engineering".

The reconstruction of the war-damaged buildings of Bedford College for Women (University of London) will be celebrated at a meeting in the College on October 28 at 3.0 p.m. Addresses will be delivered by the Chancellor of the University and the Principal of the College; Queen Mary, patroness of the College, hopes to visit the College during the afternoon.

Prizes of value up to £150, with a maximum of three awards, are being offered for 1953 by the Council of the British Plastics Federation, as administrators of the Bowen (Cables and Plastics) Prize Fund. The awards will be made for papers on original investigations in engineering and/or physical problems relating to compression, transfer or injection moulding. Further information can be obtained from the General Manager of the British Plastics Federation, 47/48 Piccadilly, London, W.1, to whom contributions for the prizes must be submitted not later than July 31, 1953.

An international congress on medical librarianship will be held in London during July 1953, with Sir Cecil Wakeley, president of the Royal College of Surgeons of England, as honorary president. The congress will include formal sessions for reading and discussion of papers, visits to medical libraries and social functions, and also, it is hoped, an exhibition of medical books and periodicals and library equipment. All those actively engaged or interested in medical librarianship are invited to participate. Further information can be obtained from the Honorary Secretary, First International Congress on Medical Librarianship, c/o London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

GOVERNMENT RESEARCH IN AUSTRALIA

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

THE third annual report of the Commonwealth of Australia Scientific and Industrial Research Organization*, which now numbers fifteen divisions and expended more than £3 millions during the year, covers the year ended June 30, 1951, and again tresses the extent to which slow progress with the building projects handicaps the development of research programmes.

In spite of staff problems, the Division of Soils continued work on some fifteen soil surveys and a compilation of a manual of Australian soils was nearing completion. Chemical work on the basaltic soils from Lismore, New South Wales, was completed, studies on the availability to plants of copper and manganese continued, and an investigation into he ion exchange and *p*H relations of cation-dominant soils commenced. Studies on the stability of naturally occurring aggregates have shown that natural aggregation can be measured by a drop-shatter method, which has been used to help define the structure and consistency of soils of the Riverina and Abermusden districts.

During the year, 518 samples of seed and plant material, chiefly pasture and forage plants, were ntroduced from thirty-three countries for trial in Australia, and in the latter part of the year the active collection of plant materials in other countries was developed with the view of testing in Australia. Further trials have confirmed the value of *Lathyrus ochrus* as a green manure for use in vineyards especially on lighter soils, and of *Phaseolus* as grain egumes, while studies of flowering and seed-setting of introduced sunflower varieties continued. A section of plant genetics has been re-established and its work extended to include genetical and cytogenetical investigations of pasture species for Australian conditions, cereal problems not being pursued elsewhere, and problems in the resistance to disease of major vegetable crops such as the tomato and potato. The Plant Diseases Section has given special attention to the chemotherapeutic control of virus diseases, and investigations on the use of antibiotics for controlling plant diseases continued. Some six hundred further tests of native species were made for the presence of alkaloids, saponins, cyanogenetic glycosides and other chemical principles, and two hundred and fifty bulk samples were collected for more detailed examination. At Clare, Queensland, the two previous seasons investigations on the water requirements of tobacco showed that yield and quality were maintained over a wide range of treatments, and the effect of nitrogen-levels and rates of planting on quality was being investigated. Detailed studies of he nutritional requirements of subterranean clover are being continued under field, greenhouse and aboratory conditions; and other pasture investigations have included ecological studies on native and exotic pastures, nutrition and soil deficiencies, the use of pastures and maintenance of fertility. Weed investigations again indicated that plant-growth regulating substances alone offer no prospect of controlling established skeleton weed (*Chondrilla uncea*). At the Katherine Research Station, the limestone red soils of the Tipperary land system were being examined for determining the possibilities of agricultural development under dry-land conditions, while at the Kimberley Research Station agronomic and pasture problems under irrigation were being studied in co-operation with the Western Australia Department of Agriculture.

Research into problems of animal health and production at the McMaster Animal Health Laboratory, Sydney, included further studies with phenothiazine against internal parasites. Studies at the Veterinary Parasitology Laboratory, Yeerongpilly, Queensland, on the identification of the species of amphistomes infesting cattle have been completed, and evidence obtained that the 'Queensland itch' of horses is associated with hypersensitivity to the bites of sandflies (Ceratopogonidæ); protection by regular spraying with DDT was being investigated. Progress is reported in the development of the Poultry Research Centre at Werribee, Victoria, and studies of the vitamin A requirements of sheep, the effects of zinc and copper deficiency on the biochemical processes involved in phosphorylation within the tissues of plants, on carbohydrate metabolism, and on sheep feeding with particular reference to drought conditions continued, as well as on the influence of nutrition on the breeding performance of merino ewes.

Besides its work on the cattle tick, the Division of Entomology obtained very promising results in co-operative work on the control of the Argentine ant in Sydney and in Western Australia, which points to the possibility of complete eradication of the ant. The expected outbreak of the Australian plague locust did not materialize during 1950–51, and earlier work on the relation between trees and locust abundance was extended. A long-term experiment on the control with DDT of the pasture cockchafer, *Aphodius howitti* Hope, was concluded; but use of DDT against the red-legged earth mite in pastures also infected with the lucerne flea (*Sminthurus viridis* L.) is not recommended. Work on biological control has emphasized the importance of detailed attention to the flora associated with a weed, both to ascertain the extent to which other plants are likely to assist the insects and to determine the species likely to replace the weed. In the Wildlife Section, the work on the virus disease of rabbits, myxomatosis, was given priority, and the night-biting mosquito, *Culex annulirostris*, was shown to be the principal vector along the Murray main stream. Of poisons now in use, only sodium fluoroacetate showed promise for rabbit control.

Fisheries research at the Dunwich Field Station, Stradbroke Island, South Queensland, covered the distribution and movements of mullet in the estuarine and river phases of their history, the development of the oyster industry of Queensland, the distribution of prawns and preliminary work on lagoon fish-farming. The laboratory at Thursday Island, Torres Strait, was equipped and progress is reported in the study of plankton and the biology of pearl oysters. To extend the oceanographical work, preliminary plans were prepared for an oceanographical research vessel to be constructed in Great Britain. Studies on fouling by marine growths continued at various points, and this work has revealed the importation, on ships bottoms, of fouling organisms from other countries. A programme covering the biology and distribution of *Macrocystis* aims at giving a reliable estimate of the quantity of this seaweed in Australian waters, the seasonal and long-term fluctuations in yield of the seaweed and its products, and the method of regeneration of the plant.

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* Parliament of the Commonwealth of Australia. Third Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ending 30th June 1951. Pp. 167. (Canberra: Commonwealth Government Printer, 1952.) 9s. 6d.

Food research included a detailed study of the performance of refrigerated railcars with end bunkers and coolers, which led to the preparation of a statement of the principles governing the use of these vehicles for chilled beef transport. An account of the work on the evaluation of canning processes was published. Studies of the temperature relations of *Clostridium botulinium* and of the factors affecting the germination of heat-treated bacterial spores continued, while much work was done on the development of rapid laboratory and field methods for estimating the degree of fish spoilage. The longer storage life of dehydrated sugared fruit compared with ordinary dehydrated fruit has been confirmed, and varieties of fruit and vegetables were being tested for suitability for freezing.

The anatomical studies of timbers from Malaya, Borneo and New Guinea have proved of considerable value, and attention has also been paid to the factors causing the death of medullary ray and vertical parenchyma cells in sapwood-heartwood. Activity in the wood preservation field markedly increased; a survey of the causes of failure of preservative treatment of cross-arms was completed in Western Australia, Victoria and New South Wales, and a laboratory study of the toxicity and permanence of water-borne preservatives was commenced. Research on the properties and uses of building materials continued in the Division of Building Research; but the only new project was the preparation of a paper on the weathering and durability of building materials in the tropics for the International Building Research Congress held in London in September 1951.

Wool textile research was extended to cover the improvement of wool as a textile fibre and the reduction of costs of production of woollen, worsted and felted materials, but several years must elapse before the new laboratories are fully staffed with adequately trained research workers. Considerable interest has been displayed in the two processes recommended by the Organization for the recovery of wool from sheepskin pieces and broken skins. A suitable method has been developed for the alkaline hydrolysis of wool wax to wax alcohols and acids, and the study of the formation of fibres under natural conditions has been continued in the Division of Industrial Chemistry, where much attention has also been given to the study of wool wax and sugarcane wax. Steps were taken to provide a more comprehensive microanalytical service for scientific institutions and industry. Attention was also being given to analytical problems in connexion with the uranium ores of South Australia, the chemistry of alunite and its utilization in the production of potash fertilizers, the physiologically active alkaloidal principle of the Dwalganup strain of subterranean clover, and to liquid and vapour equilibrium concentrations of binary mixtures and their variation with temperature or pressure, in relation to plant design. A satisfactory method of concentrating topaz (used in ceramic ware) has been devised. The Section of Physical Metallurgy was concerned mainly with the metallography of alloys of titanium, gas surface reactions of titanium, and the influence of prolonged stress on lead alloys.

The work of the Division of Tribophysics continued on the same lines as in the previous year, but was still hindered by lack of space; and that of the Division of Metrology was largely determined by its statutory responsibilities for Commonwealth standards. The Division of Physics was also concerned with research designed to improve the accuracy of the methods of maintenance of standards, to increase the accuracy of measurement, the determination of properties of materials at extremely low temperatures and the study of the physical processes associated with the emission of radiation from the sun, including the development of new techniques for the study of the ionosphere and improved navigational aids under Australian conditions. The work of the Section of Meteorological Physics was consolidated and extended on the previous lines, including the prevention of frosts in orchards, the physics of rain and clouds, and the artificial formation of rain. In the Section of Mathematical Statistics two further centres have been established to provide direct assistance to divisions of the Organization in their experimental work. The Organization continues to co-operate with the Physics Department of the University of Melbourne in research on nuclear physics and cosmic rays under the direction of Prof. L. H. Martin.

AMERICAN SCIENTIFIC EQUIPMENT FOR BRITISH LABORATORIES

THE last report of the director of the Chemical Research Laboratory, Teddington, acknowledged the indebtedness of the Laboratory to the European Co-operation Administration of the United States for the supply of equipment unobtainable in Britain, including a Podbielniak Hyd-Robot self-recording low-temperature fractional-distillation unit, a Beckmann flame spectrophotometer and a multi-source unit for spectrographic work. A list of scientific equipment to the value of more than £350,000 made available in this way, chiefly to the Department of Scientific and Industrial Research, but also to some twenty-four other research institutions throughout the United Kingdom, has now been published*. The equipment, much of which is obtainable only in the United States, has been made available for a wide range of industries, and about three-quarters of i has already been received. It includes such diverse items as: an anderometer, enabling investigations to be made on precision bearings used in machine-tool spindles, etc., with the view of improving economy and quality of production; a compact surface analyser; a 'Falex' lubricant tester; multi-channel direct-reading spectrographs permitting the use of methods much in advance of existing rapid analytical technique; and a high-temperature dilatometer for research into moulding sand.

The National Physical Laboratory has been supplied with a set of valves for the construction of instruments for calibration in the frequency-range 2,660–10,000 Mc./s., a Carey recording spectrophotometer, a thallium boron-iodide prism, *K*-band klystron oscillators and crystal detectors, and with 'Fosterite' photoelastic material, as well as with nine Berkeley decimal electronic counting units. The Building Research Station has received two American explosive-actuated fastening tools as well as a portable strain-indicator, while American 'trafficators' with magnetic counters and accessories will assist the Road Research Laboratory in taking traffic censuses. The Fuel Research Station has received a centrifugal molecular still, a Brabender semi-automatic moisture tester, a temperature-compensated Worden gravity meter and deep-sounding gear; and a special disk of metals not available in Britain will assist the Gas Research Board in furthering its fluidized bed technique for gasifying coal. The development of heat pumps has been assisted by the supply of a special small thermostatic expansion-valve, and in connexion with the generation of electricity from wind power special transducer valves have been supplied for gust recorders.

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* Issued by the Industrial Correspondent, Mutual Security Agency American Embassy, Grosvenor Square, London, W.1.

A Franz isodynamic separator has been supplied for the magnetic separation of minerals used in the atomic energy programme, and a small high-pressure pilot plant for catalytic flow-through experiments in organic synthesis. The work of the Shirley Institute has been facilitated by the installation of two Saco-Lowell speed frames and a ring frame, as well as a Scott serigraph for testing the strength of coarse yarns and light-weight fabrics. A special tensile testing instrument is being supplied to the Wool Industries Research Association, and a laboratory-type steamer, with pneumatically operated squeeze-rolls, to the Linen Industry Research Association. Other equipment supplied to research associations include the following: to the British Scientific Instrument Research Association, a Beckmann quartz spectrophotometer; the Motor Industry Research Association, a 'Stresscoat' equipment for stress analysis of crankshafts; the Pest Infestation Laboratory, American methyl bromide applicators; the Leather Manufacturers' Research Association, a Beckmann ultra-violet spectrophotometer; and to the British Paint, Colour and Varnish Manufacturers' Research Association, equipment to modernize a Perkin–Elmer spectrograph, a set of diffraction reference cards, and an automatic mixer for pigments and various media.

SURAMIN (BAYER 205) IN ANIMAL TISSUES

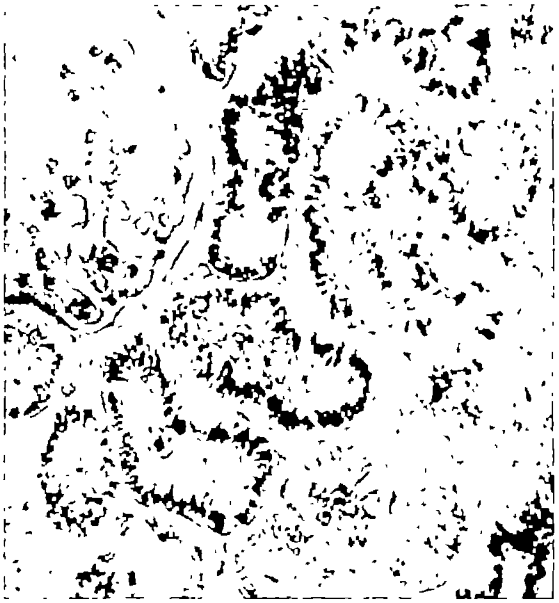
Demonstration of Bayer 205 (Suramin) in Tissues and its Cellular Distribution

THE purpose of our investigations was the elaboration of a histological method suitable for the study of the microscopic localization of suramin. Such a procedure seemed all the more desirable as this important chemotherapeutic drug is also, from a general theoretical point of view, an extremely interesting compound, owing to its being closely linked to proteins and its extremely long persistence in the organism (see refs. 1 and 2 for the literature).

Our experiments were based on the conception of combining the colourless sulphonic acid with a dye cation, thus rendering it visible. On the interaction of suramin and basic dyes in aqueous solution, coloured complexes are formed and, at a certain ratio of suramin to the dye, precipitation occurs, the same colloid chemical rules being valid as in the case of the interaction of acid and basic dyes having opposite electric charges. Among the quinone dyes with closed rings, several were found which could be also combined with the suramin present in the cells. Suramin could be 'stained' successfully with the following dyes: phenosafranin, cresyl blue, azure *B* (trimethylthionin). The best result was, however, obtained with methylene blue eosinate, which stained the cytoplasmic granules containing suramin deep violet; the nuclei were also faintly stained, and the counter staining of the eosine became visible too.

The essence of the specific staining technique is that a methyl alcoholic dye solution is used for fixing and staining simultaneously and, in contrast with routine histological methods, water is not employed, only organic solvents. A membrane cut from the connective tissue, omentum or mesentery is quickly spread out by means of pins on a slide, and, before drying, May–Grünwald stain is poured over it and left until it has nearly evaporated; then it is differentiated with continuous agitation in absolute ethyl alcohol for 20–30 sec.; the differentiation is interrupted with xylene, and the preparation is thoroughly washed in xylene and mounted in copaiva balsam. Smears of blood or exudate can be similarly stained as well as kidney tissue smears, in which the localization of the suramin in the nephron can be followed to great distances.

A second method is to place small pieces of organs in excess of May–Grunwald solution for about 10 hr. and then transfer them directly into benzene and embed them in paraffin; afterwards the sections are floated on slides, deparaffinized and mounted in copaiva balsam (see photograph).



Rat kidney 72 hr. after intravenous injection of 20 mgm. suramin. Granules containing suramin in the epithelial cells of the proximal tubular segment

Our investigations, with mice, rats and guinea pigs treated with suramin, furnished evidence that the drug is ingested by reticulo-endothelial cells in which it accumulates, forming granules in the course of a few days. Suramin could also be detected in fibrocytes and serosal epithelial cells. It appears in the course of the first few hours in the epithelial cells of the proximal tubules of the kidney, and may be stored there in large amounts, being visible even after one or two months, inducing occasionally a nephrosis. Thus suramin behaves in the organism similarly to the vital acid dyes (for example, trypan blue) or the chemotherapeutic arseno-benzene compounds[3]; however, in the elastic tissue of the vascular walls and in the fibrillar structures suramin could not be detected.

Suramin is not present in a free state in the intracellular granules, but in combination with a protein carrier. This view is supported by the fact that, on complete extraction of the dye from the preparation with methyl alcohol, the granules can be stained again. As suramin is very soluble in this solvent, this can only be interpreted by assuming that it is present in a protein linkage, which is in agreement with the fact that methyl alcohol is not capable of splitting off suramin from the protein[4].

In such staining, therefore, suramin plays the part of a mordant, being closely linked to the protein, reacting simultaneously with the basic dye and thus fixing it to the specific granules.

In interpreting the picture demonstrated in the kidney, the close combination between suramin and plasma proteins must be taken into consideration; it makes most unlikely the continuous penetration of the unbound drug through the glomeruli. In our opinion, the histological picture can be interpreted by assuming that a certain amount of protein escapes continuously through the glomeruli and is usually reabsorbed by the tubules. Thus if suramin is present in the plasma, the drug bound to the protein also gains access to the epithelial cells of the tubules and accumulates there. Suramin acts as a tracer showing the physiological path of the protein. We have also completed investigations showing that suramin is introduced into the reticulo-endothelial cells by a similar mechanism, because these cells also ingest proteins from their environment.

Visual Demonstration of Immune Reactions in Tissue

In the preceding communication, microtechnical methods have been reported which enable one to stain Bayer 205 (suramin) in cells so that the fate of the injected drug in the organism can be studied with histological preparations. The great affinity of suramin for proteins and its stability in the organism suggested the use of the drug as a label, thus making possible the demonstration by staining procedures of the further fate of proteins in normal and immune animals. It could be assumed that with suitable experimental conditions the *in vivo* reaction proceeding between the antigen and the antibody will be accessible for direct visual observation. It seemed that for this purpose the elicitation of the Arthus phenomenon with suramin-labelled protein would be the most appropriate.

Rabbits were injected intraperitoneally three times with 1 ml. of horse serum at intervals of two days; the test injection was carried out 5–15 days after the last sensitizing injection. At the test injection the rapid formation of a firm linkage between suramin and the proteins even at physiological *p*H and temperature was taken into consideration. The horse serum was mixed with an equal quantity of physiological saline solution containing 0·5, 0·8 or 1 per cent suramin, and 0·5 ml. was injected intracutaneously or subcutaneously in the dorsal or abdominal region. In animals sacrificed after 48–55 hr., a hæmorrhagic œdematous inflammation developed in an area 5–7 cm. in diameter at the site of the injection, which was absent in the similarly treated non-sensitized controls. Membranes from the subcutaneous connective tissue put on slides were stained with methylene blue eosinate dissolved in methanol in the manner described in our previous paper to demonstrate the suramin deposited in the tissues.

In the controls, the connective tissue is in a resting state exhibiting multipolar or spindle-shaped histiocytes with but few cytoplasmic granules containing suramin, and some round cells of monocyte character with a few specific granules. Undoubtedly the suramin was almost entirely resorbed together with the foreign protein from the local depot. In sensitized animals, on the contrary, it was retained in large quantities in the inflamed area and could be detected as accumulations in different types of cells. Not only the histiocytes, but also the capillary endothelial cells—the connexion of which was interrupted here and there—were crowded with granules containing suramin, and even the fibrocytes contained granules. However, the whole picture was dominated by the presence of numerous macrophages loaded with dark-coloured granules (Figs. 1 and 2).

The considerable storage observed at the site of the Arthus reaction cannot be ascribed to the enhanced capacity for phagocytosis of the cells of the animals pretreated with protein, since on injecting human serum mixed with suramin into rabbits sensitized with horse serum, this phenomenon could not be observed. The characteristic picture must therefore be due to specific serological causes. Local anaphylaxis is generally attributed to the combination of the antigen and the precipitin—mainly to circulating precipitin (cf. ref. 5)—occurring in the tissues. Hence we believe the explanation of the considerable storage of suramin is that these cells ingest the resulting antigen–antibody complexes and, with the large amount of protein, the bound suramin too.

Hitherto there has been inadequate explanation of the vigorous and specific inflammatory stimulus caused by protein injected into the tissues of the sensitized organism. We think that the characteristic

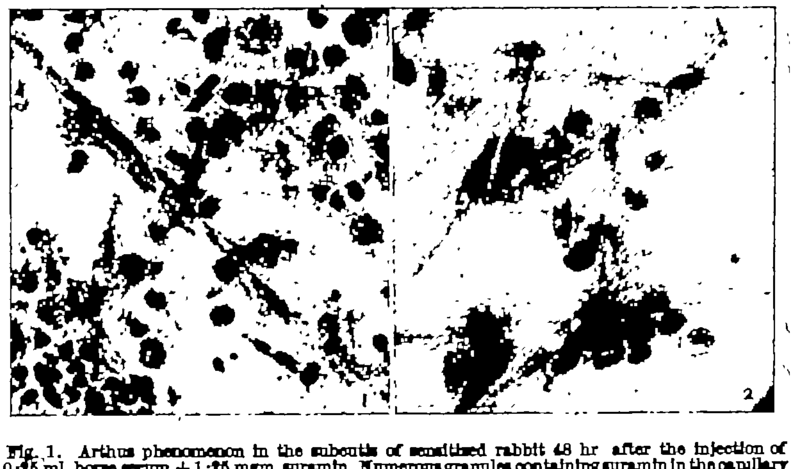


Fig. 1. Arthus phenomenon in the subcutis of sensitized rabbit 48 hr after the injection of 0·25 ml. horse serum + 1·25 mgm. suramin. Numerous granules containing suramin in the capillary endothelium and in the macrophages

Fig. 2. Control experiment, non-sensitized animal. In the body of resting histiocytes there are only a few granules containing suramin

histological picture of the Arthus phenomenon becomes much clearer by the actual demonstration that many cells of various types, including capillary endothelial cells, become heavily loaded with large masses of foreign and their own proteins.

It is a fundamental serological observation that foreign serum proteins and antibodies are eliminated at an accelerated rate from the blood stream as soon as the incubation period of immune body production ends; they persist only a very short time after sensitization in the circulating blood, and in the case of the subcutaneous application they become fixed locally. Undoubtedly the phenomenon described above plays a decisive part in local fixation. However, investigations in progress suggest that in general the rapid elimination of foreign proteins is due to the fact that the cells of the reticulo-endothelial system promptly ingest the antigen–antibody complexes owing to their colloid chemical properties.

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THE DE HAAS – VAN ALPHEN EFFECT AT HIGH FIELDS

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RECENT experiments[1] have shown that the dependence of susceptibility on the periodic field originally discovered in bismuth by de Haas and van Alphen occurs also in many other metals at temperatures in the liquid helium range and magnetic fields up to about 15,000 gauss, such as are available in an ordinary electromagnet. According to the theory, however, the effect is detectable at such low fields only because of the anomalous values of the electronic parameters (effective masses and effective degeneracy parameter) characteristic of the complicated form of the Fermi surface in the metals concerned. For an ideal 'free electron gas' metal, the amplitude of the susceptibility oscillations should become appreciable only at much higher fields—of order 10^5 gauss; and the period should then be very small—of order 50 gauss or so. This is in agreement with the fact that no effect has yet been found by conventional techniques in metals such as gold, silver and copper. Experiments at higher fields are therefore of interest not only because they offer the possibility of discovering the effect in other metals and studying it in conditions where the theory can be tested most directly, but also because it would be of interest to study the effect at higher fields in metals for which it has already been found at lower fields. Comparison with theory suggests that in such metals only a very small proportion of the conduction electrons contribute to the effect at low fields, and it might be expected that short-period oscillations corresponding to the remainder of the electrons would occur at higher fields.

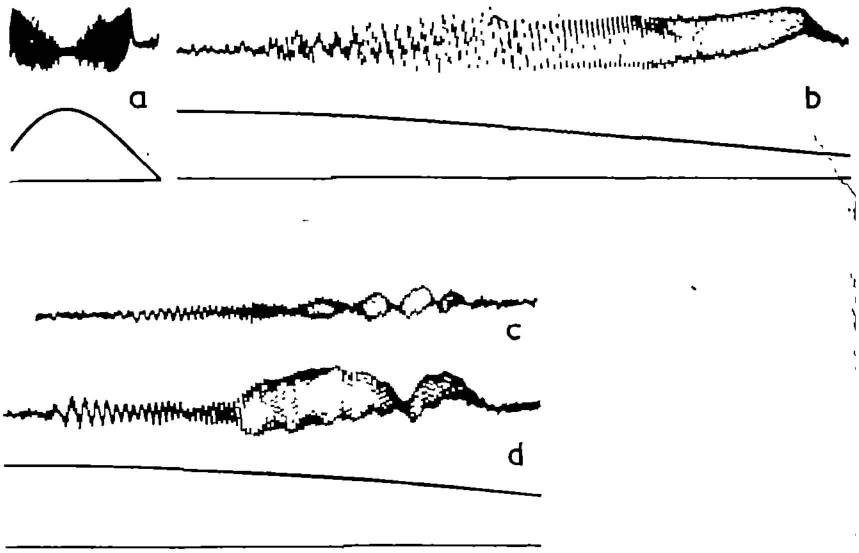
The usual method of studying the de Haas – van Alphen effect is to measure the torque on a single crystal suspended in a uniform magnetic field, but considerable difficulties are involved in extending this method to much higher fields. Such fields are most easily available in large water-cooled solenoids; but the geometry of such solenoids would make measurement of the torque awkward, and moreover it would be difficult to hold the field sufficiently stable—to 1 part in 10^4 or 10^5—to avoid smearing out oscillations of short period. It was therefore decided to try an entirely different technique of the type used by Kapitza, in which the high field is produced only momentarily, and to observe the oscillations of susceptibility by electromagnetic induction rather than by a mechanical method. The advantage of an induction method is that it measures the differential susceptibility $\mathrm{d}I/\mathrm{d}H$ rather than I/H, and if I/H oscillates rapidly with H the amplitude of $\mathrm{d}I/\mathrm{d}H$ may become large even though the amplitude of I/H is only of order 10^{-5}, since $|\mathrm{d}I/\mathrm{d}H| = \frac{2\pi H}{h}|I/H|$, where h is the period of the oscillations. With the development of cheap high-capacity condensers, it is a simple matter to produce fields of order 10^5 gauss in a fairly small coil, designed so that the field should be uniform to 1 part in 10^4 or 10^5 over the length of a short specimen ($\sim$ 5 mm.).

In the actual arrangement used, a condenser of capacity 1,000 µF. is discharged through a liquid-air cooled coil 12 cm. long, of external diameter 2·9 cm. and with an internal hole 0·8 cm. diameter, wound with 1,670 turns of 22 S.W.G. copper wire. When the condenser is charged to 1,750 volts, discharge produces a field rising to a maximum of $0{\cdot}9 \times 10^5$ gauss in about 3 m.sec., which then falls off to zero rather more slowly (the circuit is approximately critically damped). The solenoid fits closely around a Dewar vessel inside which are two 'pick-up' coils, each 1 cm. long and each wound with about 1,450 turns of 47 S.W.G. copper wire, connected in opposition so that the E.M.F. induced in the empty coils by the changing field is roughly zero. The specimen is placed in the region of uniform field of the solenoid at the centre of one of these coils, so that, if its magnetization varies, an E.M.F. proportional to $\mathrm{d}I/\mathrm{d}t$, and therefore to $\mathrm{d}I/\mathrm{d}H$ and $\mathrm{d}H/\mathrm{d}t$, is produced across the coils. This E.M.F. is amplified about 10^5 times and displayed on a cathode-ray oscilloscope triggered to give a single sweep when the discharge takes place. The exact moment of triggering and the duration of the single sweep can be varied so that any part of the curve can be examined in detail; the other beam of the cathode-ray oscilloscope is used to display the time variation of the solenoid current, that is, the field variation, and the picture is recorded photographically.

In order to try out the method and to develop the technique, the first experiments were made with tin, in which the de Haas – van Alphen effect has already been studied at low fields; using a single crystal with its tetragonal axis at about 70° to the field, the oscillations were successfully observed. Fig. *a* shows the oscillograph record at 1·2° K., using a sweep-time of about 10 m.sec. with a triggering delay time of about 1·5 m.sec.; the oscillations are unresolved and only the envelope can be seen as a kind of 'butterfly' pattern. As already mentioned, the observed amplitude is proportional to $\mathrm{d}H/\mathrm{d}t$ as well as to $\mathrm{d}I/\mathrm{d}H$, and so vanishes at the maximum of H. Fig. *b* is a composite picture of 1-m.sec. sweeps with various delays showing the oscillations in the right-hand half of the 'butterfly' resolved; the apparent frequency varies because equal intervals of H do not correspond to equal intervals of time, and also because the periodicity is uniform in $1/H$ rather than H. Analysis of the curves shows that the main period in $1/H$ is $2 \cdot 2 \times 10^{-7}$ gauss^{-1}; according to the theory, this period gives β/E_0, where β is an effective double Bohr magneton (that is, $e\hbar/mc$, where m is an effective electron mass) and E_0 is the degeneracy parameter. From the temperature variation of the amplitude, β is found to be $6 \cdot 5 \times 10^{-20}$ (that is, $m = 0 \cdot 28\ m_0$, where m_0 is the true electronic mass), so that $E_0 = 3 \times 10^{-13}$ erg (that is, T_0, the degeneracy temperature, is 2,200° K.). These values are in good accord with the results found from the low-field experiments, where it may be noted that the oscillations were at the limit of resolution of the torque method. It can be seen also that, superimposed on the main oscillations, there are other oscillations of about 4·5 times shorter period. It is probable that these arise from electrons which do not contribute to the effect at lower fields, but no detailed study of these higher-frequency oscillations has yet been made.

A serious difficulty in the general application of the method is the induction of eddy currents in the specimen by the varying magnetic field. These eddy currents can mask the effect in two ways. First, they cause the field in the interior of the specimen to lag behind that at its surface, and if the lag is too great the resulting non-uniformity of the field will smear out the oscillations; and secondly, the eddy currents may raise the temperature of the specimen sufficiently to reduce the amplitude of the de Haas - van Alphen effect. Both eddy current effects can be reduced by using specimens of small diameter, and are further reduced by the increase of resistance in a high magnetic field (fortunately, for many metals this increase is considerable at low temperatures). For oscillations with the relatively large period shown by the tin specimen, the 'smearing' effect due to non-uniformity is not serious except perhaps at fairly low fields, where dH/dt is large and the period in H is small. The seriousness of the rise of temperature was, however, clearly demonstrated by an experiment in which the tin crystal was contained in a glass envelope, and it was found that the amplitude was considerably reduced—presumably due to the poorer thermal contact with the bath. It is probable that the relaxation time for heat transfer is short compared with 1 m.sec., so that the instantaneous rise of temperature should be proportional to $(dH/dt)^2$, and the reduction of amplitude was indeed most marked where dH/dt was large. With the tin directly in contact with liquid helium, the heat transfer appeared to be adequate to prevent any serious rise of temperature. These considerations suggest that fo really high-frequency oscillations—such as are t be expected for a metal such as gold—it will b possible to observe the oscillations only very clos to the maximum of H, that is, where dH/dt i sufficiently small. The position is made more difficul also by the fact that in such metals as gold th increase of resistance with magnetic field is not nearl as great as with tin, so that the eddy current effect should be much greater. In fact, in one trial experi ment with a gold crystal, no oscillations greater tha the background noise were observed, and it is clea that the technique will have to be refined before i will work for metals approaching the ideal free electron model.

So far, the only success of the method, other tha indicating new high-frequency oscillations in tin, i the discovery of the de Haas - van Alphen effect i lead, for which no effect could be found at low field by the torque method. The results for two singl crystals are illustrated in Figs. c and d, and it can b seen that the period is appreciably shorter than fo the tin specimen. The 'beats' in the oscillations which are similar to those found in other metals a low fields, are presumably due to the presence o several nearly equal frequencies. Rough extrapola tion to low fields makes it plausible that the amplitud of the oscillations in lead would indeed have been to small to observe at 15,000 gauss by the torque method and even at somewhat higher fields the period woul have been too short to resolve. Analysis shows tha β/E_0 is $3 \cdot 9 \times 10^{-8}$ gauss^{-1} for crystal A with H a 20°, 73°, 81° to the cubic axes and $4 \cdot 5 \times 10^{-8}$ gauss for crystal B with H at 52°, 54°, 58° to the cubi axes; a third crystal, C, with H at 47°, 48°, 72 to the cubic axes, gave $\beta/E_0 = 4 \cdot 6 \times 10^{-8}$ gauss^{-1}, s it seems that β/E_0 is not very sensitive to the directio of H relative to the crystal axes. From the tempera



(a) Tin: 'butterfly' pattern showing the oscillations unresolved, 1·2° K.; peak field, $7 \cdot 0 \times 10^4$ gauss.
(b) Same as right-hand half of a but on expanded time-scale.
(c) Lead A, 1·2° K.; peak field, $8 \cdot 2 \times 10^4$ gauss, on expanded time-scale, as in b.
(d) Lead B, 1·2° K.; peak field $8 \cdot 2 \times 10^4$ gauss, on expanded time-scale, as in b.

The lower curves in a, b and d show the variation of the solenoid current measured from the horizontal base-line; c is arranged so that the same current curve applies as for d. In all the curves the time increases from left to right: a is 7 m.sec. long, b 3 m.sec., and c and d 2·4 m.sec. The slight ripples on the current curves are caused by a slight coupling between the two beams of the cathode-ray oscilloscope; the 'dot' pattern superimposed on the oscillations is due to a high-frequency modulation in the beam strength of the cathode-ray oscilloscope ture variation of the amplitude, rough estimates of β could be made for the three crystals, from which it was found that E_0 was about 8×10^{-13} erg (that is, T_0, the degeneracy temperature, was about 6,000° K.); the value of m/m_0 for crystal A was about 0·5. For crystal C, oscillations of roughly five times shorter period were visible near the maximum of H; it is interesting that this short period ($\beta/E_0 \sim 10^{-8}$ gauss^{-1}) approaches the order of magnitude to be expected for one free electron of normal mass per atom ($\beta/E_0 = 0{\cdot}3 \times 10^{-8}$ gauss^{-1}). The conditions for showing up these very short-period oscillations seem to be rather critical, and their behaviour has not yet been studied in detail. The very short period oscillations visible at the left in Fig. *d* are probably not due to the de Haas – van Alphen effect, but to some stray effect, since they appear to be of constant period in time rather than in $1/H$.

These preliminary experiments suggest that the method will be useful in giving new information about the electronic structure of metals, and it is planned to extend the work both to study in greater detail the characteristics of the de Haas – van Alphen effect at high fields in metals for which it is known to occur at low fields, and to look for the effect in other metals. The initiative in developing the condenser discharge method of producing high magnetic fields came from Mr. E. Laurmann before its application to the present problem suggested itself, and I owe him a great debt of gratitude for his success in making it work and for his assistance throughout these experiments. My thanks are due also to Dr. R. G. Chambers and Dr. D. V. Osborne for their valuable collaboration in designing and in part constructing the necessary electronic apparatus, without which the experiments could not have been carried out.

[1] Shoenberg, D., *Phil. Trans. Roy. Soc.*, A, **245**, 1 (1952). This paper gives a general account and full references to other work.

LUMINESCENCE OF AQUEOUS SOLUTIONS OF RADIOACTIVE ISOTOPES AND THE ČERENKOV EFFECT

By Dr. E. H. BELCHER

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IN studies of liquid luminescent systems for use in scintillation counters, Mayneord and Belcher[1] observed a luminescence of low order in aqueous solutions of radioactive isotopes. Such an effect might be attributed to excitation of the substrate[2] or to the Čerenkov effect[3,4]. In view of the significance of these phenomena in the fields of radiation chemistry and biology, a quantitative study of the intensities of emission induced by beta-emitters of various energies has been made.

The emission intensities were measured with a 1-*P*-21 photomultiplier tube cooled with liquid nitrogen coupled to a linear amplifier (type 1008) and counting-rate meter (type 1037*A*). The radioactive solutions were contained in small cylindrical cells of 'Perspex', and of 'Dural' in which a 'Perspex' window formed one basal plane. The cells had a capacity of 6·25 ml. and were optically coupled to the photomultiplier by a short light guide. Quartz cells were at first used but proved unsatisfactory owing to fluorescence excited in the cell walls.

Experimental results for a number of beta- and beta–gamma emitting isotopes are tabulated below. For these studies, the amplifier was set at its maximum gain of 16,000, and the ratemeter discriminator at its minimum setting of 5 volts. The radioactive concentrations studied were chosen so that the counting-rates lay initially between 100 and 200 counts/second, but the rates shown in the table have been fully corrected for the small background effects and referred to a concentration of 1 μC./ml. With two exceptions, the activities of the solutions were measured in sub-standard liquid Geiger–Muller counters[5], themselves calibrated in terms of carbon ionization chamber gamma-measurements and defined solid angle beta-counting[6]. The exceptions were the low-energy beta-emitters calcium-45 and sulphur-35, which were standardized directly by defined solid-angle methods.

Studies of the amplitude distribution of the pulses at the input to the ratemeter indicated that they corresponded to the emission of single electrons at the photomultiplier cathode. It is thus permissible to treat the observed counting-rates as measures of the intensities of emission in the spectral range of the photomultiplier.

The classical theory of Frank and Tamm[7] implies a low energy limit for the Čerenkov effect satisfying the relationship $\beta = 1/n$, where β is the velocity of the emitting particles relative to that of light and n the refractive index of the medium. For electrons, this limit corresponds to 0·260 MeV. in water and 0·177 MeV. in 'Perspex'. The luminescence observed in solutions containing sulphur-35 and calcium-45 can thus be ascribed entirely to excitation processes in the substrate.

To a first approximation luminescent effects due to such processes may be assumed proportional to absorbed energy and thus, ignoring effects due to self-absorbed gamma-radiation and to the escape of electrons through the cell walls, to mean beta-particle energy. The expected contribution of excitation processes to the observed emission in the case of the higher-energy emitters studied can thus be estimated from the observed intensities for sulphur-35 and calcium-45. This contribution is found to represent only a small fraction (< 2 per cent) of the observed total intensities. The residuum after the estimated excitation intensity has been subtracted may be attributed to the Čerenkov effect.

Frank and Tamm's theory gives the following expression for the number dN of photons with wavelengths lying between λ_1 and λ_2 emitted in a length dl of track:

$$dN = 2\pi\alpha\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right)\left(1 - \frac{1}{\beta^2 n^2}\right) dl, \qquad (1)$$

where $\alpha = \dfrac{2\pi e^2}{hc}$. Hence, the total number N_E of photons within these limits emitted along the track of a particle of initial energy E brought to rest within the medium is given by

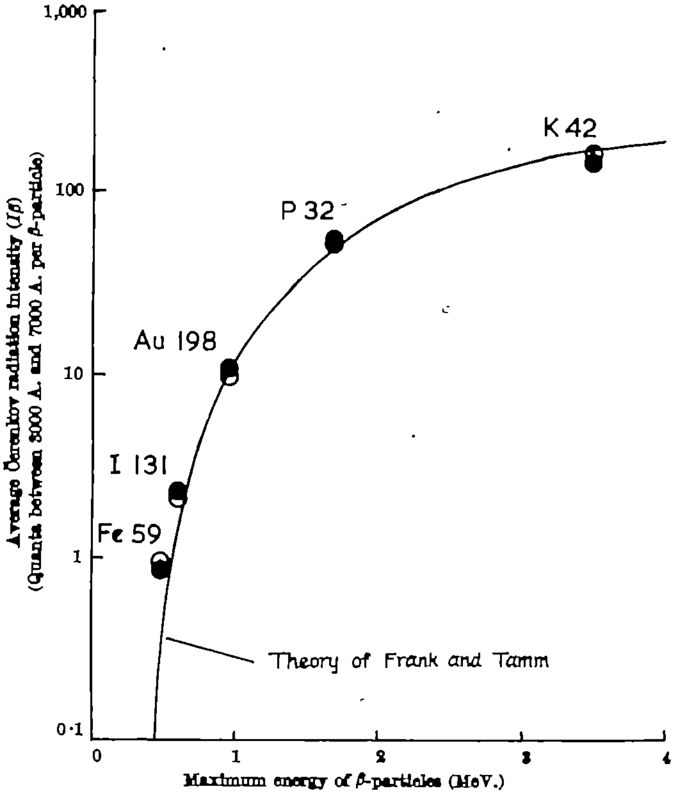
$$N_E = 2\pi\alpha\left(\frac{1}{\lambda_2} - \frac{1}{\lambda_1}\right)\int_{\beta n > 1}\left(1 - \frac{1}{\beta^2 n^2}\right) dl. \qquad (2)$$

For the spectral range of the photomultiplier ($\lambda_1 = 7000$ A., $\lambda_2 = 3000$ A.) equation (2) reduces to

$$N_E = 874 \int_{\beta n > 1}\left(1 - \frac{1}{\beta^2 n^2}\right) dl. \qquad (3)$$

EXPERIMENTAL RESULTS FOR BETA- AND BETA–GAMMA EMITTING NUCLEAR SPECIES IN AQUEOUS SOLUTION

Nuclear species	Chemical form	Radiations		Observed counting-rate for 1 μC./ml. (corrected for background effects)		Remarks
		β (MeV.) max.	γ (MeV.)	'Perspex' cell counts/second	'Dural' cell counts/second	
S-35	SO_4^{--}	0·168	—	0·25 ± 0·017	0·25 ± 0·017	
Ca-45	Ca^{++}	0·254	—	0·55 ± 0·038	0·55 ± 0·038	
Co-60	Co^{++}	0·31	1·17 1·33	160 ± 10·6	85 ± 5·9	
Fe-59	Fe^{+++}	0·26 0·46	1·10 1·30	105 ± 7·3	72 ± 5·0	
I-131	I^-	0·32 0·60	0·08 0·28 0·36 0·64	65 ± 4·5	64 ± 4·5	
Au-198	Au	0·96	0·41	280 ± 20	280 ± 20	Gelatine stabilized sol.
P-32	PO_4^{---}	1·69	—	1,500 ± 110	1,440 ± 100	
K-42	K^+	2·07 3·58	1·51	4,200 ± 290	3,100 ± 210	



Exp. values: ○, 'Perspex' cell; ●, 'Dural' cell

This integral can be evaluated graphically from a knowledge of the range–energy function for electrons in the medium. In the case of a beta-emitting radioisotope, the energy distribution of the emitted beta-particles must be taken into account. If P_E is the probability of release of a beta-particle with energy between the limits E and $(E + dE)$, then the average total intensity I_β of Čerenkov emission per beta-particle is given by

$$I_\beta = \int^{E_{\text{max.}}} P_E \,.\, N_E \,.\, dE. \qquad (4)$$

In the accompanying figure, the relative values of the observed intensities, corrected as described above for excitation effects and also for escape of electrons from the medium, for self-absorbed gamma radiation, and for Čerenkov emission in the 'Perspex' walls, are compared with the theoretical intensities per beta-particle obtained from equation (4), the intensities being plotted against maximum beta-particle energy. The corrections were small except in the case of the energetic gamma-emitters iron-59 and cobalt-60. The observed relative intensities have been superimposed on the calculated intensity–energy function so that exact agreement is obtained for gold-198 solutions in 'Perspex' cells. The relative values for the other nuclear species studied show good agreement with Frank and Tamm's theory, though there is some evidence of a systematic deviation at energies near the threshold. Similar deviations have been reported by Wyckoff and Henderson[8] for the angular distribution of emission induced by mono-energetic electrons in mica films.

Equation (3) predicts the release of some 90 photons between 3000 A. and 7000 A. by a single 1-MeV. electron brought to rest in an aqueous medium. The observed intensities were in general agreement with this value, although uncertainties in the detection efficiency of the measuring system did not permit its accurate confirmation. A more detailed account of this work will be published at a later date.

I wish to record my indebtedness to Prof. W. V. Mayneord, director of the Physics Department, for his interest and encouragement throughout these studies. Acknowledgment is also due to the Medical Research Council which supported the investigation.

[April 9.

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LETTERS TO THE EDITORS

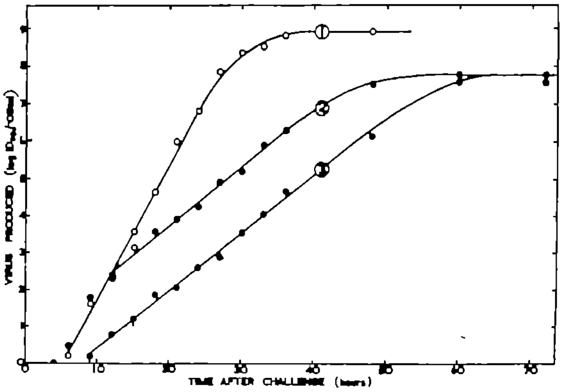
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Multiplication of Influenza Virus under Conditions of Interference

ALTHOUGH it is well established that inactivated viral particles interfere with the multiplication of active virus, the intimate mechanism of the phenomenon is unknown. The fundamental experiments, confined to the comparison of final yields, did not show whether the observed depression resulted from complete incapacitation of some cells, from an overall owering of cellular output, or merely from the slowing-down of the process. Similarly, it is not clear whether the challenging inoculum enters all cells at random, or only those which have the potential ability to yield virus. Some of these questions have been answered by the kinetic study of interference, and the results will be reported in full elsewhere; here we propose to point out some peculiarities of the growth curves, as they reveal possible pitfalls in the planning and interpretation of interference experiments.

Heat-inactivated *LEE* (influenza *B*) virus was used as interfering agent in 0·5-ml. volumes injected allantoically into eleven-day eggs. The challenging dose, 100 ID_{50} of *MEL* (influenza *A*) virus, followed after 45 min.; in later experiments, for reasons set out below, a second group was included with 24 hr. between the two inoculations. The group of control eggs received only the challenging inoculum of *MEL* virus. At intervals, 0·05-ml. samples of allantoic fluid were withdrawn and titrated for infectivity.

The group of controls (curve 1) behaved as would be expected from earlier reports in the literature[1]; the titre rose at a steady logarithmic rate between the sixth and twenty-seventh hour, and then levelled out at a maximum of $10^{9\cdot 20}$ ID_{50} per ml. Curve 2 the group challenged 45 min. after administration of the interfering inoculum) is remarkable for the change in slope after the fourteenth hour. This means that, in spite of the interfering dose, the first cycle of multiplication was in every respect the same as in normal eggs, that is, either interference had not yet been established or, if so, the challenging inoculum multiplied only in cells not affected. To clear up this point, the interval between the administration of interfering and challenging doses was increased to 24 hr. (curve 3). This curve has a uniform slope (1·43), the same as that of curve 2 from the fifteenth hour onwards (1·45), and also reaches the same maximum ($10^{8\cdot 85}$ ID_{50}/ml.), though 12 hr. later. The difference between curves 2 and 3 suggests that the establishment of interference—as opposed to the adsorption of virus[2]—is not instantaneous; and in the special case when active virus closely follows inactive, the high final yield after large challenging inocula which could exhaust all available cells within two cycles of multiplication might appear as the 'overcoming of interference'[3], though, in fact, it is but the 'by-passing of interference'. With an appropriate interval between the two inoculations, the final yield is independent of the challenge dose[3,4].



Curve 1: 100 ID_{50} of active *MEL* (*A*) virus; curve 2: 400 agglutinating doses of heated *LEE* (*B*) virus followed after 45 min. by 100 ID_{50} of active *MEL* (*A*) virus; curve 3: 400 agglutinating doses of heated *LEE* (*B*) virus followed after 24 hr. by 100 ID_{50} of active *MEL* (*A*) virus.

Infectivity titrations were done in 3·16- or 10-fold steps, using 5–10 eggs per dilution. The points of curves 1 and 2 are the geometric means of four, those of curve 3 of three, replicate experiments

Comparison of curves 1 and 3 shows that a lower slope is as characteristic of the growth-curve during interference as is the lower final yield. By failing to reckon with this (that is, if experiments are terminated as is usual after 48 hr.) an exaggerated picture might be obtained, as smaller challenging inocula might not have reached maximum titres at the time of harvesting. It is interesting to note that a log 1·15 reduction of yield goes with a log 0·205 reduction of slope, and from this the average length of the multiplication cycle works out as 1·15/0·205 = 5·6 hr. Though this is considerably lower than the value given in the literature (release of virus starting at 6 hr. and not completed before 10 hr.), it seems significant that the hitherto available estimates of burst size and length of cycle are incompatible with the observed growth-curves[1], while the above value fits them all.

This work was carried out at the Walter and Eliza Hall Institute of Medical Research, Melbourne.

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Macrophages in the Periodontal Tissues of Rats' Incisor Teeth

IN a previous communication[1], it was reported that the incisor teeth of rats kept on a poor South African diet developed signs of deficiency of vitamin A and of calcium. In addition, the sub-enamel tissues contained a large number of macrophages laden with highly refractile orange-coloured granules, as has also been described in vitamin E deficiency by Granados, Mason and Dam[2]. The present communication records investigations of the granular ameloblasts and macrophages of normal and experimental rats' upper incisor teeth.

The material examined was from normal rats and those with acute or healing rickets or suffering from deficiency of vitamin A or E. Preparations of enamel organs were dissected from teeth which had been fixed in formol-saline but not decalcified. These were mounted as smears or frozen sections. In addition, central longitudinal sections of ground or decalcified tissues were examined. The ground sections were impregnated with acrylic after bulk staining with alcoholic borax-carmine and were ground to a thickness of about 15 μ, using the technique already described[3]. With such thin sections, histological details were well seen. The decalcified sections were treated, after fixation, with 5 per cent nitric acid in formol-saline for about five days, and were afterwards processed in the usual way.

It was found that decalcification of the tissues often altered the appearance and histochemistry of the granules in an unpredictable way, so the decalcified sections were chiefly used for studying the cytology and situation of the macrophages.

Refractile orange granules were found in the granular ameloblasts and also in macrophages situated under the enamel organ of undecalcified preparations. The granular ameloblasts are found just behind the area where pigment is first deposited on the enamel[4]. The granules in both situations had the same histochemical properties. They did not stain with hæmatoxylin and eosin, basic fuchsin or osmic acid; they were not acid-fast, did not fluoresce in ultra-violet light nor were they doubly refractile. They stained intensely for iron and also with ammoniacal silver. In sections where the pigmented enamel had remained in strips, this structure gave the same reactions. The various experimental procedures did not alter these reactions of the granules and pigmented enamel, except that the iron reaction was greatly reduced or absent in the later stages of vitamin E deficiency. From the above evidence it would appear that the granular material in the ameloblasts and macrophages and the pigment of the enamel were identical or very similar chemically. Stein and Boyle[5] considered the pigmented enamel layer to be a melanin, while Dam and Granados[6] stated that it was not a lipochrome, porphyrin or melanin.

After decalcification with nitric acid, the character of the granules sometimes changed; those in the ameloblasts might disappear, while those in the macrophages might lose their refractile appearance and positive iron reaction, stain grey with hæmatoxylin and intensely with basic fuchsin. Ground sections made from the corresponding opposite tooth invariably showed orange refractile granules in both types of cells.

Macrophages were only found where the enamel organ had normally retrogressed, in the incisal quarter of the tooth, or where it had atrophied prematurely owing to the experimental procedures used. They appeared to originate from fibrocytes in contact with the enamel. These spindle-shaped cells contained small amounts of refractile material which seemed to come from the pigmented layer of the enamel. As they receded from the enamel, these cells grew in size until they became large oval cells with a deeply stained round, oval or indented nucleus. The refractile material in their cytoplasm coalesced by a proces of coacervation into large granules.

In normal teeth a few rows of macrophages wer found in the sub-enamel organ tissue between th crest of the labial alveolar bone and the gingiva margin. In experimental conditions, when the ename organ had retrogressed prematurely or atrophied macrophages were found much farther back, lyin under the area of atrophy, while in vitamin A-, an especially vitamin E-, deficiency, when almost th entire enamel organ was atrophied[7], a great numbe of them would be found under the atrophied organ It was noted in several teeth dissected from vitami E-deficient animals that, whereas the enamel wa almost entirely white, an area of pigmentation wa to be seen at the extreme formative end. The sam was seen in ground sections.

It appears from the above observations that th macrophages or their precursors remove the pigment in part or wholly, from the enamel when it is no covered with functional ameloblasts. In vitamin A and E-deficiency, so much of the enamel organ ha atrophied that the whole of the pigment may b removed. In the vitamin E-deficient animals studied which had been on the diet about sixty days, th granules in the ameloblasts and those in the macrophages still contained iron. Possibly at a later stag these granules became iron-free, as would be suggeste by the work of Dam and Granados[6,8]. It is ver unlikely that the macrophage pigment in vitamin E deficiency is ceroid, as has been suggested by Dam Granados and Maltesen[8].

I am indebted to Profs. J. Gillman and J. G Thomson for helpful information. The expenses o this work were met by grants from the South Africa Council for Scientific and Industrial Research.

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Localization of Erythemal Processes caused by Ultra-Violet Light in Human Skin

SINCE the fundamental experiments of Hausser an Vahle[1], in 1922, it has been known that two wavelength regions of the ultra-violet spectrum, namely near 297 mμ and about 250 mμ, have maximu efficiency in producing erythema in human skin These regions are separated by a region near 280 m with small erythemal activity. The explanation fo this action spectrum has been sought in the screeni function of the superficially situated horny laye which, as a protein with aromatic compounds, ha a maximum light absorption[2] near 280 mμ.

Radiation experiments with a quartz spectrogra and the interpretation of the results of reflexio xperiments prove that it is converted into methane ery rapidly indeed.

Further experiments are in progress, particularly n the importance of hydrogen gas as a source of umen methane. They will be published in detail lsewhere.

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Use of High Molecular Weight Solutes in the Study of Isolated Intracellular Structures

During a study of red algal plastids ('rhodoplasts') *in vitro*, some facts came to light which may have general interest in a study of isolated cell components. Sugars, such as sucrose, are the substances commonly used for the maintenance of the osmotic environment for isolated cellular components[1].

The red algal plastids are apparently permeable to low molecular weight solutes such as sucrose and potassium chloride, but not to higher molecular weight solutes such as some polyethylene glycols, dextrin and egg albumin. This result is not surprising in view of the colloidal nature of the cytoplasm and the obvious necessity for small molecules to pass rapidly into or out of the plastids. It is suggested that mitochondria and nuclei may be found to have similar properties in many organisms. We may note the ineffectiveness of sucrose in preserving the form of mitochondria from tobacco leaves[2] and pea seedlings[3], and of the pigment granules from sea urchin eggs[4].

The plastids most used in this study were those of *Griffithsia pacifica* Kylin, because of the large size and fragility of the cells. If the plants are crushed in distilled water, sea water (concentrated up to three-fold), potassium chloride (up to 1·5 *M*) or sucrose (up to 2 *M*), the plastids swell and lose their red pigment to the medium within a few minutes, and the suspension changes colour from a dark red to a brilliant orange. This colour change is due to the fluorescence of the phycoerythrin when released from the plastids. Under the microscope, the plastids round up, gradually swell, and often become vacuolated; the phycoerythrin dissolves in the vacuole, and the chlorophyll and carotenoids are in a misshapen mass at one side. The vacuolar membrane appears colourless. Under some conditions, vacuoles may not form. In striking contrast to this is the behaviour in 'Carbowax 4000' [5] (polyethylene glycol, $HOCH_2(CH_2OCH_2)_nCH_2OH$, mol. weight about 2,400 [6]). With this at a concentration of 0·8 gm. per ml. of 0·1 *M* buffer, the plastids appear as they do in the cell and are smooth and homogeneous. In a concentration of 0·4 gm./ml. the plastids round up, but remain smooth and homogeneous. In either of these the plastid form remains unchanged for hours or days at room temperature or in a refrigerator; the phycoerythrin remains in the plastids and does not become fluorescent. A similar picture is given with 'Carbowax 6000' (higher mol. weight), dextrin or egg albumin in sufficient concentrations. But 'Carbowax 1540' (average mol. weight about 1,500) and lower molecular weight polyethylene glycols gave only temporary protection when compared at the same percentage concentrations. Experiments with *Antithamnion uncinatum* Gardn. and *Corallina* spp. gave similar results with respect to fluorescence. Due to deviations from van't Hoff's law, in concentrated solutions of 'Carbowaxes', dextrins and proteins, molarities are meaningless with respect to osmotic pressures, but 0·4 gm. 'Carbowax 4000' plus 1 ml. 0·1 *M* phosphate buffer was found to be about isotonic with intact *Griffithsia* cells.

That the observations reported above are due to osmotic effects is indicated by the effectiveness of widely different substances and the ineffectiveness of similar substances of lower molecular weight. Dialysis of 'Carbowax 4000' did not alter the above results. By successively decreasing the concentrations of 'Carbowax 4000', sucrose and sea water, minimum values of 20 per cent, *M*/8, and 2/3 normal concentration, respectively, were found which just prevented fluorescence and the rounding up of *Griffithsia* plastids. Tests of some other high molecular weight substances (algin, gelatin, methyl cellulose) were unsuccessful, apparently due to low solubility, while a sample of 'polyglucose' supplied by the U.S. National Research Council (average mol. weight about 2,000), although very soluble, was also ineffective. The polyethylene glycols have the great advantages of controllable molecular weight, high solubility and chemical inertness[5].

Electrometric measurement of the Hill reaction (photolysis of water using ferricyanide at the oxidant) have shown that *Griffithsia*, *Antithamnion* and *Corallina* plastids are very active in solutions of 'Carbowax 4000'; but the activity is greatly reduced or eliminated in dilute buffer alone. Tests were also made with several green plants. *Nitella* and *Elodea* chloroplasts maintained activity in the Hill reaction longer in 'Carbowax 4000' than in sucrose, while buffer alone was very injurious. Chloroplasts of several land plants (spinach, New Zealand spinach, tobacco), on the other hand, showed *lower* initial activities in 'Carbowax 4000' compared to sucrose, although New Zealand spinach and tobacco, at least, seemed to show microscopically more normal chloroplasts in the 'Carbowax'. Of these, only tobacco revealed any preservative effect of the 'Carbowax' when chloroplast suspensions were kept overnight at about 15°, the activity in sucrose decreasing ten-fold compared to three-fold in 'Carbowax'. *Bryopsis corticulans* Setch. also failed to show any beneficial effect of 'Carbowax' on the Hill reaction. The chloroplasts of this species swell only slowly in sea water or sucrose.

Work on the red algal plastids is still in progress and will be reported in greater detail later. This work was done under contract with the U.S. Office of Naval Research (*ONR* 414(00)). We are indebted to Dr. A. R. Moore and the Carbide and Carbon Chemicals Co. for supplying samples of 'Carbowaxes'.

Since the above work was completed, two papers by H. G. Callan have come to our attention[7]; he reports that nuclei from amphibian oocytes are permeable to low molecular weight solutes (up to tetranucleotides), but not to egg albumin, glycogen, acacia or soluble celluloses.

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Sodium Acetate Agar as a Sporulation Medium for Yeast

THE formation of adequate numbers of 4-spored asci in yeasts is essential for genetical analysis, and, as spore viability decreases with age, it is advisable to induce rapid sporulation and transfer spores as soon as possible to a nutrient medium containing sugar.

Adams[1] has obtained high yields of spores with baker's yeast by incubating for seven days on a sporulation medium consisting of 0·14 per cent anhydrous sodium acetate, 0·04 per cent dextrose and 2 per cent agar. I have tested various modifications of this formula on American 'Yeast Foam' (a strain of *Saccharomyces cerevisiae*); incubation of sporulation media, after inoculation, was restricted to 40–48 hr. at 25° C. On a medium consisting of 0·3–0·5 per cent anhydrous sodium acetate + 1·5 per cent agar, *p*H 6·5–7·0 (sterilized for 20 min. at 122° C.), 40 per cent sporulation (percentage of cells forming asci) has been recorded several times. Although sporulation is inferior to that recorded for the same yeast by Hartelius and Ditlevsen[2] on gypsum (45 per cent) and cement (56 per cent), this is more than compensated by a higher proportion of 4-spored asci: on the acetate medium, these constitute 12 per cent of the cell population (mean of twelve trials) compared with 8 per cent on cement[2] and 4 per cent on gypsum[2].

Trials with other yeasts have shown that sodium acetate agar, prepared as above, gives consistently high numbers of 4-spored asci after 48 hr. Thus, in several hybrids, up to 50 per cent of the cells have produced 4-spored asci. The introduction of this sporulation medium, therefore, should prove of great value in genetical studies on yeast.

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Coupling Azo Dye Methods for Histochemical Demonstration of Alkaline Phosphatase

THE coupling azo dye methods of Menten, Junge and Green[1], and of Manheimer and Seligman[2], have generally been found insensitive and unsatisfactory for the demonstration of alkaline phosphatase. The recent improvement of the method by Gomori[3], using sodium α-naphthyl phosphate, has overcome some of their disabilities. We have confirmed that this substrate is the best available, but find that with acetone-fixed paraffin sections the method is still insensitive and useful only for the demonstration of sites of high enzyme activity.

If brief cold formalin fixation (4°, 8–16 hr.) is substituted, and 10–15-μ frozen sections, the method becomes as sensitive as any so far published. Preservation of enzyme is good, fixation artefacts few and enzyme diffusion negligible. Nuclear staining, reported absent by Gomori[3] and Novikoff[4], we have often observed in paraffin but never in frozen sections. Using cold formalin-fixed sections, the most important single factor becomes the choice of a suitable diazonium salt for coupling at an alkaline *p*H.

We have tested a number of stable diazotates thought likely to be suitable on theoretical grounds as coupling agents in the alkaline phosphatase method. Cold formalin (4°) fixed (16-hr.) frozen sections (15 μ thick) of rat kidney were used, in veronal acetate buffer at *p*H 9·2. A note was made of (1) the speed of the reaction, (2) the rate of decomposition of the diazonium salt, (3) the colour of the final product, and (4) the type of precipitate. The results, in the case of nine stable diazotates, appear in the accompanying table.

Diazonium salt of	Inhibition	Decomposition	Colour	Diffuse or particulate
1. 1-Amino-anthraquinone	+++	+++	Brick-red	Diffuse
2. 4-Benzoylamino-2 : 5 dimethoxy-aniline	+	+	Black	Particulate
3. *p*-Nitroaniline	+++	++	Brick-red	Particulate
4. 4-Chloro-2-nitro-aniline	++++	+	Rose-red	Particulate
5. 2 : 5 Dichlor-aniline	++	++	Red-brown	Particulate
6. *o*-Dianisidine	+	++++	Black	Diffuse
7. 4-Chloro-*o*-anisidine	+	++	Brick-red	Particulate
8. 5-Nitro-*o*-anisidine	++	+++	Red-brown	Diffuse
9. 5-Chloro-*o*-toluidine	+	nil to +	Brown	Particulate

*p*H 9·2

Degrees of inhibition are registered from + to ++++, the former indicating almost complete absence. Similarly, in the case of decomposition, one + means practically no visible staining of the background structures. The reference 'particulate' means that the dye particles were large enough to be clearly visible with the 2/3 objective; diffuse means a particle size not appreciable at this magnification.

The question of diffusion of the reaction product was controlled by incubating two sections face to face, one inactivated by heat (15 min./90°) and Lugol's iodine solution (15 min.), the other untreated. No diffusion of the reaction product was detected with any of the salts within the limits (100 μ) of the distance between the two sections, provided that the concentration of the diazonium salt was sufficiently high. The optimum concentration for all these salts was found to be in the region of 1 mgm. per ml. substrate solution. With stronger concentrations, in the region of 5 mgm. per ml., inhibition was excessive, and with lower concentrations (0·1–0·2 mgm./ml.) two effects were noted. First, diffusion of α-naphthol occurred which was greater than 100 μ, and secondly, the final azo dye product was not as deeply coloured. With those salts producing a black dye, for example, the resulting dye was invariably red. Absence of enzyme inhibition by salts 2, 6, 7 and 9 was indicated by the production of a strongly positive result in 2–5 min., using the optimum concentration of diazonium salt in each case. With all the other salts inhibition was considerable. The decomposition of salts 2 and 9 was negligible, even after incubation for 2–4 hr., and with salt 7 it was only slight up to 1 hr. Salt 6, on the other hand, rapidly stained the tissues dark brown. Size of precipitate was largest with 2, smaller with 7 and very much smaller with 6; but in spite of this the reaction with salt 9 (diazotate of 5-chloro-o-toluidine) is the best so far obtained in respect of speed, colour and lack of decomposition.

With a suitable diazonium salt, the coupling azo dye method, applied to formalin-fixed frozen sections, should become the method of choice for the investigation of alkaline phosphatase in normal and pathological tissues.

One of us (E. G.) acknowledges the receipt of a grant from the Swiss Academy of Medical Sciences.

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Separation of the 2,4-Dinitrophenylhydrazones of Volatile Aldehydes and Ketones by Paper Chromatography

It is possible to separate the dinitrophenylhydrazones of keto-acids by paper partition chromatography with the usual two-phase alcohol – water solvents[1,2]. Aldehydes and ketones without a carboxyl group are not appreciably separated by this means because, being less soluble in aqueous media, they have uniformly high R_F values. Rice, Keller and Kirchner[3] were able to separate a number of these compounds by using single-phase solvents such as diethyl ether – petroleum ether. They also found that filter paper impregnated with silicic acid was helpful. Kostir and Slavik[4] used paper on which the solvent phases were reversed. They acetylated strips of filter paper and used two-phase solvents such as ethanol-chlorobenzene, the ethanol phase being the mobile one. In this way they separated acetaldehyde, formaldehyde, acetone and a number of keto-acids and dicarbonyl compounds.

The following method gives improved separations of the dinitrophenylhydrazones of a number of aldehydes and ketones and has been useful in the detection of volatile aldehydes and ketones dissolved in petroleum ether in quantities greater than 10^{-7} gm. mole. The non-aqueous two-phase solvent methanol – heptane is used, the heptane phase being the mobile one. The slight modifications that are necessary to obtain equilibrium conditions in the chromatographic chamber with these volatile liquids have been described[5]. By the method of descending irrigation, the solvent front moves about 20 cm. in an hour. The yellow spots, which are somewhat elongated, can be revealed more clearly by spraying with aqueous 10 per cent sodium hydroxide solution. The red-brown colour obtained varies slightly with the compound and is sometimes an aid to identification.

The accompanying table shows the R_F values (± 0·02) obtained for the dinitrophenylhydrazones of the compounds from a run of about 20 cm. at 20° C. on Whatman No. 1 filter paper.

Formaldehyde	0·09	Acetone	0·30
Acetaldehyde	0·18	Methyl ethyl ketone	0·43
Propionaldehyde	0·32	Methyl *n*-propyl ketone	0·53
n-Butyraldehyde	0·42	Methyl *n*-butyl ketone	0·65
n-Valeraldehyde	0·54	Furfural	0·06
n-Caproaldehyde	0·57	Acrolein	0·21
		Crotonaldehyde	0·22

Keto-acids and dicarbonyl compounds do not travel.

If the values for the homologous series of derivatives of saturated aldehydes are used for calculating the corresponding R_M values[6], and these plotted against the number of methylene groups in the aldehyde, the points lie approximately on a straight line. For the ketones a similar graph is obtained.

The work described in this paper was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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Proline and Hydroxyproline in Leaves

In the course of investigations on the nitrogen metabolism of plants, the distribution of free amino-acids in the leaves of a number of plant species was studied by the circular paper chromatographic technique[1]. The occurrence of proline and hydroxyproline in relatively high concentrations in some of the leaves investigated prompted us to report these preliminary observations.

Fresh leaves were extracted with ethyl alcohol by blending 20-gm. portions with 80 ml. of alcohol (final concentration, 75 per cent) in a Waring blendor for about 5 min. After centrifuging, the alcohol extract was well shaken with three times its volume of chloroform and again centrifuged. The aqueous layer containing the free amino-acids was used for chromatography. The method followed for running the chromatograms was essentially the same as that described by Giri and Rao[2] using Whatman No. 1 filter paper and *N*-butanol–acetic acid–water as the developing solvent.

Among the plants investigated, those belonging to the genus *Citrus* (*Citrus decumana*, *Citrus acida*, *Citrus medica* and *Citrus aurantium*) and family Rutaceæ contained high concentrations of free proline in their leaves, compared to other amino-acids present. Although proline is distributed widely in plant tissues, the occurrence of free hydroxyproline in high concentrations has not been reported so far. However, Joslyn and Stepka[3] found traces of free hydroxyproline in prune extract. Dent *et al.*[4] could not detect this amino-acid in potato tubers although twenty-one other amino-acids were identified. However, the circular paper chromatograms of fresh sandal leaf extracts (*Santalum album*) showed the presence of hydroxyproline, proline, arginine, glutamic acid, alanine and traces of other unidentified amino-acids. The dried sandal leaf extract contained, in addition, leucine (or *iso*leucine), phenyl alanine, valine and tryptophane. But the most prominent and intensely coloured (yellow) band was that of hydroxyproline. Proline and hydroxyproline were identified by their position and the characteristic yellow colour of their bands on the chromatogram, and further confirmed by the specific test with isatin[5].

Sandal leaves collected in the morning and dried at 50° C. and powdered showed there was no deterioration in the hydroxyproline content after drying. 50 mgm. of powder were extracted four times with 5-ml. aliquots of 75 per cent alcohol. The combined extract was treated with chloroform as before and the aqueous layer used for the estimation of hydroxyproline by the method of Neuman and Logan[6] involving oxidation with alkaline hydrogen peroxide and copper sulphate, followed by acidification and reaction with *p*-dimethyl amino-benzaldehyde. The dried healthy leaves contained about 1·7 gm., and a sample of spiked leaves contained 3·0 gm., of hydroxyproline in 100 gm. of material. The predominance of hydroxyproline over other amino-acids present in the leaves of *Santalum album* is striking. So far as we are aware, this is the first record of the occurrence of free hydroxyproline in high concentrations in leaves.

The practical application of these results in the preparation of proline and hydroxyproline from leaves at least on a laboratory scale is an inviting possibility. Investigations in this regard and on the role of the two amino-acids, especially of hydroxyproline in the nitrogen metabolism of spiked and healthy sandalwood trees, are in progress. This has added significance in view of the recent finding of Steinberg[7] that hydroxyproline was toxic to tobacco seedlings, even at 5 p.p.m., indicating a specificity of action.

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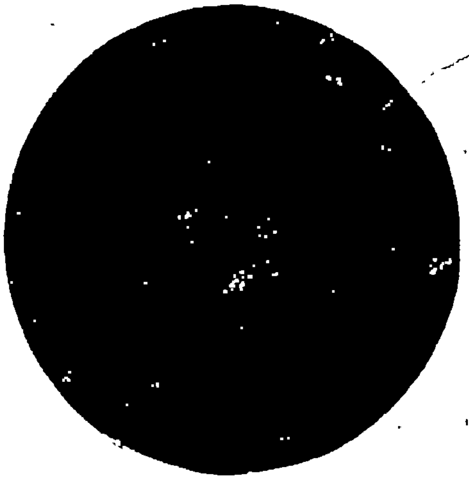
Improvements in Optical Fourier Synthesis

A METHOD has recently been described of producing Fourier syntheses of centro-symmetrical projections by means of optical interference[1]. The biaxial nature of mica was used to introduce into the diffracting beams both intensity and phase relations corresponding to those of the X-ray spectra. The resolution obtained was poor, and it was suggested that this could be improved by using lenses corrected for spherical aberration.

Corrected doublets have now been fitted to the existing apparatus, and considerably better resolution has been obtained. The accompanying photograph is of the optical Fourier synthesis of hexamethylbenzene, based on the X-ray data of Brockway and Robertson[2]. This is a striking improvement over previous work.



Optical Fourier synthesis of hexamethylbenzene

In a recent article[3] it was suggested that, unless the available beam of parallel light were greatly extended, this method of optical Fourier synthesis would probably be of very limited application. Work now in progress will make it possible to pack more terms into the available beam; it is hoped that in this way it will be possible to accommodate a maximum index of 15 in each direction. This should greatly increase the scope and usefulness of the method.

A full account of recent developments will be published elsewhere.

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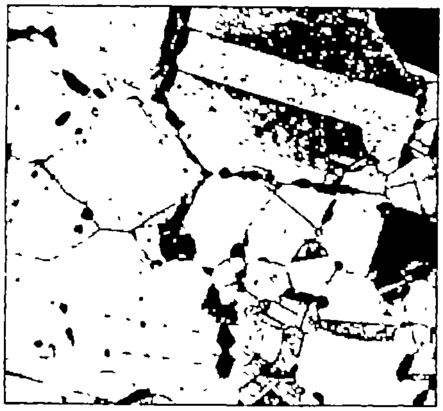
Lattice Vacancies and Porosity in Copper–Nickel Alloys

IN work on the aluminium–zinc[1] and gold–nickel alloy systems[2], it has been shown that lattice vacancies occur in solid solutions when Brillouin zones are filled. Similar experiments have been made on copper–nickel alloys, and it is found that lattice vacancies occur in these alloys particularly when they contain less than 80 per cent nickel, the maximum being about 2 per cent at 45 per cent nickel.

The alloys were melted and solidified *in vacuo*, annealed in a vacuum for seven days at 900° C., reduced in thickness by 50 per cent by hammering at room temperature and then annealed *in vacuo* at temperatures between 700° and 970° C. for periods of up to 4,175 hr. Density measurements were made from time to time. It has been found that the alloys grow progressively, the amount of growth depending on the temperature of annealing and number of lattice vacancies.

The accompanying photograph shows the micro structure of an alloy containing 80 per cent copper after annealing for 4,175 hr. at 900° C., during which treatment its volume increased by about 4·5 per cent. It will be seen that considerable micro porosity has developed during treatment. Almost all the porosity occurs in crystal boundaries with very little at twin boundaries or in the crystals.



Micro porosity developed in 80/20 copper–nickel alloy by prolonged annealing *in vacuo*. × 150

Alloys containing less than 20 per cent copper, in which there are comparatively few vacancies, show less than 0·1 per cent growth under similar conditions.

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Ellwood, E. C., *Nature*, **163**, 722 (1949); *J. Inst. Metals*, **80**, 217 (1951–52).

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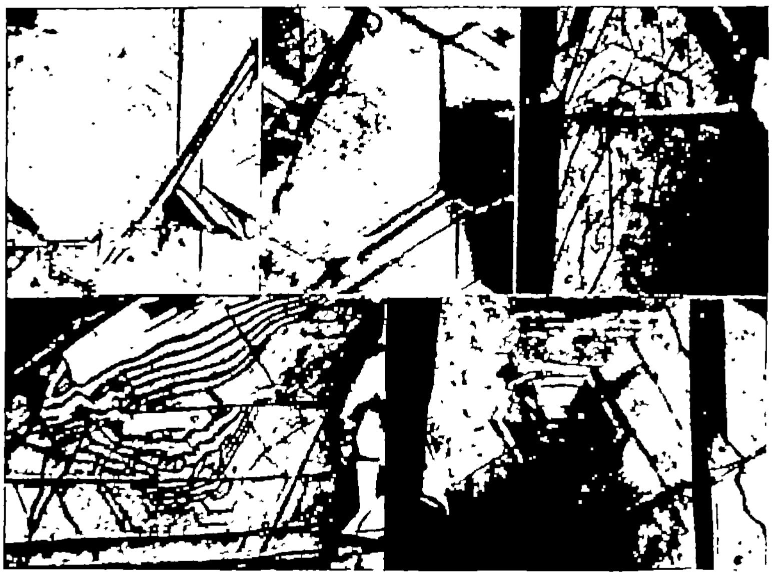
Spiral Growth on Graphite

SPIRAL growth patterns have been observed on natural graphite. Typical spirals are shown in the accompanying photographs. The spirals have been predominantly hexagonal, although some with curved edges, particularly at the centre of the spiral, have been noted. The step-heights vary widely; the step-height of the spiral shown in (*b*) is about 500 A., those in (*c*) and (*e*) are apparently many orders larger. Photograph (*d*) shows a double spiral and serves at the same time to give an idea of the density of spiral patterns. Areas have been noted in which the density of spirals is of the order of 10^4 per cm.^{2}.



Spiral growth on natural graphite: (*a*) 1,000 ×. (*b*) 1,500 ×. (*c*) 150 ×. (*d*) 500 ×. (*e*) 150 ×

Of the graphites studied, those which lend themselves best to the observation of spirals have been obtained from the crystallized limestones of the Grenville series ranging from the Adirondacks to north of Quebec. The spiral patterns are observed on the natural surfaces of the embedded graphite and also on surfaces exposed by carefully separating the graphite layers. No spirals have been observed on the surface of the limestone at the point from which the graphite is removed. Spirals have not been observed on samples of graphite obtained from Ceylon, nor from columnar graphite from Quebec. Neither of these samples has the distinct sheet-like structure of the Grenville series graphite. It is not possible yet to determine whether it is simply more difficult to resolve the spirals or whether they are not present on such samples.

The observation of growth spirals on graphite may be taken as evidence—in the same sense at least as has been established for silicon carbide[1] in particular —that graphite may grow from screw dislocations. It is believed that certain structural problems in graphite may be clarified knowing that screw dislocations may be present. Thus, the polytypism in graphite may be developed along lines similar to those applied to the problem in silicon carbide[2].

As developed *a priori*, the theory of crystal growth by screw dislocations is considered to pertain to growth under somewhat restricted conditions[3]. If spiral growth on graphite is limited to graphites from certain localities, the observation of spiral growth may be of assistance in interpreting the geological origin of graphites.

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[1] Verma, A. R., *Phil. Mag.*, **42**, 1005 (1951).

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Relativity and Indeterminacy

Without wishing in any way to disagree with H. Bondi's view[1] that "relativity demands a non-deterministic theory", I would suggest that his final summing-up is somewhat misleading. He says: "The flow of time has no significance in the logically fixed pattern of events demanded by deterministic theory, time being a mere co-ordinate. In a theory of indeterminacy, however, the passage of time transforms statistical expectations into real events".

In the case of deterministic theories, we must surely distinguish between reversible and irreversible determined processes. Time, in statistical but determined laws, as distinct from dynamical laws, surely has a very definite significance, for example, in its relation to entropy changes and especially to those processes which Prof. A. R. Ubbelohde[2] has described as "disentropic". (These are defined as "happenings which turn against the trend towards increasing entropy".) Many statistical laws depend on determined processes. The motions of individual components may be difficult to observe, or too numerous or complex to calculate, yet their behaviour certainly falls outside the range of appreciable indeterminacy.

It is true, if not a truism, that where there is no cause–effect relation, real events become actual from mere statistical expectations during the course of time. But can this passage of time rightly be described as the transforming agent? This would involve a return to causality with time as the cause!

I would suggest that there is at least as much difference between time used as a co-ordinate in dynamical processes and time describing local variations in efficiency (both being determined) as there is between either of these and time during which (not by which) non-determined statistical probabilities become actualities.

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[1] Bondi, H., *Nature*, 169, 660 (1952).

[2] Ubbelohde, A. R., "Time and Thermodynamics", 97 (Oxf. Univ. Press, 1947).

In a recent communication in *Nature*[1], Mr. H. Bondi (in common with a large number of writers in the field) took as a fundamental postulate of relativity the principle P that effects are delayed relative to causes by amounts corresponding to transmission speeds less than or equal to the velocity of light, c. This led him to the conclusion that indeterminacy is fundamental to relativity, and so we must abandon the complete determinacy contemplated in classical physics (and, it should be noted, in at least one approach to quantum theory[2]). The argument was, more or less, that there is no unique cause–effect link, and so no unique meaning for P, in a deterministic system.

The principle P is commonly employed in setting up a system of space–time co-ordinates by means of light signals, and it appears that this is the use envisaged by Mr. Bondi. However, the important fact in such a co-ordinate formation is not that c is the maximum speed between cause and effect, but rather that c is a speed on which relatively moving observers will agree for all directions of motion.

One can set up one's own co-ordinate system in any number of ways, using light signals or not; all that is needed is a unique (to an arbitrary factor and self-consistent method of correlating event which occur at separated spatial and tempora positions. Whether or not these events are relate through a cause–effect link is irrelevant and, som would say, meaningless.

If two correlated events occur at separations Δ and Δt, then one can introduce an effective speed o correlation, $s = |\Delta r/\Delta t|$. This need not be th speed of a ponderable body nor of a light signal it could just as well be, for example, a group spee or the speed of the juncture point of two straigh edges in relative motion. It need not, then, be confined to values less than or equal to c. In this connexion, it may be pointed out that no escape, fo example by considering discontinuous fields, nee be made from the fact that group speeds ca exceed c.

A difficulty arises only if we attempt to compar our measurements with those made, on the sam events, in a relatively-moving co-ordinate system. I general, correlation is obtained by means of Lorentz rather than Galilean, transformations, and in particular, the effective speeds are found equal (for al directions) in those cases when $s = c$ rather tha when s is infinite. It is these circumstances that giv c its unique position in the establishment of co-ordinate systems. Cause–effect links and limitin velocities are not involved, and conclusions base on them are therefore irrelevant to the fundamental of relativity.

For those who may not agree with the foregoing I shall add the following remarks. There are alternative, though less popular, methods of introducin relativity which postulate neither a cause–effect lin nor limiting velocities. We are quite at liberty t adopt one of these other methods, and many woul choose to do so. Mr. Bondi's apparent preference fo P does not commit the rest of us to indeterminacy any more than Prof. P. A. M. Dirac's interpretation of his symbolism—whether it leads to quantizatio or not—commits us to an æther.

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[1] Bondi, H., *Nature*, 169, 660 (1952).

[2] Bohm, D., *Phys. Rev.*, 85, 166 (1952).

[3] Dirac, P. A. M., *Nature*, 168, 906 (1951).

It is not clear why the subject of statistics shoul throw any light on this problem, as Dr. G. W. Scot Blair suggests. There are two possible logical foundations for the use of statistics in physics: either, i the framework of a fully deterministic theory, wherei statistics may be used for the discussion of problem of such complexity that the detailed application o the supposedly known physical laws is impracticable or within a non-deterministic theory, where the mo basic physical laws may be concerned with the stat ment of probabilities.

In the former case, time is a co-ordinate, that, lik space, is required for plotting the world lines of th particles. Whether this fixed pattern of world line is simple so that we can construct it directly fro the deterministic laws, or whether it is so complicate that we use statistical theorems as well as th deterministic laws in the calculation, does not alte the significance we attach to the various co-ordinate

In the case of indeterminacy, the passage of tim has a further significance, being concerned with th realization of probabilities. A variety of verbal methods of description can be used for this, from which Dr. Scott Blair has chosen some.

In the unique pattern of world lines appropriate to a completely deterministic world, it is not clear how an analysis would reveal the rules of causality (the physical laws). Since every set of events would be in some way unique, any selection of apparently recurring patterns would be arbitrary.

Such sets of recurring patterns would be the only way of investigating possible causal relations. It would, however, still require an arbitrary judgment to say which patterns represent direct cause–effect relations and which represent the various effects of some previous cause. In a deterministic world, it would be necessary to understand all causal connexions in the entire pattern before any particular laws of causality could be singled out.

In a non-deterministic system the situation is quite different. If it is found that certain events occur invariably after the occurrence of some uncaused event, but not in its absence, then a causal connexion can immediately be inferred, for no such events can be regarded as distant effects of earlier causes.

Mr. C. O. Hines presents a completely acceptable definition of the velocity c from the experimental verification of the Lorentz transformation. But he does not point out that this implies a limiting velocity c also for the transfer of information if cause–effect relations are to be unidirectional in time. We are therefore led back to what Mr. Hines calls principle P, and so to the starting point of this discussion.

The essential fact is that no *step-by-step* investigation of Nature is logically possible without some indeterminacy. This statement does not conflict with the possibility of constructing deterministic mathematical theories to cover any known field, but denies their scientific utility.

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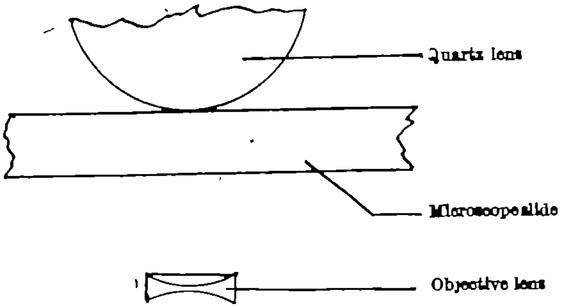
Measurement of Thicknesses of Fine Particles

A method for measuring thicknesses of particles in the sub-sieve range has been devised. Measurements are made using the Vickers projection microscope. The apparatus required is an attachment to the sub-stage condenser which replaces its front lens; it consists mainly of a quartz spherical lens, which is allowed to make contact with a microscope slide carrying a dispersion of fine particles mounted dry on its uppermost surface—which is most distant from the objective lens—as shown in the diagram.

Contact is made on a strip which has been wiped free of particles, near the left-hand edge of the slide. The point of contact is focused on to the screen and is arranged to lie at the middle of the left-hand side of the screen. When the slide is traversed from right to left, particles enter the field and are seen to meet the lens at varying distances from the point of contact of lens and slide. These distances are proportional to the square roots of the thicknesses of the particles.



By having interchangeable spherical lenses of different diameters and the choice of suitable magnifications, lens diameter being decreased when the magnification is increased, the thicknesses of particles of diameters in the range 76–3 microns can be measured with the same degree of accuracy throughout, the standard error of a single measurement being 5 per cent, if the smallest thickness measured is not less than 0·4 micron.

Transmitted light is used for all measurements, and the illumination and image definition do not deteriorate even when objectives of 4 mm. and 2 mm. focal lengths are used. When these particular objectives are used, rectangular No. 1 microscope cover slips carry the particles.

This method of measurement is eminently suitable for the Vickers projection microscope but is not easily adapted to the normal light microscope; it could be readily adapted to the inverted microscope, measurements being made with a suitable eyepiece graticule.

The method is the subject of a patent application and more details will be reported at a later date.

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Scintillation Spectrometer Studies on the Decay Schemes of Silver-110, Antimony-124 and Iodine-131

In order to study the decay schemes of radioisotopes, we have used two scintillation spectrometers in coincidence. The construction of the spectrometers used and the measuring technique have been described earlier[1]. The pulses from one of the spectrometers are analysed by a single-channel pulse analyser. Pulses corresponding to a certain energy-range are selected by the channel, and the output pulses from the analyser are fed to the sweep-trigger of an oscilloscope. The pulses from the second spectrometer are led to the vertical deflexion plates of the oscilloscope. Only pulses which are in coincidence with those selected by the pulse analyser then appear on the screen. The coincidence-rate is 10–100 pulses per minute. The screen is photographed for a few hours. A picture of the pulse-height distribution is then obtained on the photographic plate; the density at a particular point is a measure of the number of pulses with the corresponding height. The density is determined by means of a microphotometer, and, from the known density curve of the plate, one obtains the pulse-height distribution curve. With the pulse analyser one thus selects pulses corresponding to a certain beta- or gamma-ray energy, and from the shape of the coincidence spectrum obtained one can infer what gamma-rays are in coincidence with the selected radiation.

The apparatus described here has been used to investigate some decay schemes. The following results have been obtained:

Silver-110. It has been possible to determine in a satisfactory way the coincidence relations of the two beta-components and of the strongest six gamma-rays. Our results are in complete agreement with the decay scheme proposed by Siegbahn[2].

Antimony-124. Our results agree on the whole with the decay scheme suggested by Kern *et al.*[3]. We have found, however, that the 2·06-MeV. gamma-ray probably does not go to the ground-state but to the first excited level at 0·60 MeV.

Iodine-131. From our measurements, we conclude that the only coincident gamma-rays are those at 80 keV. and 284 keV. The gamma-rays at 638 keV. and 720 keV. go directly to the ground-state. The results obtained thus support the decay scheme suggested by Metzger and Deutsch[4]. The coincidence measurements described here do not agree with the gamma–gamma coincidence experiments performed by Bell *et al.*[5]. On the other hand, they agree with the beta–gamma coincidence measurements published quite recently by Ketelle *et al.*[6].

A detailed account of this work will appear in *Arkiv för Fysik*.

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[1] Johansson, S. A. E., *Nature*, 166, 396 (1950); *Arkiv för Fysik*, 2, 171 (1950); 3, 533 (1951).

[2] Siegbahn, K., *Phys. Rev.*, 77, 233 (1950).

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[4] Metzger, F., and Deutsch, M., *Phys. Rev.*, 74, 1640 (1948).

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Use of Radioactive Tracer in the Study of Insect Populations (Lepidoptera)

It has up to now been impossible to mark larvæ in the wild because of their frequent skin changes and their pupation; consequently, the method usually adopted in population studies of distinguishing an insect with a spot of cellulose paint is not applicable to them. It was therefore decided to attempt the marking of larvæ by feeding them on radioactive material.

A suitable isotope would require the following properties: a half-life long enough to survive the pupal period yet short enough to ensure against building up radioactive populations in the wild; easy ingestion and incorporation into the food plants and afterwards into the living tissue of the insect; slow elimination. Sulphur-35 answers these requirements, having a half-life of 87·1 days and being an essential element in both plant and insect physiology. However, it has the drawback of emitting a low-energy beta ray (0·168 MeV.). This difficulty was overcome by the use of a Geiger–Müller counting tube fitted with a thin mica window.

The species chosen for study were *Panaxia dominul* and *Arctia caja*. The food-plants selected for ther were dead nettle (*Lamium* spp.) and dock (*Rume* spp.), respectively, and these were treated wit sulphur-35. The following procedure was adopted t ensure its uniform incorporation throughout the plant proteins. Plants stripped of most of their olde foliage were established in water culture for two t three days, during which time root regeneratio occurred. They were then supplied with one par in a million of sulphur (given in the form of potassiu sulphate) and 100 micro-Curies of sulphur-35 per litre A balanced medium containing necessary material other than sulphur was then added at weekly interval and, after three weeks or more, the larvæ were fe on these. It was found that if the plants wer used shortly after treatment with sulphur-35, th bulk of this was concentrated in the young tissues so that the degree of radioactivity varied greatl from leaf to leaf, with the result that no uniformit of count was shown by the larvæ which had fed on them.

Nearly full-fed larvæ of *P. dominula* fed on suc treated material for 65 hr. were presented to a mica-window counter tube in a lead castle and the count for one minute recorded. These gave only low counts, while their excreta were highly radioactive. When returned to non-radioactive food plants, however, they continued to show increasing counts for some hours, the reason being, no doubt, that the soft-ray sulphur was in the process of absorption and had not yet been incorporated into the superficial structures. Larvæ near to pupation ate less and therefore gave low counts. An arbitrary figure was taken of about 20 counts per minute above the background and larvæ were placed in one of two groups—those which 'qualified' over this value, and those which did not. In due course, they pupated and the pupæ showed counts comparable with their larval stage.

Six to eight weeks after radioactive treatment, the imagines hatched and it was noted that they all gave counts far in excess of those obtained from the larvæ and pupæ, so that all the 'qualifiers' showed counts two to six times higher and many of the 'non-qualifiers' were easily recognizable (experiment *C/A*, No. *A* 17, pupa 13 counts per min.; imago 79). This, doubtless, is due to the fact that an imago has a much greater surface area than a larva, in the more bulky body of which the majority of the beta-rays must be absorbed. Furthermore, it has been shown that there is a concentration of sulphur in the wings of some Lepidoptera[1].

It should also be pointed out that holometabolous insects are, in general, an excellent medium for such work, inasmuch that there can be no 'sulphur exchange' during the pupal stage and thereafter; the only loss occurs in the excretion of a small amount of meconium on emergence, while the chitinous pupal case does not appear to contain much sulphur. Further experiments using *Arctia caja* confirmed these results. Other relevant points which arose during these experiments were: a batch of ova laid by a female *A. caja* with a count of 417 per min. gave 676 counts per min. Dead and dehydrated larvæ and pupæ gave higher counts than when living, as probably less absorption in the body takes place, a fact of use in substantiating doubtful instances of radioactivity. There was no evidence of decreased viability among the treated specimens compared with their controls.

It is hoped in the near future to release a known number of radioactive larvæ into a normal population. By recapturing the individuals as moths, by such neans as mercury vapour lamps and assembling raps, and at the same time estimating the total of he imagines by the methods used by Fisher and Ford[2], t should then be possible to estimate for the first time the mortality-rate in the early stages :

$$\text{Total larval population} = \frac{\text{radioactive larvæ released} \times \text{total imagines caught}}{\text{radioactive imagines caught}},$$

Mortality = total larval population — total population of imagines.

Similar methods might be applicable in modified vays to ascertain total populations, larval deathates, dispersal activity, and other aspects of population dynamics as well as pigment chemistry in many orders of insects.

I wish to thank Dr. D. F. Shaw, of the Clarendon Laboratory, Oxford, for his advice on suitable sotopes ; also Dr. Scott Russell and Dr. R. P. Martin, f the Department of Agriculture, Oxford, and their ssistants, who both prepared the radioactive food lants and offered me their amenities and equipment. am grateful to Prof. G. E. Blackman for his enouragement and Dr. E. B. Ford for helpful sugestions. I am indebted to the Nuffield Foundation or a grant which made this work possible.

H. B. D. KETTLEWELL

Genetics Laboratory,
Department of Zoology,
University of Oxford. July 22.

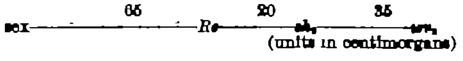
Bull. U.S. Nat Mus., 157, 237 (1932).

Fisher and Ford, *Heredity*, 1, 143 (1947).

A New Linkage in the House Mouse : Vestigial and Rex

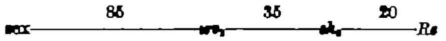
IN 1947, Wright[1] (Mrs. M. E. Wallace) reported e remarkable discovery of recombination frequencies xceeding 50 per cent in linkage group VII of the ouse mouse. Such a phenomenon had been predicted a theoretical possibility by Jennings[2] in 1923 for stantially the right reasons, although he based his gument on a theory of two-strand crossing-over and simplified discontinuous theory of interference. Mrs. Vallace found that the genetic markers sh_2 (shaker-2) nd wv_2 (waved-2), which show loose linkage with ach other of about 30 per cent recombination frequency, both recombined with sex with a frequency f about 56 per cent. This finding was the first case f partial sex-linkage to be reported in any mammal ther than man. Rex (symbol *Re*), which was known be about 20 per cent from sh_2 and about 40 per nt from wv_2, assorted independently of sex in other ata from the same department.

A theory of interference between adjacent chiasata advanced by Fisher, Lyon and Owen[3] offered basis for the resolution of these apparent contraictions. From this theory it is calculated that the equency of recombination with an end marker rises, the map distance increases, to a maximum of bout 56 per cent before falling back to the 50 per nt level. They accordingly prepared a map of the x-chromosome as follows :



while specifically not excluding the possible order sex wv_2 sh_2 *Re*.

Dr. T. C. Carter[4] has very kindly sent me additional data on recombination between sex and *Re* collected since the above maps were proposed. His results, when combined with those of Fisher, Lyon and Owen, give 52·2 ± 1·1 per cent as an estimate of the recombination frequency, and suggest that the distance from sex to *Re* in the above map is a slight underestimate, and that the second alternative map should be given distances roughly as follows :



The purpose of this communication is to present evidence that : (i) the recessive mutant 'vestigial' (symbol *vt*), found and described by Heston[5], is linked with *Re*, and lies at a distance from it of about 19 centimorgans on the same side as sh_2 ; and (ii) females heterozygous for the two markers produce a much higher proportion of recombinant gametes than do males.

512 mice were raised from backcrosses of double heterozygotes of both sexes, in both the coupling and the repulsion phase. The results are summarized in the accompanying table.

Segregating parent	Phenotypes of progeny				Total	Recombination frequencies (per cent)
	+ *Re*	+ +	*vt Re*	*vt* +		
♂ $\frac{+\ Re}{vt\ +}$	80	9	19	59	167	17 99 ± 2·20
♂ $\frac{+\ +}{vt\ Re}$	11	57	56	16	140	
♀ $\frac{+\ Re}{vt\ +}$	29	15	15	33	92	27 55 ± 3 15
♀ $\frac{+\ +}{vt\ Re}$	13	39	48	13	113	

In order to allow for viability differences, the recombination frequencies for the two sexes are estimated from the combined coupling and repulsion data by the method of Fisher[6]. As shown in the table, the estimated recombination frequency for males, p_m, is 17·99 per cent, and its standard error, s_m, is 2·20 per cent. The estimate for females, p_f, is 27·55 per cent and its standard error, s_f, is 3·15 per cent. The corresponding estimates, p_c and s_c, for the sexes combined are 21·66 per cent and 1·82 per cent respectively. The significance of the sex difference is given by :

$$\chi^2_{(1)} = \frac{(p_f - p_c)(p_c - p_m)}{s_c^2} = 6{\cdot}52 \qquad P < 0{\cdot}02.$$

The more direct test afforded by a 2 × 2 contingency table runs the risk of a slight bias if both segregating genes affect viability.

In order to determine the position of *vt* relative to other marked loci in the same chromosome, tests were made of the joint segregation of *vt* with sh_2. The resulting estimate of recombination was 1·7 per cent, with 9·5 per cent as the upper fiducial limit at the 2½ per cent probability level. Hence *vt* lies within a few units of sh_2.

It should, therefore, according to either of the alternative maps given above, show more than 55 per cent recombination with sex. Extensive tests were made of the joint segregation of *vt* and sex. These gave an estimated recombination frequency of 51·64 ± 1·94 per cent, which accords poorly with expectation. This result, if combined with other data to which reference has been made, can only be accommodated by a map approximately as follows (map distances based on male gametogenesis) :

$$sex \overset{95}{\text{―――――――}} wa_1 \overset{35}{\text{―――――――}} (vt, sh_2) \overset{20}{\text{―――――}} Re$$

On the other hand, the position on the sex chromosome of the centromere, as described cytologically by Slizynski[7], militates against such an interpretation. I have discussed the problem with Sir Ronald Fisher and Mrs. Wallace; they have suggested to me that the true explanation of Mrs. Wallace's observations may lie not in partial sex-linkage but in 'affinity', a new genetic phenomenon which other work has led me to postulate, and on which both Mrs. Wallace and I hope shortly to publish preliminary evidence.

My thanks are due to Prof. L. C. Dunn for the gift of vestigial mice; to Dr. T. C. Carter and Dr. D. S. Falconer for the gift of Rex and shaker-2 mice; and to Dr. E. B. Ford and Sir Ronald Fisher for advice and encouragement. This work was done while I was in receipt of a research training grant from the Medical Research Council. I also wish to thank the Agricultural Research Council for the provision of facilities.

DONALD MICHIE

Genetics Laboratory,
University of Oxford.

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[1] Wright, M. E. (Mrs. M. E. Wallace), *Heredity*, 1, (3), 349 (1947).

[2] Jennings, H. S., *Genetics*, 8, 393 (1923)

[3] Fisher, R. A., Lyon, M. F., and Owen, A. R. G., *Heredity*, 1, (3), 355 (1947).

[4] Carter, T. C. (personal communication, 1951)

[5] Heston, W. E., *J. Hered.*, 42, (2), 71 (1951).

[6] Fisher, R. A., "The Design of Experiments", section 70 (London, 6th edit., 1951).

[7] Slizynski, B. M., *J. Genet.*, 49, 242 (1949).

Body-Temperature of Arthropods

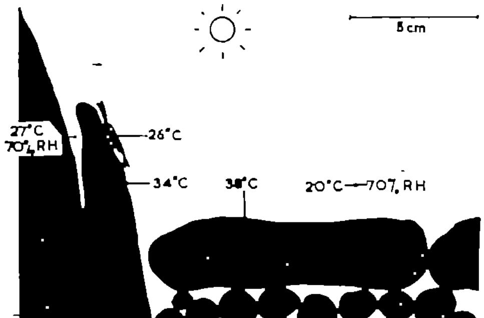
PARRY[1] has recently concluded that evaporation is insignificant as compared with radiation and convection in determining the equilibrium temperature of small animals in direct sunlight, except in unusual circumstances. While this is probably true for insects and spiders, in which evaporation of water is severely restricted at low temperatures, isopods and millipedes are known to evaporate water more rapidly, and I am prompted to report the following preliminary field observations on the body-temperature of *Ligia oceanica*.

Three of these animals were exposed to direct sunlight on the surface of a concrete quay at Dale Fort (Pembroke) at 2.0 p.m. G.M.T. in August 1951. One was alive, another was freshly killed by chloroform and a third was also dead and thoroughly dry. A fine thermocouple was inserted into the rectum of each, and another thermocouple was in contact with the surface of the quay. During a 30-min. observation period, the quay surface temperature varied between 34° and 36° C., while that of the living and freshly killed *Ligia* dropped to 28° C. That of the dry specimen rose during the first 10 min. to within 0·5° C. of the temperature of the quay surface and remained there. The air, of relative humidity 66–68 per cent, was moving gently (force 1 on the Beaufort scale), and its temperature 2·0 cm. above the quay was 21° C. These results suggest that evaporation was playing a large part in determining the equilibrium temperature; but on theoretical grounds this will only be so if the evaporation factor in the heat balance-sheet (radiation + conduction = convection + evaporation) is of the same order of magnitude as the other factors. (Metabolism as a source of heat may be neglected.)

As regards radiation, Parry has shown that the mean total radiation load (long and short wave) upon a rectangular plate or bar exposed to the sun, with a surface reflectivity of 50 per cent, varies from 9 to 22 mW./cm.², according to its orientation. The radiation load of *Ligia* may therefore be approximately estimated at 15 mW./cm.². Conduction is an unknown value. The convection coefficient for a disc 1 in. × 3/32 in. at a wind speed of 50 cm./sec. ha been shown (also by Parry) to be 1·4 mW./cm.²/° C. and this amounts to 9·8 mW./cm.² for a temperature difference of 7° C. (*Ligia*, 28°; air, 21° C.). No measurement of the rate of evaporation was made during the field observations recorded above, bu laboratory measurements show[3] that in slowly moving air (c. 5·0 cm./sec.) having a saturation deficiency of 32 mm. mercury, *Ligia* at 30° C. loses water at the rate of 11·5 mgm./cm.²/hr. On the quay referred to above, the saturation deficiency (assuming the surface temperature of *Ligia* to be 28° C. and that of the surrounding air to be 21° C. at 67 per cent relative humidity) was 16 mm. mercury, so that evaporation would be approximately 16/32 × 11·5, or 5·75 mgm./cm.²/hr. Now at low wind speeds, the rate of evaporation from a free surface is approximately proportional to the square root of the ai velocity. This was 5·0 cm./sec. in the laboratory and has been taken as 50 cm./sec. (force 1 on the Beaufort scale) over the quay. At a conservative estimate, we may therefore double the rate of evaporation, giving 11·5 mgm./cm.²/hr., and this is equivalent to 7·7 mW./cm.².

The heat balance is now as follows (in mW./cm.²): 15 (radiation) + x (conduction) = 9·8 (convection) + 7·7 (evaporation). Without evaporation, the balance would be maintained largely by increasing the loss due to convection (to nearly 17·5 mW./cm.²), and this would mean raising the temperature of the animal to 33·5° C. (which is approaching the temperature found experimentally in the dry *Ligia*). It seems clear, therefore, that in this case evaporation is significantly affecting the equilibrium temperature

These considerations may help to explain the fact that *Ligia* and *Porcellio* were often to be seen on rocks in direct sunlight. The accompanying diagram shows the temperature and humidity measured at various points near the foot of an insolated red sandstone cliff, and it seems not unlikely that the high body temperature of *Ligia* below the shingle, where the air was still, and nearly (perhaps quite) saturated



Vertical section of base of cliff and shingle inhabited by *Ligia* (diagrammatic) ith water vapour, may result in a temporary up-ard migration to the cliff face, where evaporation nd convection together lower the body temperature.

The humidity measurements referred to were made ith a small electrical hygrometer, about the size f *Porcellio*. The instrument is to be described lsewhere shortly.

The observations recorded above were made while ı receipt of a grant from the Agricultural Research ouncil.

E. B. EDNEY

Zoology Department,
University of Birmingham.
March 21.

Parry, D. A., *J. Exp. Biol*, 28, 445 (1952).
Edney, E. B., *J. Exp. Biol.*, 28, 91 (1951).

Pelagia in Manx Waters

The occurrence of the scyphomedusan *Pelagia* near lymouth referred to recently in *Nature*[1] reminds one hat early in October of 1899 the genus invaded Port rin Bay, Isle of Man, in astonishing numbers. It as a truly remarkable spectacle. The sea looked s if converted into a solid mass of the jelly-fish. he species had not been reported in Manx waters efore, nor has it been seen there since. They ppeared suddenly, remained for a short time, and s suddenly disappeared. When the record was osted to the late E. T. Browne, he was at first ery sceptical as to our identification ; but an examnation of some actual specimens enabled him to ecognize the animal as *Pelagia perla*. He assumed hat its presence in Manx waters was due to "a ortherly current bringing down animals through the orth channel from the Atlantic shores of Ireland nd Scotland". Two of the specimens are preserved n the Zoology Museum, University of Reading. It nay be added that on August 10, 1903, a large shoal f *Pelagia* appeared in Valencia Harbour, along with huge drift of Salpas on which the pelagias were eeding[2].

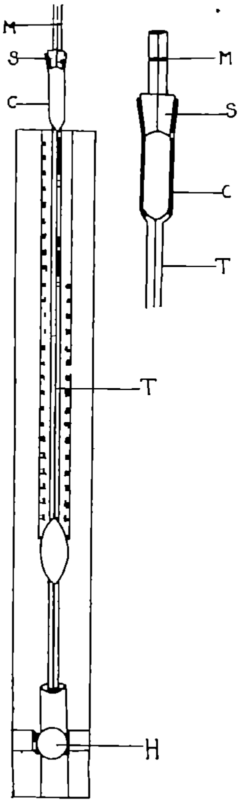
F. J. COLE

Littledown,
Kingwood Common,
Henley-on-Thames.
June 5.

Nature, 169, 934 (1952)
Cf. Report on Sea and Inland Fisheries of Ireland for 1905, 163 (Dublin, 1907).

A Simple Device for measuring the Volume of an Aquatic Animal

DIFFERENT methods of determining the volume of mall animals have been described by Lowndes, Iolter, Kuenen and Smallman[1]. None of these is onvenient and simple for rapid measurements. I ave found the volumometer sketched here very seful. It consists of a long capillary tube T with a mall cylinder C closed with a stopper S to ensure a acuum seal. The capillary and the cylinder are lled with water and the cylinder is then closed with he stopper. By using the screw-head H at the ottom, mercury is forced from below and the water s raised up the capillary within the stopper to the nark M. Using a hand lens, the base of the water olumn in the capillary T is read to a fraction of a nillimetre. Water is lowered well below the stopper.



The creature whose volume has to be measured is dried with filter paper and dropped into the cylinder. When the stopper is replaced, the water is raised to the mark once more and the position of the base read. If the creature cannot be safely wiped with filter paper, the water in the cylinder is lowered until a short column of air enters the capillary and the animal is pipetted along with a minimum of water into the cylinder. The water around the creature is drained into the capillary, and a spill of filter paper is used to remove the last traces of water. The stopper is replaced and the column of water thus drained from the creature is measured. Next, the water is raised to the mark and its position read once more. The last reading minus the column of water drained from the animal will give the volume of the animal.

To test the accuracy of the apparatus, a copper wire, 0·315 gm. in weight and 35·1 c.mm. in volume, was cut into pieces ; the pieces were introduced into the apparatus with some adherent water and their votal volume was measured. The mean of ten readings was 34·928 c.mm.—an error of 0·57 per cent (S.D. ± 0·2207, S.E. ± 0·069). Volumes were measured on *Gammarus pulex*, using single specimens of different sizes, and the results were compared with volumes calculated from density measurements. The density was found by weighing groups of ten animals first in air and then in water ; from six such groups the average density at 20° C. was found to be 1·0665, varying from 1·032 to 1·087 (Lowndes gives the range as 1·065–1·086). To take an example, a specimen weighed 34 mgm. ; its volume calculated from density is 31·880 c.mm. The cross-sectional area of the capillary being 0·476 sq.mm., this volume corresponds to a scale-reading of 66·9 mm. When this specimen was introduced with some adherent water and drained into the apparatus, the mean of eleven readings was 70·3 mm., an error of 5 per cent (S.D. ± 0·511, S.E. ± 0·154) ; when the animal was dried before being introduced into the apparatus, the mean of ten readings was 63·9 mm., an error of 4 per cent (S.D. ± 0·679, S.E. ± 0·214).

I wish to thank Prof. J. Gray for permission to work in his Department, and I also wish to thank Mr. W. S. Darkin for assistance in the construction of the apparatus.

C. P. GNANAMUTHU*

Department of Zoology,
Cambridge.
March 10.

* Zoology Laboratory, University of Madras, South India

[1] Lowndes, A. G., *Proc. Linn. Soc., Lond.*, 150, 62 (1938). Holter, H., *C.R. Trav. Lab., Carlsberg*, série chimique, 25, No 8 (1945). Kuenen, D. J. *Archiv. Neerl. Zool., Leiden*, 3, 409 (1939). Smallman, B. N., *Proc. Roy Soc., Edin.*, 61, Pt. II, B (1942).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 6

Society of Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Hal Gutteridge: "Refuse-Sewage Composting—Engineering Aspects".

Society of Chemical Industry, London Section (joint meeting with the London and South-Eastern Counties Section of the Royal Institute of Chemistry, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Dr. H. K. Cameron: "The Chemist in the Electrical Industry" (Chairman's Address).

Tuesday, October 7

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. R. S. Phillips: "Engineering and the Postal Service" (Chairman's Address).

Chadwick Public Lecture (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. H. E. Magee: "Food as a Health Factor".*

Society of Chemical Industry, Agriculture Group (joint meeting with the Oils and Fats Group, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. F. B. Shorland: "New Zealand Researches on Animal Fats". (Members of the Food Group are invited.)

Wednesday, October 8

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. J. R. Joyce: "Methods of Atomizing Liquid Fuels".*

British Institution of Radio Engineers (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Annual General Meeting; Mr. W. E. Miller: Presidential Address.

Institution of Mechanical Engineers, Graduates' Section (at Storey's Gate, St. James's Park, London, S.W.1), at 6.30 p.m.—Mr. J. Halling: "Surface Finish Measurement".

Institute of Welding (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6.30 p.m.—Mr. A. Robert Jenkins: Presidential Address.

Society of Chemical Industry, Corrosion Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "Filiform Corrosion and related Phenomena".

Thursday, October 9

Linnean Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. William J. L. Sladen: Colour Films and Slides of the Falkland Islands and Antarctic.

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Colonel B. H. Leeson: Inaugural Address.

Friday, October 10

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Saturday, October 11

British Psychological Society (in the Department of Psychology, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. James Laver: "Fashion and the Freudians".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer or Lecturer in Geography—The Registrar, The University, Bristol 8 (October 10).

Physicist or Physical Chemist (with a good honours degree) to take charge of laboratory investigations of problems in coal preparation and treatment in which physical chemistry plays a major part (Ref. TT/534); a Scientist (with a good honours degree and an interest in physical chemistry or in the general properties of matter) (Ref. TT/535), and Scientific Technical Officers trained to degree standard (Ref. TT/536); in the Physics Department of the Central Research Establishment at Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (October 11).

Physiologist (with a good honours degree in physiology, and research experience, preferably involving the perfusion of isolated organs) for research on the bovine udder—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (October 11).

Principal Scientific Officers (Ref. 100) (with a first- or second-class honours degree in physics engineering or mathematics, or alternatively have high professional attainments together with suitable experience and responsibility, and for Position 1, extensive experience on radio receivers, including high-quality reception of radio communication, and experience in ionospheric reception; and for Position 2, extensive experience in circuit research and design particularly related to radar, electronic computors, or pulse communication systems) for the planning and supervision of the activities of a group undertaking research and development on all aspects of radio communications, a Senior Scientific Officer (Ref. 101) (with an honours degree in mathematics and physics and with some experience in the application of mathematical assessment to physical problems) as Mathematician in Telecommunication Group; a Scientific Officer (Grade 1) (Re 102) (with a degree, preferably with honours, in physics or electrica engineering, together with experience in ionospheric investigatio transmission and reception) to undertake, under supervision, researc and development work on all types of high-quality radio reception an Experimental Officer (Grade I) (Ref. 103) (with a degree i science and experience in radio communication) to undertake, unde supervision, the development of new defence equipment in the fields o radar and telecommunications, in the Commonwealth of Australi Supply Department, Electronics Research Laboratory, Salisbury—Senior Representative, Department of Supply, Canberra House, 8 Jermyn Street, London, S.W.1, quoting the appropriate Ref. N (October 13).

Station Chemists at Croydon A and B Stations, and Littlebroo Power Station—The Establishments Officer, British Electricit Authority, South Eastern Division, Lower Ham Road, Kingston-upo Thames (October 13).

Research Assistant in the Department of Pharmacolog and Therapeutics in the Medical School, Dundee—The Secretar The University, St. Andrews (October 15).

Electrical Engineers for service in the Admiralty—The Civ Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.210/52 (October 16).

Professor of Structural Engineering at the University of th Witwatersrand, Johannesburg—The Secretary, Association of Univer sities of the British Commonwealth, 5 Gordon Square, London, W.C. (October 25).

Analytical Chemist in the Government Analyst's Laborator Salisbury—The Secretary, Southern Rhodesia Government, 429 Strand London, W.C.2 (October 31).

Lecturer in the Department of Electrical Engineering University of Cape Town—The Secretary, Association of Universitie of the British Commonwealth, 5 Gordon Square, London, W.C. (Cape Town, October 31).

Smartt Memorial Scholarship for research in some subject o matter bearing upon agriculture, at the University of Cape Town o elsewhere in South Africa—The Secretary, Association of Universitie of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Cap Town, October 31).

Agricultural Statistician (with a degree in mathematic statistics, as well as experience in the statistics of field experiments)—The Secretary, Tobacco Research Board, P.O. Box 1909, Salisbury Southern Rhodesia (December 1).

Agriculturist, Somaliland Protectorate, to take charge of experi mental scheme for date cultivation with a view to its eventual ex pansion—The Director of Recruitment (Colonial Service), Colonia Office, Sanctuary Buildings, Great Smith Street, London, S.W.1 quoting Ref. CSC.63/5/01.

Assistant Mechanical Engineer to the Sudan Gezira Board—The Sudan Agent in London, Wellington House, Buckingham Gate London, S.W.1, endorsed 'Engineer 2407'.

Chemists at Ministry of Supply Research Establishments i Southern England for (*a*) inorganic analysis (Ref. F.597/52A), (*b*) wor in laboratory providing chemical services, including effluents testing boiler water treatment, and process control (Ref. F.598/52A), an (*c*) physical chemistry research (Ref. F.599/52A)—The Ministry o Labour and National Service, Technical and Scientific Register (K) Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

Chief Veterinary Research Officer in the Sudan Veterinar Service—The Sudan Agent in London, Wellington House, Buckinghan Gate, London, S.W.1, endorsed 'Chief Veterinary Research Office 2207'.

Civil Engineers (Main Grade) in the Civil Engineer-in-Chief Department of the Admiralty, Pinner—The Ministry of Labour an National Service, Technical and Scientific Register (K), Almac House, 26 King Street, London, S.W.1, quoting H.149/52A.

Engineers and Physicists (particularly with electronics) in Seni Scientific Officer and Scientific Officer grades (Ref. A.246/52A) Senior Experimental Officer, Experimental Officer, and Assist Experimental Officer grades (Ref. A.247/52A), in the Royal Na Scientific Service, at Experimental Establishments in London, Portsmouth, Weymouth areas and Scotland—The Ministry of Labour an National Service, Technical and Scientific Register (K), Almac House, 26 King Street, London, S.W.1, quoting the appropriat Ref. No.

Junior Hydraulic Engineer, and a Junior Hydrologist, in the Public Works Department, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. CSD.64/7/01.

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Mechanical and Electrical Engineers (2) in the Public Works Department, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, quoting 'M/E Engineer 1813'.

Meteorology and Hydrology Specialist, a Soils Classifier, an Estimator, a Soil Mechanics Specialist, a Concrete Design Engineer, a Chief of the Civil Engineering Research Laboratory, an Irrigation Operations Engineer, and Junior Engineers (10), to assist in the design, construction and supervision of numerous irrigation and drainage works for the Iraq Development Board—The Ministry of Labour and National Service, (A.S.12, Iraq Development Board), Almack House, 26 King Street, London, S.W.1.

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UTILIZATION OF FUEL IN BRITAIN

THE report of the Ridley Committee[*] is marked by a pronounced cleavage of opinion on one essential point and, in general rather than technical matters, seems to raise fresh issues as well as settle others. The report, however, contains many sensible and unanimous recommendations, and on the whole it carries us a step farther towards a national policy for the use of fuel and power resources. No government will, in future, be able officially to ignore the existence of a continuing rather than a temporary fuel shortage, and policy must be framed accordingly. Nevertheless, the Committee deals a shattering blow at any exalted ideas as to what can be achieved by central direction: its stricture, though implied, on the Ministry of Fuel and Power, is scarcely less severe than are its restrained comments on the warfare between the great nationalized industries which that Ministry is supposed to co-ordinate and which is displayed so frankly in the memoranda appended to this report.

The Committee was appointed to advise on possible measures to promote the best use of the fuel and power resources of Great Britain. It decided to interpret this as meaning that the general aims of a national policy should be: first, to meet in full the demands of the community for the different fuel and power services, when those services are sold at prices which closely correspond to the relevant costs of production and distribution; secondly, to provide for export fuels on such a scale and of such types as can be sold abroad with most gain for the country; thirdly, to promote the maximum economic efficiency in each use of each fuel; and to encourage the use for particular services of the fuel which gives the best return on the resources consumed. The first two of these aims raise questions of pricing policy, and the other two depend on comparative costs. Throughout the report, therefore, the importance of price policy is stressed. Furthermore, it is emphasized that all these aims must underlie a sound national policy at all times, even in the next few years when the gap between supply and demand makes it a first objective to divide what is available between different claimants so as to make the best use of it, and when immediate policy may require measures conflicting with the general aims of policy for the long run.

Reviewing first the prospects for fuel supply, on the evidence it examined the Ridley Committee expects a continued shortage of fuel and power in Great Britain. Future years may bring extra supplies from water, peat, wind and nuclear energy, but no significant return in power supplies is likely within the next few years from the development of power from ocean waves, the internal heat of the earth, solar heat, nuclear energy and other potential sources. Thereafter supplies should be easier, but it appears to the Committee that, to be able to meet in full prospective demands over the next decade, the National Coal Board may have to accelerate and expand its plans for future output. A certain complacency on the part of the Board in this respect left the Ridley Committee quite unmoved and, like Political and Economic Planning in its broadsheet last December, it considers that the Board's estimates of inland demand are too low and its production plans insufficiently related to national needs.

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[*] Report of the Committee on National Policy for the use of Fuel and Power Resources. (Cmd. 8647.) Pp. v+242. (London: H.M. Stationery Office, 1952.) 6s. 6d. net.

Measures to improve the efficiency of the use of fuel in the next few years are thus essential if the fuel needs of the country are to be satisfied, and in the longer run will always be important as a means of economizing resources. Many constructive proposals are made in the report in this connexion, and to a number of them the Committee attaches special importance. It recommends, for example, that new standards of performance based on achieving a room efficiency of the order of 40 per cent with coal should be determined for solid-fuel room-heating appliances, and it suggests a 100 per cent purchase tax for solid-fuel room-heating appliances and their parts which do not achieve these new standards. It recommends encouragement of the production of high-efficiency open fires of 'utility' pattern capable of easy installation in existing fire-openings and with convection heating and a restricted throat, as well as of simple devices for adapting existing fireplaces, and financial incentives for the installation of fires of the new standards and for improved insulation in new houses.

Subsidies for new house building and the granting of building licences offer obvious opportunities of encouraging such developments, and the Committee thinks that there is a sound case for the provision of some special financial incentive for firms to install fuel-saving equipment. It recommends expansion on more attractive terms of the present experimental scheme, announced by the Ministry of Fuel and Power last March, of government loans for approved fuel-saving appliances. Stokers, too, should be encouraged to raise their efficiency by arrangements for improving their status, and the Committee refers pointedly to the responsibility of government departments and other public bodies for taking the lead in promoting fuel efficiency, and to that of the Railway Executive for planning for increased fuel efficiency and accelerating trials of new forms of traction. A great increase in the service for providing industry with advice on fuel efficiency is recommended; but the Committee wisely emphasizes the responsibility of industry for solving its own fuel efficiency problems, and it recommends that industry should be invited to organize its own fuel efficiency advisory service to supplement that of the Ministry.

There are other sensible recommendations on which also the Committee is unanimous. In view of the greater efficiency of fluorescent lighting, it recommends removal of the purchase tax on fluorescent lighting tubes. The need for training in fuel technology is seen against the background of the general problem of technological education, and it recommends that measures for dealing with the general problem should take full account of this particular need, including the provision of financial aid. There are words for nationalized fuel industries which stress particularly the great importance of pressing forward the investigation of methods for the total gasification of coal, and the Committee lends strong support, as a help both to fuel economy and the export trade, of the early introduction of petrol with a higher octane rating. Unmoved by blast and counter-blast from the rival industries, the Committee notes the costs to the country of overloaded electricity capacity in a period of shortage, and the damage done at all times by smoke pollution, of which the domestic use of coal is a main source. Its impartial analysis of rival claims regarding domestic heating, which is rather kinder than some surveys have been to solid fuel, leads to the conclusion that no fuel or combination of fuels can be selected as the 'best' for domestic fuels in all or most or even 'normal' conditions; the main room-heating and winter-heating services in new houses should normally be provided by solid fuel directly burnt in efficient appliances.

This conclusion is reached on the ground of cost, and it is on this question of costs and prices, especially the price structure for coal, that cleavage of opinion appears. The Committee is unanimous that, from the point of view of the community, the price of coal should not be less than cost. Half of the Committee, however, believes that it should continue to be based on the average cost of production; the remainder would raise the price to cover marginal cost of production by imposing an excise duty of £1 per ton. Without entering here on the merits of argument and counter argument, it might be observed that the price of coal already appears to be sufficiently high to compel attention to fuel economy, and that the proposed excise duty is more likely to penalize the efficient user who has already eliminated waste than those whose extravagance leaves them with a margin for economy. Apart from this, such a proposal prejudices any attempt to devise a price structure based on the quality of the fuel.

It is not, however, this division of opinion that leads the Committee to reject some of the grandiose proposals for the formulation and co-ordination of national fuel policy which were suggested to it i evidence. The Ridley Committee prefers to use tl price mechanism rather than physical controls on fuel consumption to achieve the desired ends, taking into account such factors as the expensiveness of electricity for domestic service at peak hours and its inexpensiveness off the peak. The small specialized Tariffs Advisory Committee, which it recommends should be set up to assist the Minister of Fuel and Power in his general control over the price policies of the nationalized fuel and power industries, is recommended to see that electricity tariffs discriminate, if possible, between peak and off-peak use, while the Committee also recommends that immediate steps be taken to make extensive practical trials of the various methods of measuring or controlling the consumption of electricity during peak hours.

Besides these, the Committee makes the important recommendation that full publicity should be given to the reports and recommendations of the proposed Tariffs Advisory Committee. It rightly attaches the utmost importance to public opinion being well informed on fuel- and power-pricing problems. This s essential if there is to be ready acceptance of price structures determined so as to promote the best use of fuel and power. The Ridley Committee may have also had in mind the restraining influence of such publicity on some of the struggles between the fuel and power industries, and the manifest tendency of uch vast monopolies to seek sectional rather than he national interest.

That is one of the most disturbing features revealed by the Ridley report, and it speaks well for the sound ense of the members of that Committee that they hold firmly and unanimously that the right policy, and indeed the only practicable one, is to leave the pattern of fuel use to be determined by the con-umer's own choice between competing services. The Committee does not believe that direct intervention by the central government would be effective in mproving the pattern of fuel use. Such intervention would unduly restrict the competition between the uel and power industries, which it regards as one ondition if 'freedom of choice' is to produce an conomic pattern of fuel use. The 'rationing' of ouse-coal is accepted as necessary, but only for the present. This, moreover, is not the only factor militating against 'freedom of choice' at present; and he Committee also puts forward three conditions essential for competition to be effective in the desired direction. First of all, the prices and tariffs for fuel nd power should correspond closely to the relevant osts of the particular services provided; secondly, he fuel industries should not impose on consumers any conditions of supply which may restrict their freedom of choice and are not justified by costs; nd thirdly, full and objective information of fuel services and fuel appliances should be made readily vailable to the public.

It will be noted, too, that the Ridley Committee rests its hope for the success of the measures it recommends largely on the willing and continuing o-operation of all fuel users. This presupposes a considerable educational campaign. No doubt the rliamentary and Scientific Committee will give ly attention to this aspect; from that Committee may well come a lead to many professional bodies of scientific men and technologists who could give invaluable help.

There is scope, however, for more co-operation etween the fuel and power industries themselves, nd the Ridley Committee also recommends that the Ministry of Fuel and Power should establish a joint lanning board through which the fuel industries ould concert policy, with the assistance of the Minister. This board would be concerned essentially ith the production and distribution of fuel and ower. Its functions are conceived as embracing ecision as to the selection of projects for investi-ation as possible joint enterprises, reference of the selected problems to the Board's staff for detailed study, the introduction of new projects to the fuel industries and possibly advising on the establishment of organizations to operate joint projects.

The Ridley Committee believes that such a planning oard, in collaboration with the Scientific Advisory ouncil of the Ministry, would accelerate the application of the results of research, and secure necessary routine collaboration at all technical levels. In the last resort, however, the board would, the Committee observes, "depend on the Minister to ensure collaboration when one industry was unwilling to join in a scheme because its particular interests appeared to be prejudiced". Elsewhere, in rejecting proposals made in evidence for the establishment of a single statutory body with executive powers to co-ordinate the activities of the nationalized fuel and power industries as a whole, the Committee observes: "To the extent that co-ordination measures have to be imposed on the Boards (or on any one of them) that, in our view, is a matter for the Minister. In fact we look upon this function of co-ordination and of the control of policy as the main reason for the existence of a Minister of Fuel and Power".

This clear statement that it is the technique or will, and not the power, to co-ordinate that is lacking is an indictment of successive Ministers of Fuel and Power; it is also an indictment of the failure of Britain to deal effectively with the question of Parliamentary control of the nationalized industries, and indeed of the ability of Ministers to ensure that the nationalized industries are administered in the national and not in a sectional interest. That is a failure for which both major political parties must share the responsibility. The Ridley report throws into such strong relief the critical importance of an early solution of this problem of control for the implementation of national fuel policy that it is to be hoped that both political parties will join in the attempt to find a satisfactory solution. Much fresh constructive thought will be required, but given goodwill and an unprejudiced approach the task is not impossible. The Ridley report, itself marked by so much sense and moderation on controversial subjects, may possibly give a further impulse to such inquiry; without it there can be small hope of a national policy effective to eliminate waste of a precious resource, to mitigate domestic hardship and social inconvenience, or to remove the handicap to industrial expansion and economic recovery of which the Federation of British Industries has complained.

ATOMS AND AXIOLOGY

Philosophic Problems of Nuclear Science

Eight Lectures. By Werner Heisenberg. Translated by F. C. Hayes. Pp. 126. (London: Faber and Faber, Ltd., 1952.) 16*s*. net.

ONE summer evening in 1925, a small and very select meeting of theoretical physicists took place in one of the Fellows' rooms in Trinity College, Cambridge. It was a special occasion, and the host may even have 'sported his oak' meanwhile. A brilliant young mathematical physicist, fresh from Munich, Göttingen and Copenhagen, was about to expound his work in the field of atomic physics to a handful of people capable of appreciating it. The speaker was none other than Werner Heisenberg, before long to become a celebrity for his 'uncertainty principle'. Subsequent events have added not only to his distinction but also to the debt which philosophers and scholars everywhere owe him for the profundity of his thought, and for the elegance of his expression. The present book does something to bring these things home to English-speaking readers. 'Something' is probably fair comment, for here is a collection of lectures, originally in German, translated with obvious sincerity but not always with complete *idiomatic* success. To this, some further reference will be made later in this review.

Meanwhile, with engaging humility, Prof. Heisenberg implies that his particular technique, though potent, was not the most beautiful, or even the most unusual. Yet concord upon all essentials concerning atomic configuration was achieved between his results—including the labours of his colleagues—on one hand, and those of Dirac on the other. Encouraging proof of the existence of "a bond unhampered", as Dilthey called it, in reference to seventeenth-century Paris, was near at hand.

History, however, does not repeat itself: these were no 'conversions' to mathematics such as that experienced by Hobbes, and brought about by the presence of Descartes. On the contrary, the twentieth century was to witness a forward surge by the specialists towards a deepening of physical science, and a fresh realization of its implications—for good or for ill—for all mankind.

The reader may well delight in the details elaborated in these eight lectures; but he will probably be the better rewarded if he takes them for what they are assuredly intended to be—an epistemology of Nature on the grand scale. An example (lecture 6) appears in the tracing of the beginnings of the modern era with Galileo and Kepler. Certainly there then existed a unified concept of Nature, namely, that conformable to Scriptural revelation. The aim of the men of science, in modern language, was "to find out God, and read Him everywhere". Later, however, as we all know, other motives gained the initiative.

Prof. Heisenberg brings his readers to the edge of the cliff in his last lecture. He almost invites them to look over and keep their heads. "The core of science is formed, to my mind, by the pure sciences which are not concerned with practical applications." Again, science *can* help international understanding, not because it succours the sick and so forth, but because it may direct our attention to a "centre" (call it what you will, the scholastics knew it as the *deus philosophorum*) in harmony with "the fact that the world is beautiful".

Now all this is exactly what one would expect from a mind of the author's calibre. He writes elsewhere of a region wherein science and art are scarcely separable, and, it might be added, "few there be that find it". This theme, laid before a university audience in Gottingen in 1946, was a brave confession to make before the Germany of that year. It may not be without influence over a wider company.

Philosophically considered, two questions arise. One is the relation of such a view as this to the scholastic doctrine of *analogia entis* (to which in structure it bears some likeness). The other is the marked contrast with the essential outlook of the great humanist architects, in the tradition of Vitruvius. They set out, deliberately, to build geometrically to the glory of God and erected many and great domes to declare His glory above the firmament. Taken together, the Thomist conception seems closer to that of Prof. Heisenberg—his "centre" and the visible world, while incommensurable, permi of a balance, enabling decisions to become real an living experiences.

The poise of the author's mind is perhaps bes revealed in his treatment of the age-long Newton Goethe conflict. This occupies practically the whol of lecture 5 and should be read as a worthy companion to the late Sir Charles Sherrington's Denek Lecture of a few years ago.

In the result, the battle was not pointless, but i may be all too easily taken to be so if the dichotom is not fully appreciated. For Newton, colour was t become an exact part of physics: Goethe was no wholly biased against mathematics, but he feare mathematical analysis and (for him) the destructio of the arena of sense-enjoyment. Yet, as Pro Heisenberg remarks, the loftiest science and th poet's vision are not far apart. It is in passage like these that a rare quality of insight stand manifest, to fortify troubled mankind.

Nobody can expect discussions at this level not t suffer in translation (not to mention being wrenche out of the particular circumstances in which the were originally delivered), but certain easily avoidable blemishes are surely out of place. Examples ar "experience" for "experiment", "apprehensible" fo "comprehensible", and [mental] "deformation" fo "deformity". They do not mislead, but merel annoy: one looks forward eagerly to their correctio in a later edition.

In a sentence of impressive restraint (spoken a Göttingen), these lectures end with a precept akin t the famous one of Wittgenstein—"Whereof one canno speak, thereof one must be silent".

F. I. G. Rawlins

CLINIC AND SOCIETY

The Psychology of Pierre Janet

By Elton Mayo. Pp. ix+132. (London: Routledg and Kegan Paul, Ltd., 1951.) 8s. 6d. net.

It is much to be regretted that the work of th eminent French psychiatrist, Pierre Janet (185 1947), was overshadowed during his lifetime by th of his greater contemporary Freud and, consequent is little known in English-speaking countries. W are therefore grateful to the late Prof. Elton May for his concise introduction to some of Janet's ideas Prof. Mayo addresses himself, not to the student o medicine or psychiatry, but chiefly to students o social and industrial administration, and he confine himself to theories of Janet which are relevant t these areas of activity. His aim is to show how th clinical study of individual psychopathology ma help us to understand how a person's social role become disorganized. He is concerned, of course with the psychopathology of everyday life, not th disorders of the psychotic safely tucked away in a institution.

Taking as his point of departure Janet's view tha "social actions are the most complex human activit and that the costs exacted by adaptation to th individuals around us are by far the heaviest" (p. 90) he proceeds to trace the various ways in whic obsession stultifies or distorts social action. He distinguishes two kinds of obsessive formula, one bein "The world is hostile, let me attack it", and th other "The world is dangerous, I must be careful" nd he devotes his analysis mainly to the second, which he thinks is much more common.

His theme, accordingly, is the social and intellectual neffectiveness of the obsessive person. Beyond a eference to the fact that Janet saw in the obsessive's difficulties a failure to develop in early life the skills necessary for ordinary social communication, the discussion avoids the etiology of obsession and attempts rather to elucidate its nature and effects. Since nearly every intelligent person suffers obsessive pisodes from time to time, the personal and social disruption caused by them must be of interest to all those concerned with human organization.

Janet's interest in the study of hysteria led him to revise his "method of distraction" and to develop his theory of the dissociation of the personality into primary and secondary selves. Retraction of the field of consciousness and dissociation he held to be the two characteristic features of the hysteric. This work gave him an appreciation of the complexity of the attentive act and enabled him to describe with great insight the nature of obsession, though he realized that he was now dealing with disturbances f a different order. In his studies of obsession he shows that every successful act of attention presupposes an ordered background of contributory eflexes and skills. On the interplay between acts of attention and reflective thinking, which gives unity to experience, depends the capacity for decision and ction. It is in the attentive act, according to Janet, hat the obsessive's disability manifests itself.

The reader may be somewhat surprised to find that Prof. Mayo omits any reference to the work of the late H. S. Sullivan who, more perhaps than any other modern psychiatrist, succeeded in synthesizing many of the ideas of Freud and Janet. Janet's notion of retraction of the conscious field becomes, in Sullivan's hands, the "principle of selective inattention". Sullivan supplements this principle with his important heory of "prehension", or perception without awareness (which I have elsewhere suggested needs to be ompleted by introducing a concept of 'apprehension', that is, apperception without awareness). In the writings of Sullivan, Janet's ideas seem to have so r found their most astute elaboration.

JOHN COHEN

FISH AND FISHERIES OF AUSTRALIA

Fish and Fisheries of Australia

By T. C. Roughley. Completely revised and enlarged dition. Pp. xv+344+81 plates. (Sydney and London: Angus and Robertson, Ltd., 1951.) 50s.

MORE than thirty years ago, Mr. T. C. Roughley published a book entitled "Fishes of Australia and their Technology", illustrated with sixty-eight colour plates of common Australian fishes. That book has long since been out of print and unobtainable; but a continuing demand for it has induced the author to write a new and larger volume—"Fish and Fisheries of Australia"—which is now available. The Publishers' description of the new book as a "completely revised and enlarged edition" of the former one seems scarcely accurate.

The book is in two parts. In Part 1 the occurrence, habits, edible qualities and commercial or sporting mportance of more than a hundred and fifty kinds of fish are described in detail and there are brief references to many more. In order, no doubt, to keep the book within reasonable limits of size, little information is included from which identifications can be made; for this the reader must rely on the plates. These are all of very high quality; but they are relatively few in number, and the absence of precise descriptions of distinguishing features limits the value of the book.

Part 2 is concerned with the industry and sport. The annual value of Australia's total fish production is small—less than one-fiftieth of that of the United States. Mr. Roughley's explanation is that "the southern hemisphere lacks the vast concentrations of fish characteristic of northern hemisphere waters", although he also admits that Australian exploitation of her pelagic fishes could probably be greatly stepped up. He offers little hope of any great expansion of demersal fishing, for already some of the most important estuarine and offshore demersal fishing grounds are being overfished, and conservation rather than expansion must be the future policy. In fresh waters, pond culture, which has not yet been tried to any great extent, is believed to offer possibilities, and the fisheries departments of both New South Wales and Victoria plan to investigate them.

Many other fishery activities are dealt with, including shark fishing, big-game angling, spear-gun fishing and fish canning. An interesting final chapter briefly describes some native fishing methods, several of which are still practised by Aborigines in northern Queensland, where the influence of the white man has not yet penetrated.

The author has gallantly attempted to present an Australian rather than a State picture. The attendant benefits of using so broad a canvas more than outweigh the disadvantages—which are many—and the book should have a ready sale in Australia, despite its high price. It should, however, be supplemented as soon as possible by companion volumes dealing in much greater detail with regional fish faunas and their fisheries.

G. A. STEVEN

SURVEY OF HORMONES

Hormones

A Survey of their Properties and Uses. (Published by direction of the Council of the Pharmaceutical Society of Great Britain.) Pp. xii+220. (London: Pharmaceutical Press, 1951.) 35s. net.

THE publication of a volume of some two hundred pages, which sets out to survey the properties and uses of hormones for "pharmacists, medical practitioners, students and other interested persons", raises hopes of a general review which would necessarily be compressed but would bring together the scattered contributions from different branches of science to the problems of endocrinology. Perhaps no one man could successfully write all such a book, and it might have to be a composite production, under the guidance of an editor with the necessary breadth of view. This book, with four named contributors, seems to have had no editor other than the anonymous writer of the preface, which, ominously enough, begins with a quotation from Starling in which ὁρμάω is misprinted ὁρμάω.

The result is a collection of articles pitched at different levels, making independent approaches to different aspects of the same subject, entirely without evidence of co-ordination. Many reiterations of summarized statements might have been avoided by cross-references, and an editor might have discovered, for example, that in spite of repetitive statements about propylthiouracil the chemical formula had not been given. The illustrations are a curious mixture of the frankly popular, such as the frontispiece, and the technical. Some of the sections are competently written; but each author seems to have had a different view of the educational level of his potential reader.

The chemistry of the steroid hormones is reviewed in the tight and abbreviated style associated with the "Annual Reports on the Progress of Chemistry" (and, rather surprisingly, the system of nomenclature is one abandoned by the Chemical Society four years ago). Dr. C. W. Emmens contributes a brief chapter on "Standardisation", but it is disappointing to find that in at least one instance, adrenocorticotrophic hormone, the information is far from up to date—in fact, less so than in the book on hormone assay which the same author edited and which was published in the United States in 1950. There is a section on "Action and Uses", perhaps necessarily superficial, and a chapter on "Pharmacy". The section on "Physiology" is an example of the worst type of scuffling and inaccurate compression. This may be illustrated by one quotation. Of the adrenal cortex it is stated: "Twenty-eight crystalline steroids have been isolated from the cortex. In 1934 Kendall *et al.* isolated a crystalline substance capable of maintaining the life of adrenalectomised animals. In 1936 Reichstein obtained from the adrenal cortex a sterol with androgenic properties which he named androsterone. Ingle isolated seven compounds which were effective in relieving different conditions associated with adrenal cortical deficiency, one of the most active being deoxycortone". It would be difficult to find a parallel to such a concentration of misrepresentations of facts.

It would be unfortunate if a book of this quality, appearing under the patronage of a scientific society of standing, should be taken to represent British knowledge and achievement in endocrinology.

R. K. Callow

PROTECTION OF COTTON IN PEACE AND WAR

Microbial Decomposition of Cellulose

With Special Reference to Cotton Textiles. By R. G. H. Siu. Pp. xi+531. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1951.) 80*s*. net.

Few textile problems owe so much to the expansion of our knowledge of cellulose and the fibres of which it is the major component as the growth of micro-organisms on cellulosic textiles. It is only necessary to compare the information available when the Fabrics Co-ordinating Research Committee of the Department of Scientific and Industrial Research began, in 1920, the first organized attempt to ascertain the causes of decay of cellulosic fibres, and to assess the value of preventive measures with the extensive literature of to-day, in order to realize the progress that has been made in the intervening period.

In peace-time, the textile technologist is content to protect cellulosic textiles against the growth of moulds at the humidities and temperatures to be expected during transport to, and storage in, tropica climates. The conditions rarely permit the growth o bacteria or even of the moulds which decompos cellulose, so that his main concern is to preven disfigurement. In service, chemical tendering by ai light and moisture is a more potent source of damag than microbial tendering, with the notable exception of fishing nets and lines and filter cloths.

In time of war, particularly in jungle warfare, us may be severe enough to reverse the relative importance of chemical and microbial tendering. Thi prospect has dominated the approach of the Unite States Army Quartermaster Corps to the problem o lengthening the useful life of textile equipment an has, naturally, tended to colour Dr. R. G. H. Siu' treatment of the subject. Nevertheless, Dr. Siu ha earned the thanks of every worker in the field fo undertaking the herculean task of summarizing more considerable body of work than the title of hi book would suggest. He covers successively th decomposition of cellulose in Nature; the structur and properties of cotton fabrics; the organisms whic have been isolated from them; the microbia degradation of cellulose; and methods of preventin microbial attack, including chemical modification.

The description of the mechanical and chemica processes applied to cotton might have been omitted it is unnecessary if the reader is familiar with textil technology, and inadequate if he is not. For the rest either by choice or by force of circumstance, Dr. Si has provided a comprehensive rather than a critica account. Thus, in Chapter 3 he stresses unduly th occurrence of chemical damage during the mechanica processing of cotton. In Chapter 4, the lists o cellulolytic and non-cellulolytic organisms would hav been more valuable if the taxonomy had bee brought up to date. In Chapter 5, it is not mad clear why the humidity of the atmosphere surrounding a textile may be more important than it moisture content from the point of view of moul growth. More attention might also have been devote to the greatly varying moisture requirements o different moulds, particularly as some of those whic decompose cellulose develop freely only at a ver high relative humidity. In Chapters 6 and 7, th comprehensive account of the mechanism of th degradation of cellulose is inevitably rather spe[illegible]lative, for many of the observations are contradictor and often lack adequate descriptions of experimenta materials and techniques.

The remaining chapters (8–12) are accounts o methods of biological testing and of the preventio of microbial attack, either by the use of antiseptic or by conversion of the cellulose into suitabl derivatives. The search for new antiseptics i described very thoroughly; the author's reliance o the soil burial test as the criterion of efficiency lead him, however, to reject treatments which hav proved valuable for specific purposes and to accep treatments which may be open to objection on othe grounds. As the soil burial technique is accepted a a satisfactory prediction of field behaviour, it i disappointing to find no assessment of the relativ importance of microbial and chemical tendering i the many practical uses of cellulosic textiles.

Dr. Siu has provided a book of exceptional valu to the specialist in any section of the field he ha covered; its merit is enhanced by the very comprehensive bibliographies appended to each chapter It is not, however, a book for the industrialist wh seeks a ready guide to the solution of his problems

The British National Bibliography Annual Volume 1951

Edited by A. J. Wells. (Published by the Council of the British National Bibliography, Ltd., British Museum.) Pp. ix+954. (London: J. Whitaker and Sons, Ltd., 1952.) £8 net.

THE objects of the British National Bibliography are to list every new work published in Great Britain, to describe each work in bibliographic detail and to give the subject-matter of each work as precisely as possible. The work is carried out at the British Museum by a team of fully qualified bibliographers. The first annual volume, which is classified according to the Dewey Decimal Classification, is provided not only with a full author, title and subject index, but also with a preface including some hints for tracing information which should smooth the path of the novice in bibliography. The fullest information about a book is given in the Subject Section; information in the Alphabetical Section is limited to author's name, short title, publisher and price.

The value of this Bibliography lies in the authoritative, full and accurate description of each book and in the detailed subject index, which facilitates the finding of books on the most specific subjects. On that it has met such tests as a leisurely examination and one person's experience has been able to apply, and its production appears to be reasonably in keeping with the scale and claims of the enterprise, though its price must restrict the use of the bibliography by the smaller libraries and by individuals. A few classes of publications, namely, cheap novelettes, periodicals (apart from the first issue of a new periodical and the first issue of a periodical under a new title), musical scores, maps, and the less significant Government publications, are omitted. On the last, the term 'significant' appears to be interpreted generously, for there are listed such minor papers as the White Papers on Higher Technological Education, issued last September, on the Future of the Overseas Food Corporation, and on Government Scientific Organization in the Civilian Field, as well as the annual reports of most departments or organizations of interest to scientific workers.

The Earliest Stages of Delinquency

A Clinical Study from the Child Guidance Clinic. By H. Edelston. Pp. vii+200. (Edinburgh and London: E. and S. Livingstone, Ltd., 1952.) 10s. 6d. net.

IT is now generally accepted that crime is the product of environment rather than inheritance. There are some factors—such as mental deficiency—which may be inherited and influence behaviour, but even with these good environment is able to prevent antisocial behaviour in the majority of cases. If environment is of such importance, it is essential that we should make the greatest possible effort to correct it as soon as there is evidence that it is having an evil effect on conduct. It is here that a child guidance centre is of such importance. The result of experience in this work is described by Dr. H. Edelston in his excellent book "The Earliest Stages of Delinquency". He states in the preface that "It is my claim that in this study I have introduced the new 'Psychiatric' approach without losing sight of traditional moral standards". In reality, it is doubtful whether any psychiatrist ever does neglect completely such standards, since he has to adapt his patient to society; but among the lay public the psychiatrist's emphasis on adjustment by removal of disrupting emotions rather than suppression of the personality in accordance with a moral code is sometimes misunderstood.

Dr. Edelston's book is divided into three parts. The first is concerned with the nature of misconduct and the use of the child guidance clinic; the second with treatment at home, by removal from home, and with those cases of severe characterological disorders which are unresponsive to the present modes of therapy. The third part is concerned with the actual administration of treatment and with practical procedures.

The author is the director of the Bradford Child Guidance Clinic, and obviously has had wide experience in this type of work. The book makes an excellent introduction to the problems of delinquency and should certainly be read by all who contemplate dealing with it. It would also be valuable to those interested more broadly in the nature of crime. If only such works were widely read we should have fewer wild statements on the imagined beneficial effects of pet remedies which have already been discarded as useless, and more real effort to cure those in need before they become hopeless recidivists.

CLIFFORD ALLEN

The Story of 100 Years of Phosphorus Making, 1851–1951

By Richard E. Threlfall. Pp. x+400 (58 plates). (Oldbury: Albright and Wilson, Ltd., 1951.) 25s.

FOR a century the firm of Albright and Wilson has been virtually the only maker of phosphorus in Great Britain, and the story of the introduction of the technical process, of its modification by the use of the electric furnace, of the collateral industries which have developed from it, and of the participation of the firm with others within the scope of its interests in two World Wars, could obviously make an interesting book. The task of producing such a book must have been difficult. Unpublished records and published material, personal details of the many who contributed to the success of the undertaking, and the traditions of the firm, have all been drawn upon. The associated companies, such as those at Niagara Falls and in Canada, come into the story. The book is well written and handsomely produced, the illustrations and plates, some in colour, being especially noteworthy. The book is interesting to read and also gives a valuable survey of an important branch of chemical industry.

Coal, Coke and Coal Chemicals

By Dr. Philip J. Wilson, Jr., and Dr. Joseph H. Wells. (Chemical Engineering Series.) Pp. ix+509. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 68s.

THIS volume is intended as a text-book for those interested in carbonization; but its main emphasis is on the coke-oven industry in the United States. It is for this reason that the book has limitations for those requiring a general survey, including British and European practice.

The early chapters deal with the combustion of fuels, the origin, classification and properties of coal, and with laboratory and small-scale tests for the selection of coking coal. Detailed descriptions and drawings are given of coke-ovens in the United States, followed by a review of the chemical and physical changes taking place during coking, and a survey of the properties of metallurgical coke. Useful tables are provided of statistics up to 1946 of the coke-oven industry and the disposition of products, and modern trends are reviewed. In one appendix there is a list of all the carbonization plants in the United States.

About one-third of the book is devoted to the recovery and utilization of by-products. This section is informative and gives a very useful survey. The account of the gas industry is limited to some seventeen pages, and it is here that the book fails to give a balanced picture of modern gas-works practice. Reference is made to the growing interest in the United States in low-temperature carbonization; but processes operated within the United Kingdom are not described.

The book fulfils a useful purpose in reviewing the carbonization industry in the United States; it has endeavoured to cover a wide field in a limited space with considerable success. The printing and reproduction of diagrams and photographs are good.

A. C. MONKHOUSE

Tests for Colour-Blindness

By Prof. Shinobu Ishihara. (Published for Nippon Isho Shuppan Co., Ltd.) Tenth completely revised edition. Pp. 27+38 plates. (London: H. K. Lewis and Co., Ltd., 1951.) 75s. net.

PROBABLY the best known of the confusion chart tests for defective colour vision is the Ishihara series, in which the subject is required to read a number made up of coloured dots printed against a background of a different colour. By the appropriate choice of colours, the various charts have been designed so that the colour defective may either misread the number or fail to read any number at all. The charts may also be a guide to the type and degree of defect depending on the mistakes made by the subject.

During the Second World War, the charts were unobtainable from Japan, and Messrs. H. K. Lewis and Co., Ltd., produced an English edition which proved a very effective substitute. Now a tenth Japanese edition has been produced and is obtainable from Messrs. Lewis, who are acting as agents for the Japanese publisher, the English edition having been discontinued. The underlying principles of the charts are sound, and the merits of different editions depend on how successfully the quality of the colour-printing is maintained. Extensive tests carried out a few years ago in the United States showed significant variations between different editions, and only time will show how the new edition ranks with the old. In some of the charts the colours are darker and more saturated than in the earlier sixth and seventh editions, so that some inconsistency in the subject's reactions may appear. One or two new charts have been added which increase the versatility of the test, and perhaps, in a future edition, charts for testing tritanopia, the blue-green deficiency, could be included.

W. D. WRIGHT

Name this Insect

By Eric Fitch Daglish. Pp. xxvi+294+64 plates. (London: J. M. Dent and Sons, Ltd., 1952.) 15s. net.

IDENTIFICATION of insects is a difficult subject for the non-specialist, the species being so numerous—more than twenty-one thousand in Britain—with many closely alike. Most popular books offer illustrated descriptions of a selection, through which laborious search is frequently necessary. "Name this Insect" is a notable attempt to make the search swifter and more direct.

Attractively written and produced, it begins with a simple exposition of structure and metamorphosis. There follows a key to major groups of insects; thence the quest is directed to the appropriate chapter, which contains a general account of the group, and a key to the adults of a good selection of species (more than seven hundred altogether). The keys are largely non-technical, and opposite each species is a brief description with notes on habits, habitat, etc. Most of the 430 or so illustrations, of which more than eighty are in colour, are good and many excellent, but some are a little inaccurate.

The book will be useful to those for whom it is intended, but there are two inevitable criticisms. First, if a convincing identification is not achieved, the inquirer does not know if this is because he has somewhere made a mistake, or because the species has not been included. Second, the designed simplicity and breadth of field of the keys entails a lack of precision, and identifications will sometimes be incorrect. Careful checking with descriptions and illustrations is essential, and, unless these clearly fit, specialist books should be consulted if certainty is desired. Unfortunately, a list of these is not provided.

B. D. MORETON

From Atoms to Stars

By Dr. Martin Davidson. Third edition, revised and enlarged. Pp. 280. (London: Hutchinson's Scientific and Technical Publications, 1952.) 18s. net.

EVEN a short compendium of modern astronomical facts, theories and methods must perforce be presented fragmentarily in so small a book as this one of Dr. Martin Davidson. Items that especially interest the author, such as atom structure, comets, meteors and tidal theory, are represented by larger fragments. The whole of the universe beyond our local galaxy receives but a small fragment, as does the subject of stars, other than Cepheids, which are intrinsically variable. Some fragments seem to be missing, notably the interpretation of spectra in the light of atomic physics, the principle of the spectrohelioscope and spectroheliograph and others on which so much present-day astronomical knowledge is based.

Nevertheless, in spite of an unbalanced effect, slips, misstatements and inadequate proof-reading, the book will help the reader whose interest in such matters has lapsed to bring himself up to date in certain particulars, especially if he is of a mathematical turn of mind. Assuredly the reader will not have to complain that this department is represented by an inadequate fragment; indeed, if he does as the author suggests in the preface to the first edition, and checks the mathematics for himself, he may spend some profitable hours.

Commendable features are the bibliography and the index.

F. M. HOLBORN

Chymia

Annual Studies in the History of Chemistry. (Edgar F. Smith Memorial Collection.) Vol. 3. Henry M. Leicester (editor-in-chief). Pp. ix+251+15 plates. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1950.) 36s. net.

THIS volume contains thirteen papers dealing with various aspects of the history of chemistry and alchemy. Those on Lavoisier's apparatus, early American chemical societies, and on a comparison of Boyle the chemist and Bayle the historian, may be mentioned as examples of the wide range of interests. The publication has taken its place among the journals dealing with the history of chemistry, and the standard of the articles is being maintained.

CONSTITUTION OF COAL AND THE FORMATION OF COKE

By Dr. W. A. KIRKBY and Prof. R. J. SARJANT, O.B.E.

Department of Fuel Technology, University of Sheffield

A PRELIMINARY investigation here described, which was initiated in this Department in 1947 nd carried out by D. K. Datta, is concerned with he constitution of coal from the point of view of the nechanism of coke formation and forms part of a ider co-operative series of researches including xperimental studies in carbonization and coke roperties.

Four coking-coal slacks were selected for study, ach being of similar ultimate composition but orming cokes which were known to have shown onsiderable differences in behaviour in industrial ractice, particularly by their use in blast furnaces, upolas and lime-kilns. The composition of the oking slacks is given in Tables 1 and 2.

TABLE 1

Coking slack	Coal seam origin	Colliery	Ash-free dry composition (per cent) Carbon	Hydrogen	Nitrogen	Sulphur	Oxygen (diff.)	Gross calorific value
A	Blend of Brockwell and Busty seams	Langley Park, Durham	87·50	5·05	1·60	0·95	4·90	15,530 B.Th.U./lb.
B	Lower Mountain Mine	Scaitcliffe, Lancs.	86·75	4·90	2·00	0·45	5·90	15,370
C	Upper Mountain Mine	Moorfield, Lancs.	84·75	5·15	2·35	1·30	6·45	15,130
D	Blend of Barnsley and Parkgate seams	Thurcroft, S. Yorks.	84·50	5·50	1·85	1·75	6·40	15,010

TABLE 2

Coking slack	Moisture (per cent)	Ash (per cent)	Volatile matter, ash-free dry (per cent)	B.S. swelling No.
A	1·1	9·1	29·4	8½
B	1·5	5·7	30·9	8
C	1·8	10·9	34·1	7
D	1·4	6·8	36·6	7

The general method used is that of selective solvent xtraction of coal under such conditions that as mild esolution as possible is obtained. The experimental rocedures adopted comprise: extraction of the coals ith phenol, pyridine and other organic solvents, and f these extracts further with chloroform, in an tmosphere of nitrogen; chromatographic separation f the latter extracts on activated alumina, eluents sed including chloroform, benzene, acetone and -hexane; and infra-red absorption spectrometric nalysis of the extracts and elutes. The effect of ltrasonic fields[1] of various characteristics upon the xtraction of the coals is also being studied.

In Table 3 values are given showing the relative roperties of cokes prepared from these slacks in an xperimental oven in the Department and also of the ommercial cokes. The 'degradation factor' is an ndex of the physical properties of coke, obtained by he use of a variable-impact shatter machine, and is xpressed as the percentage degradation per ft.-lb. of mpact energy applied. The values given in the table ere obtained in these laboratories by J. E. Littlehild, who developed this impact test for measuring he 'hardness' of coke. It was found, however, in an nvestigation of the relation between carbonizing onditions and the physical properties of these cokes s assessed by this impact test, that the so-called 'hardness' of a coke was affected to such an extent by variation of carbonizing conditions and the position of the actual sample of coke in the oven that the inherent influence of the coal in determining such properties could be masked.

In determining the reactivity by a new method it was found that the parentage of the coal in the coking blend was more definitely related to the reactivity as determined by this method. The reactivity values given in Table 3 were obtained by S. Banerjee and R. J. Sarjant[2] in another investigation in the same series of researches, using a modification of a method suggested by A. C. Dunningham as used in the laboratories at Winnington of Imperial Chemical Industries, Ltd., in which coke is burnt in a sized bed with air supplied at a standard preheat to ignite the bed, the temperature of which is controlled by an external heater. The reactivity is expressed in terms of the ratio of the actual carbon found in the gases to the theoretical maximum carbon content which would be obtained by complete conversion of the carbon dioxide to monoxide, and based in both cases on unit volume of air supplied.

Solvent extraction of the coals. For the present experiments phenol was chosen as the solvent, as it can be obtained in a high degree of purity and can be comparatively easily removed from the extract. Moreover, it has a high internal pressure of 120 cal./ml. at 150° C. and may therefore be expected to give a relatively high yield of extract. The coal samples were ground to pass a B.S.72 mesh sieve, and the extractions were carried out in an atmosphere of nitrogen in a Soxhlet apparatus devised by W. A. Bone and R. J. Sarjant for their researches on coal[3]. Extractions carried out up to 240 hr. gave 31–38 per cent of extract; and as there appeared to be no limiting value of the yields up to that time of extraction, it would seem that the process is not

TABLE 3

Coking slack	Cokes prepared in an experimental oven, carbonizing temperature 1030–1250° C. Degradation factor	Reactivity	Commercial cokes Degradation factor	Reactivity
A	4·2–5·0 × 10^{-3} *	0·606–0·612	3·50 × 10^{-3}	0·573
B	3·12 × 10^{-3}	0·666	6·73 × 10^{-3}	0·642–0·664
C				
D	2·68 × 10^{-3}	0·629	4·03 × 10^{-3}	0·592

* Under the experimental conditions of coking, the full mechanical properties of this coke had not been developed.

merely one of solution, but of depolymerization as well. In a few experiments applying an ultrasonic field (frequency 650 kc./s.) to the coal–phenol mixture, with the coking slack *D*, whereas 35·8 per cent of extract was obtained under the ordinary conditions after a period of 240 hr., after 2 hr. at 50° C. with the field applied the amount of extract was increased to 39·9 per cent.

The phenol extracts (after 240 hr.) were then resolved further by extracting with chloroform, and similar yields of soluble (14–19 per cent on the original coal) and insoluble (16–21 per cent) fractions were obtained for all the coals examined.

Chromatographic separation of the chloroform-soluble extracts. Activated alumina was used for effecting a chromatographic separation of the chloroform extract. After percolation of the solution through the column, it was developed by means of chloroform. There were formed : (i) a narrow yellow zone, about ⅛ in. in depth ; (ii) a zone about ⅜ in. with a gradation of colour from bright yellow to dark brown ; (iii) a greyish-brown zone about ½ in. deep ; and (iv) a deep-brown zone of about ½ in. in depth. Liquid chromatograms were then prepared by eluting with different solvents as follows : chloroform, (i) light-yellow solution from the yellow zone, (ii,*a*) dark-red solution with green fluorescence, (ii,*b*) light-yellow solution ; benzene, (iii,*a*) dark-red solution from the grey portion of the greyish-brown zone ; acetone, (iii,*b*) from the brown portion of the greyish-brown zone ; and *n*-hexane, (iv) from the deep-brown zone.

Infra-red absorption spectrometric analysis of the chromatographic fractions. The instrument used for this purpose was a non-recording Hilger infra-red spectrometer *D*223, with rock-salt prism and absorption cells, and photoelectric relay amplifying galvanometer system. The equivalent slit-width for the range 2·5–15 μ varies from 0·08 to 0·42 μ.

TABLE 4. ABSORPTION BANDS COMMON TO THE FOUR COALS

Eluent	Position of bands
n-Hexane	2·95–3 10 μ
Acetone	4·05–4·10
Chloroform	4·40–4·50
n-Hexane	5 9– 5·95
Acetone for coals *A*, *B*, *D* Benzene „ *C*, *D*	8·40–8·45
Acetone „ *A*, *B*, *C* *n*-Hexane „ *D*	8·55–8·65
Chloroform „ *A*, *B*, *D* Benzene „ *C*	10·20–10·35
Acetone „ *A*, *D* Benzene „ *A*, *B*, *C*	11·0–11·20
Benzene	12·05–12·20

TABLE 5. OTHER ABSORPTION BANDS

Eluent	Coal *A*	Coal *B*	Coal *C*	Coal *D*
Chloroform	2·55. 4·7–5·45, 7·4 9·15, 10·30, 13·7 μ	2·6, 5·50, 6·30, 9·15 μ	5·20, 5 50, 6·15, 6·80, 14·70 μ	3·70, 4·45–5·4, 5·60, 5 9, 6·1 7 4, 9·1 10 35 μ
Benzene	4·55, 6·05, 8·7, 10 1, 13·65, 14·20 μ	4·65, 12·65, 14·15, 14·45 μ	4·05, 4 65, 13 85 μ	6·05, 12·6, 13·2, 13·7 μ
Acetone	6 95, 8 05, 8·60, 12·35, 14·15 μ	3·10, 6·20, 7·90, 8·65, 9·0, 9 45, 10·40, 11 60 μ	3·10, 7·85, 8·60, 11·60, 12·50 μ	6·80, 7 75, 11·65, 12·40 μ
n-Hexane	3·35, 9·25, 10·05, 13·55, 14·05, 14·35, 14·80 μ	3·15, 5·0, 5·25, 9 25, 10 05, 10 80, 11·60, 12 7, 14·30 μ	7·65, 10 05, 11·60, 12·70, 13·55, 14 20, 14·40, 14·80 μ	10·70, 13·60 14·00. μ

TABLE 6. DIFFERENTIATING ABSORPTION BANDS

Eluent	Coal *A*	Coal *D*	Coal *B*	Coal *C*
Chloroform	4 7–5·45, 7·4, 10·30 μ	4 45–5 4, 7·4, 10·35 μ	5 5 μ	5 5 μ
Benzene	6·05, 13·65 μ	6·05 13·7 μ	4·65 μ	4·65 μ
Acetone	12·35 μ	12·40 μ	3·10, 7 90 μ	3·10, 7·85
n-Hexane	14·05 μ	14·00 μ	11·60, 12·70 μ	11·60, 12·70 μ

The chloroform extracts and chloroform, benzen acetone and *n*-hexane elutes were examined for the infra-red absorption spectra. There were found to very few bands in the spectra of the chlorofor extracts for differentiation of the four coals.

In the chromatographic elutes, however, numerou absorption bands have been distinguished an tentatively identified, and among them are sever which may be used for differentiating the coals. Th four eluents used differ considerably in their chemic character, and there is, as may be expected, a larg degree of selectivity shown by these eluents in respec of the absorption bands revealed in the differen elutes of any one coal. An analysis of the spect given by the various elutes is given in Tables 4, and 6.

There is to be considered the possibility that th differing proportions of phenol – chloroform-solubl material extracted from the coals may be reflected i the differences between the coals as indicated by th absorption spectra of the elutes. If that were so, th relative amounts of material extracted would lead t the expectation that coals *A*, *B*, *D* would show con siderable similarities in their absorption spectra an that coal *C* would differ appreciably from them. . comparison of absorption bands common to differen groups of three of the coals shows that the numbe of similarities in the group *A*, *B*, *D* is not significantl greater than in any other group.

In view of this, there seems at least a *prima fac* case for dividing the coals into two groups—*A* an *D*, *B* and *C*—on account of the considerable numbe of absorption bands which are common to the coa in each group respectively, as shown in Table 6.

From the information available[4] on the inte pretation of infra-red absorption spectra of organ molecules, the chemical groups in the chromat graphic fractions shown in Table 7 may be tentativ identified from the position of some of the absorptio bands, neglecting their intensities.

In the large number of bands between 9 and 14 the skeletal absorption region, there appear to some which are characteristic of benzene substitutio and condensed aromatic systems.

A notable feature so far is that the differentiatio into groups, based on the absorption spectra of th coal extract elutes, is matched by a differentiatio of the coals in respect of the properties and behavio

TABLE 7

Band (μ)	Group	Band (μ)	Group
2·55, 2 6	OH	5 9	C = O (in acid form)
2 95–3·10	OH and/or NH	6 05	C = C or C = O
3·15	CH (unsaturated) or NH	6·1, 6·15, 6·20, 6 30	C = C (conjugated ; aromatic
3 35, 3·70	CH	6·8, 6 95	CH_2, CH_3 (deformation)
4·05–4·10	NH or SH ?	7 4	OH (deformation
4 40–5 45 (complex)	multiple bonds	7·9, 8 05	— C—O
5·5, 5·6	C = O (in ester or anhydride form)		

of the cokes made from them. As judged by the figures given in Table 3 for the degradation factor and reactivity for both the commercial cokes and hose prepared in the experimental oven, it will be seen that (with the exception already noted in Table 3) the cokes from coals A and D have lower values han those from coals B and C, that is, the former pair of coals give the harder and more unreactive cokes. Moreover, as regards the relative behaviour of the cokes in industrial practice, those made from coals A and D give a very hot and narrow zone in high-temperature shaft furnaces, as compared with a wider and not so hot zone with the cokes from coals B and C, as well as a higher temperature in cupolas.

From the results obtained so far in these preliminary experiments, it would appear that by the use of these techniques there is possible a differentiation of coals in respect of at least some of the properties of the cokes produced therefrom. A considerable number of coals are now being investigated to see if there can be found in this way an understanding of the fundamental differences in coals which affect their coking properties.

See Berkowitz, N., *Nature*, **163**, 809 (1949)

Banerjee, S., and Sarjant, R. J., *Fuel*, **30**, 130 (1951)

Bone, W. A., and Sarjant R. J., *Proc Roy Soc.*, A, **96**, 119 (1919).

For example, "Infra-Red Determination of Organic Structures", by Randall, H. M., Fowler, R. G., Fuson, N., and Dangl, J. R. (D Van Nostrand Co., Inc, New York, 1949) Cannon, C. G., and Sutherland, G. B. B. M., *Spectrochim Acta*, **4**, 373 (1951) Sutherland, G. B. B. M., Discuss. Farad. Soc, No. 9, 274 (1950).

FIRST INTERNATIONAL CONGRESS ON ANALYTICAL CHEMISTRY, OXFORD

THE First International Congress on Analytical Chemistry, under the patronage of the International Union of Pure and Applied Chemistry, was held at Oxford during September 4–9, with Sir Robert Robinson as president. The Congress consisted of twelve sessions, at which forty-three scientific papers, under nine subject groups, were read and discussed, and of four Congress lectures. There were also a trade exhibition of instruments, apparatus and books, and an exhibition of analytical techniques and apparatus.

The success of the meeting was assured from the start by the attendance of about seven hundred chemists from all over the world, some of whom were also able to attend meetings of the Section Committee and Commissions of the Analytical Chemistry Section of the International Union before and after the Congress. The success of the Congress was a worthy tribute to the organizers, the burden of the work falling on Mr. R. C. Chirnside, whose ability was reflected in the smooth running of all the proceedings.

The first of the Congress lectures was given by Prof. I. M. Kolthoff, of the University of Minnesota, who spoke on the "Ageing of Crystalline Precipitates". The 'ageing' to which Prof. Kolthoff referred denotes the irreversible structural changes that occur in a precipitate after it has been formed, of which the classical 'Ostwald ripening', the growth of larger particles at the expense of the smaller, is an example.

Dr. R. H. Muller, of Los Alamos Laboratory, New Mexico, an authority on the subject of instrumentation, spoke on "Research in Analytical Instrumentation". His lecture was not a mere summary but reviewed the possibilities for the future. He discussed the need for perfected instruments such as high-speed, auto-recording balances and instruments for recording refractive index and for photoelectric titration.

Dr. L. H. Lampitt, chief chemist of J. Lyons and Co., Ltd., Laboratories, London, gave the third Congress lecture, with the title "The Value and Economic Importance of Chemical Analysis in Industry and Manufacture". He traced developments from the chemical revolution of the seventeenth century to the present time, and pointed out that to-day the analyst is in a position to aid industry in the main fields of commercial activities, namely, research, process development and process control. He stressed how, in industry, analytical control could, by means of instrumentation, be carried out by relatively unqualified (in the academic sense) persons, and their work could be assessed as a 'bench-rate', a prime charge against the article manufactured.

Finally, Prof. van Nieuwenburg, professor of chemistry in the Technical University of Delft, spoke on "A Contemporary Assessment of the Place of Classical Methods in Chemical Analysis". He spoke of the revolutionary changes in chemical analysis and of the fact that most of the papers read at the Congress were on matters or techniques unheard of twenty-five years ago. The classical methods, which are essentially chemical, may be losing ground, but they still have a future, as the new physical methods need them as a basis.

The papers read at the Congress and the discussions that followed are to be published in the November and December numbers of *The Analyst*, and the whole of the proceedings will be available as a separate bound volume for members of the Congress and others. Consequently, the papers are not here reviewed in detail, but a brief survey is given of the general and specialized subjects discussed.

Five papers on microchemical methods were read, that on the direct micro-determination of oxygen in organic substances being particularly interesting. The apparatus involved was shown at the apparatus exhibition. The micro-gravimetric determination of lead as sulphate and of silver and of mercurous mercury as chlorides was described, the determination of fluorine by the lead chlorofluoride method in compounds containing halogens, sulphur, phosphorus and arsenic was reviewed; and other papers included a description of a countercurrent micro-rotary extractor and a summary of some of the approaches that have been utilized in the development of spot tests, using either organic or inorganic reagents.

In the subject group of optical methods of analysis, there were six papers, covering two sessions. These papers served to illustrate the greater value of 'open' subjects when they are intended for general discussion at meetings. For example, an account of recent advances in infra-red spectroscopic techniques and a paper on the colorimetry of indicators both aroused keen discussion. On the other hand, the papers on ultra-violet absorptiometric determination of arsenic as 12-molybdoarsenic acid (designed for large percentages of arsenic) and on ultra-violet absorption spectra of pyridoxine and related compounds were only of interest to a limited number of people, although valuable in print. In addition, the application of emission spectrography to the routine determination of metals soluble in lubricating oils and the identification by X-ray diffraction of crystalline inclusions in glass were discussed.

The session on the presentation of data moved briskly under a forceful chairmanship. Two papers which were taken together and which aroused considerable interest were those on statistical aspects of analytical determinations, for the detection and correction of sources of error in analytical procedures, and on statistical design in the study of analytical methods, to determine the sensitivity of an analytical method. The third paper in this subject group was on statistical methods in radiochemistry.

The morning of September 6 was devoted entirely to the study of radiochemical methods, and this naturally attracted the chemists working in the newer fields of atomic research. A paper on the determination of trace quantities of the alkali metals by neutron activation analysis claimed that this type of analysis is unique because of its great sensitivity and the fact that other elements do not interfere. Two papers were read on the determination of small quantities of uranium by radioactivation and on precision counting of α-particles, while the preparation of astatine by bombardment of bismuth oxide with helium ions and the solvent extraction of Group *IIIB* metal halides with the aid of radionuclides were also discussed.

The session on organic complexes opened with a paper on some factors controlling the selectivity of organic reagents, in which a product ML_n, formed from a cation M and an acidic reagent HL, if it has suitable physical properties, may serve as a basis for a test for M. The stability of metal 'chelates' in relation to their use in analysis, and 1 : 10-phenanthroline and mono-, di-, tri- and tetra-methyl-1 : 10-phenanthrolines as chelated copper complex cations were studied; also discussions took place on the complexes formed by thorium and uranyl ions with complexones (that is, derivatives of iminodiacetic acid) and on the fractionation of ozokerites and the separation of optical isomers.

A general survey on a fundamental approach to the establishment of *p*H standards opened the session on electrical methods. It was emphasized that *p*H can never possess the absolute significance of a true thermodynamic constant. A method of determining the equivalence point in potentiometric titrations, applicable to instruments calibrated either in millivolts or *p*H units, was said to have been achieved by a numerical manipulation transforming potential-volume curves into straight lines intersecting at the equivalence point. Also included were papers on the replacement of the standard cell and salt bridge by indicator electrodes and the use of non-aqueous solutions in potentiometry, on square-wave polarography, and on polarography of the tetrathionate ion.

It was perhaps significant that nine papers were presented to the adsorption and partition methods group, involving three separate sessions of the Congress. Recent work on gas chromatography was illustrated by the separation and analysis of volatile organic mixtures by displacement chromatography from charcoal columns at 100° C. to an accuracy of better than 1 per cent. It was also suggested that some of the limitations of current chromatographic procedures are overcome by gradient elution analysis, although it has certain disadvantages. The theory of the partition column has been extended to include a compressible mobile phase of a permanent gas, and a method of determining the height equivalent to a theoretical plate of such a partition column has bee given. The apparatus involved was demonstrated a the apparatus exhibition.

The theoretical aspects of paper chromatograph have been studied with the aid of semi-automati instruments based on the square-law behaviour o the ascent or descent of liquid in a strip or sheet o paper. In the field of quantitative inorganic pape chromatography, working details were given for new chromatographic separation of aluminium titanium and iron in three individual spots within time of 330 min. and an accuracy of ± 2 per cent The separation of individual groups of water-solubl extracts of plant and animal tissues was achieved b displacement chromatography on ion-exchange resin a technique that led to the chemical characterizatio of new or unexpected components.

Other papers included one on the use of electro kinetic ultrafiltration to enable the larger molecule of the polysaccharides to enter the porous material used for chromatography, the inability to do so bein normally a serious difficulty, one paper on th applications of ion exchange to analytical chemistry and one on the quantitative determination o tantalum and niobium by inorganic chromatograph on cellulose. This last technique was demonstrate at the apparatus exhibition.

The less-exact science of biological method attracted more limited audiences. Papers in thi subject group included those on the use of protozo in analysis; the use of fungi for determining trac metals in biological materials, whereby increase growth in test fungi was stimulated by the additio of graded amounts of certain metals, from deficienc to sufficiency levels, to a culture solution containin all the other essential nutrients; and the quantitativ assay of pyrogens by the febrile response in rabbit using selected animals according to their body tem perature, body weight, sensitivity, excitation an tolerance.

In the session devoted to general subjects a titri metric method was described for the rapid analys of certain binary liquid mixtures to which alternativ methods may not be readily applicable, and th quantitative determination of organic halides b evaluation of reaction velocity curves was discusse

The exhibition of analytical techniques an apparatus, so efficiently organized by Mr. F. R Jones, was regarded by some as the most importan feature of the Congress. Sir Robert Robinson, i expressing the wish that the exhibits could b retained for his students to see, echoed the thought of many visitors who felt that it was a minor traged to have to dismantle these outstanding exhibit involving as they did a wide range of subjects an craftsmanship and ingenuity of design of a hig order. The usefulness of the exhibition was enhance by the fact that it was staffed at all hours by a enthusiastic team of demonstrators who were qualifie scientific workers specialized in their particular subject and always ready to answer questions or to discus the fundamentals of their exhibits.

It must be clearly understood that selection of th items for description in this article has been quit arbitrary and that only lack of space precludes th inclusion of them all. Some, it is understood, hav been, or are to be, published in the *Journal Scientific Instruments.*

In the case of three of the scientific papers describe above, reference was made to the fact that th instruments or techniques involved were also demon strated at the exhibition. These included: an apparatus for the determination of oxygen in organic compounds, in which the products of pyrolysis of the compound are passed in a stream of oxygen-free nitrogen over carbon at 1,120° C., the carbon monoxide produced being oxidized by iodine pentoxide at 120° C. and the liberated iodine oxidized to iodate and determined by thiosulphate; the use of partition chromatography involving a mobile gas phase and a stationary liquid phase to separate and estimate micro-amounts of volatile fatty acids from formic acid to lauric acid, including all the isomers of valeric acid; and the application of paper strip technique, widely used in organic separations, to inorganic materials covering a very wide range, and the application of the method to separations on a larger scale using columns of cellulose powder.

A popular exhibit was that demonstrating remote-handling devices for radioactive work. It comprised a 'gamma handling cell' for the safe handling of 100 mC. of 1-MeV. gamma-ray sources, tongs for changing tong-heads remotely and a mechanical simulator which is a model of a machine used for accurate manipulation from behind a dense shielding-wall—for example, 2–3 ft. of concrete. An excellent instrument was shown, known as the 'thermistor ebullioscope'. This instrument is intended for the rapid and precise routine determinations of molecular weight. Rapidity is achieved by employing thermistors as short time-constant differential thermometers, and precision by the use of specially designed vapour-jacketed ebullioscopes. Boiling-point elevations, accurate to 0·0005 deg. or less, can be read within about two minutes of adding the solute.

A large and beautifully laid-out exhibition of microchemical apparatus had been organized by the Norwood Technical College (London County Council). This exhibit aroused considerable interest, and the demonstrators were tireless in answering questions. Most of the items were of very simple construction, but the success of the exhibit lay in the fact that the large number of pieces of micro-glassware—methods of stirring in small-scale work, micro-conductometric and other electrochemical techniques and apparatus for small-scale organic syntheses and identification and for general microchemistry—had been made and assembled by a team of enthusiasts working in their spare time.

A fascinating demonstration of new methods of microscopy was organized by Dr. R. Barer, of the Department of Anatomy, Oxford. The subject was, of course, highly specialized, but was of considerable interest to all the visitors who saw the demonstration. There were also demonstrations of a new method of identifying crystalline substances by measurement of interfacial angles, and of the Federov universal stage for determining the optical constants of crystals.

Altogether there were eighty-seven exhibits provided by forty-one individuals, firms, laboratories, research associations or colleges. There was also a trade exhibition of instruments, apparatus and books, effectively organized by Mr. W. Thompson, in which forty-four trade exhibitors were represented.

Apart from the purely scientific side of the Congress, the social side was catered for in a simple but effective manner by the arrangement of tours and excursions. Several informal receptions took place, and a banquet was held in the Hall of Christ Church. The Congress was undoubtedly a great success, and the next one will be awaited with pleasurable anticipation.

ELECTRICAL DISCHARGES IN GASES

AT the recent Belfast meeting of the British Association, a session was held on September 8 by Section A (Mathematics and Physics) which was devoted to electrical discharges in gases. The rather full programme included six papers on important aspects of this subject and a discussion. Prof. A. M. Tyndall presided.

The application of the subject of electrical discharges to-day covers a wide range in physics, including, for example, the investigation of certain properties of matter; the nature of ion–atom reactions; metal surface phenomena in discharge tubes, Geiger counters, and electrical contact devices of every kind; radar switches and the generation of radio-frequency oscillations; high-voltage insulation by compressed gases; and ion sources for nuclear physics. The strong interest was reflected in the full attendance, which included a number of electrical engineers.

The session was opened with a paper by Prof. F. Llewellyn Jones (University College, Swansea) on the electrical breakdown of gases. Discharge phenomena at low pressures, at atmospheric pressures, in highly compressed gases and at electrical contacts appear very different, and different theories have been proposed. Recent work, however, suggests that there are basic principles common to all these aspects. Breakdown at low pressures has been shown to be controlled by primary ionization with a secondary process determined by the nature and geometry of the cathode. For sparks at atmospheric pressure an entirely different theory depending on space-charge effects has been proposed, but recent precision measurements of the ionization currents just prior to sparking show that breakdown in uniform fields at this pressure also is controlled by primary and secondary ionization processes the relative importance of which is controlled by the nature of the cathode[1]. No space-charge effects have been found. With high voltages and compressed gases breakdown appears to be different again in that Paschen's law fails, but this can be explained by the additional generation of electrons by field emission from the cathode. Similar effects can occur at electrical contacts[2]. On the generalized theory proposed, breakdown is a consequence of the development of ionization currents in the gas by primary and secondary processes. No single secondary process always predominates; several can and do occur, sometimes together, sometimes singly. The factors which mainly determine the predominant process in any particular case of breakdown are the nature and geometry of the cathode. In this respect, therefore, the physics of electrical breakdown of gases has much in common with the physics of surfaces.

Dr. C. Grey Morgan (University College, Swansea) described an investigation of cold-electron emission both from electrodes covered with thick oxide layers and from those with thin tarnish films. With heavily oxidized metals, of the type often encountered in heavy electrical engineering, emission of 10^4 electrons/sec. was obtained with low electric fields of about 10^5 V./cm. The fundamental physical process underlying this emission is considered to be the extraction of electrons from ionic sites on the thick contaminating oxide layers always present on surfaces operated in the atmosphere[1]. Another class of surfaces, of great interest in applied and theoretical physics, was also investigated; these were surfaces covered with thin tarnish films of but a few atoms thick. Again, unexpectedly high electron currents were obtained at the low electric fields of 10^4 V./cm., but investigation of the mechanism of this emission showed it to differ from that for thick films. While the mechanism was still a cold field extraction process, it is thought that the electrons actually came from the underlying metal by extraction in an intense surface field set up by the positive ions lying on the surface tarnish film. This effect can lead to a considerable enhancement of the Townsend secondary coefficient. This work directs attention to the important part played by the electrode surfaces in initiating spark breakdown.

Experiments designed to investigate the ionic constituents in gaseous discharges were described by Dr. R. L. F. Boyd (University College, London). The use of the magnetic mass-spectrograph as a probe is impracticable in this work because of difficulties of obtaining radial movement of the probe, screening the discharge from the magnetic field, and collimation of the beam of particles. A new small radio-frequency mass-spectrometer probe which avoids these difficulties was described. This employs a time-of-flight method of discrimination between ions of different mass/charge ratio. With this instrument measurements of the radial variation of negative ion density was measured in oxygen, where the negative oxygen ion concentration is only a hundredth of that in the halogens at the same electron concentration, although the probability of attachment of electrons to iodine atoms and to oxygen is about the same. Preliminary evidence indicates that associative detachment is the most likely process able to account for the sufficiently fast removal of negative ions in oxygen.

Prof. K. G. Emeléus (Queen's University, Belfast) described experiments on the generation of plasma electron oscillations by a hot-cathode discharge. The oscillations (5 cm. $< \lambda <$ 200 cm.) were picked up by a small probe projecting into the glow in the region near the filament. The frequency f of the oscillations was of the same order as that calculated on the assumption of electrostatically controlled vibrations of an electron cloud displaced from an equilibrium position in the discharge plasma, and is given by the Tonks–Langmuir relation

$$f = (Ne^2/\pi m)^{1/2},$$

where N is the number of electrons per c.c., and e and m the electronic charge and mass. With directly heated cathodes oscillations are detected at discharge currents below saturation values. Both with directly and indirectly heated cathodes, the oscillations appeared to be produced over a wide range of tube characteristics. The experimental observations of Merrill and Webb showed that the oscillations were confined to narrow layers of glowing gas near the filament; the primary electrons passing through these sheets were subjected to velocity modulations. These conclusions were confirmed by Prof. Emeléus and his co-workers. Experimental observations support the view that both a primary beam of electrons and a discharge plasma are essential for the generation of oscillations. It is suggested that the complicated motions of the ions and electrons in discharge tubes set up, for example, by the influence of the magnetic field due to the drift current, are analogous to hydrodynamical turbulent flow in fluids. The apparatus used in this work was described by Prof. Emeléus: the discharge tubes could be made easily demountable, as the results were not affected appreciably by impurities in the gas.

Present knowledge of the physical processes which initiate and maintain high-frequency discharges was outlined by Dr. A. H. von Engel (University of Oxford). Experiments covering a wide range of frequencies and pressures were described. At ultra-high frequencies ($\sim 3 \times 10^9$ c./s.) the work of MacDonald and Brown on the limits of the application of the diffusion theory of electron loss and the work of Prowse at atmospheric pressure were outlined. The case where the mean free paths of the electrons are much less than the dimensions of the tubes or electrode separations was next considered: Llewellyn Jones and his collaborators have established a general similarity theorem involving the oscillation frequency as well as the linear dimension of the discharge tube. The work of Gill and von Engel and of von Engel and Francis on the growth of the discharge was then described. The mean free paths of the electrons in these experiments were greater than the dimensions of the discharge tubes, and the field required to initiate the discharge was dependent on the nature of the end walls of the tube on which the electrons impinged. The growth of the electrodeless discharge was shown to depend both on the production of a space charge which reduced the amplitude of oscillation of the electrons until it was less than the length of the discharge tube, and on the establishment of an equilibrium state in which the generation of ions and electrons in the gas equalled the losses to the walls[1,2].

Mr. C. E. R. Bruce (British Electrical and Allied Industries Research Association) considered the case of discharges on both the largest terrestrial and on the cosmical scale; a certain resemblance between photographs of the largest laboratory spark, the lightning flash and solar flares has been found. In discussing the lightning flash, it was pointed out that the earlier recombination theory of the so-called leader stroke is incompatible with the large currents of the order of 1,000 amp. deduced both from magnetic field changes produced by the upward leader strokes from the Empire State Building, New York, and also from changes in the electric field observed to accompany propagation of normal downward leader strokes from the cloud. It was suggested that the leader stroke column has arc characteristics, and that there is a high radial loss of ions from this column by corona loss; the steps by which the leader stroke progressed may represent corona-to-arc transitions. Such a transition may represent the criterion of instability determining the breakdown of very long gaps.

An interesting discussion followed occupying all the time available. Prof. Emeléus discussed certain anomalous inductance and capacitance effects in neon discharge tubes. Mr. S. C. Haydon (Swansea) considered the case of photo-ionization of the gas as a possible secondary ionization mechanism in the breakdown process. He gave the results of calculations on the growth of pre-breakdown ionization currents when photo-ionization was taken as the predominant secondary ionization process. These showed that photo-ionization did not account for the observed growth of currents in air.

Prof. Tyndall raised the question of the possible micro-distortion of the electrode surface due to the sparks used in the experiments on the cold electron emission from surfaces, and pointed out that appreciable disturbance of the surface geometry can enhance the local electric field by producing sharp points. In reply, it was stated that the current in these measuring sparks is severely limited, and experiment shows that no significant distortion of the surface and field enhancement occurs throughout the whole period of measurement. Dr. J. Dutton (University College, Swansea) discussed the significance of the formative time-lag of breakdown, and pointed out that the magnitude of the formative lag depends on the particular Townsend secondary ionization process which is predominant in the generalized theory of breakdown here put forward. Assuming cathode electron emission due either to incidence of photons alone, or with positive ions, calculations showed that in both cases a rapid fall of formative lag from 10^{-4} sec. to 10^{-6} sec. is to be expected as the overvoltage increases from 0 to 2 per cent, although the shape of the two curves differs significantly in detail.

Dr. Boyd discussed further the case of recombination in helium and also gave a fuller account of the radio-frequency mass-spectrometer probe. The high recombination observed in a decaying radio-frequency discharge can be accounted for by the process, proposed by Prof. D. R. Bates (Queen's University, Belfast), of dissociative recombination involving a preponderance of molecular helium ions. This view has been confirmed by measurements with the radio-frequency probe. The reaction involving metastable atoms of helium with a hydrogen molecule was discussed in some detail by Prof. Bates and Dr. Boyd.

F. LLEWELLYN JONES

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[1] *Nature*, 168, 140 (1951).
[2] *Nature*, 169, 960 (1952).
[3] *Nature*, 169, 317 (1952).

CHEMISTRY AND FOOD PROCESSING

A DISCUSSION on food processing, arranged by Section B (Chemistry) of the British Association, took place on September 8 during the Belfast meeting. The food processing industry is steadily developing in Northern Ireland, and Prof. W. Wardlaw's presidential address to the Section, on "The Advancing Front of Chemistry", had dealt *inter alia* with some recent aspects of this industry.

The chair was taken by Prof. H. D. Kay (Shinfield), who gave an introductory paper. He pointed out that a very large proportion of what modern civilized man eats (and much of what he drinks, including many town and country water-supplies) is processed, with the object either of increasing keeping quality, thus permitting the conservation or the long-distance transport of perishable foods, or of rendering the raw food more palatable or digestible or of removing danger of disease. Typical examples were given of foods in each category.

Better food processing would enable the very considerable loss—possibly 15 per cent or more—of human food between production and consumption to be markedly reduced, a matter of real significance in a world where food supplies are increasing less rapidly than populations. Further, many human inhabitants of the world to-day are more-or-less severely parasitized, and efficient food processing would reduce food-conveyed infestation and thus improve general health and working capacity.

The addition to food of chemical substances such as colouring, flavouring and preservative agents and 'improvers' is now under good control in the United Kingdom, and, continued Prof. Kay, there is little evidence that any of those which are at present permitted are dangerous to human health. In fact, some of these additions, like that of vitamins A and D to margarine, are nutritionally beneficial.

In the category of food processing come also the manufacture of new foods, not previously eaten, for human or animal consumption. An example is the production of acceptable human foods from the world's most important crop—grass—and another is the production of palatable, protein-rich food for man and for farm animals by growing yeasts and other organisms on waste carbohydrate (of which a great deal is available) in the presence of inorganic sources of nitrogen and phosphate. Circumstances in the near future will probably compel the active prosecution of further research on such problems.

Prof. Kay also mentioned the development in the United Kingdom of improved methods for the processing of home-produced feed for the winter keep of farm animals. He discussed modern ensilage technique and gave the results of some recent experiments at the National Institute for Research in Dairying, Shinfield, in which different methods for making silage from young herbage crops were compared.

A valuable summary of the science underlying modern bread-making was given by Dr. A. J. Amos (London). He described the biochemical processes involved in the steady production, from the starch of the wheat, of the sugar necessary for gas formation by the yeast incorporated in the dough. Sugar production, which usually requires several hours, depends in part on the quality of the original wheat and in part on the damage caused to the starch granules during milling. The addition of enzymes derived from cultures of *Aspergillus oryzae* is a recent development, now used commercially in the United States, for the correction of low diastatic activity in flour. Slides were shown illustrating the rather complex relationship between the amount of yeast present and the rate of gas production.

In addition to an ample supply of sugar for the yeast, and the satisfactory conversion of this into carbon dioxide, the physical nature of the flour proteins when made into dough must be suitable. Bread made from fresh-milled flour is quite unacceptable; the flour has to be 'aged' for some weeks, during which time changes due to the action of atmospheric oxygen take place, before it is fit for commercial use. In the ageing process the flour also becomes whiter owing to the oxidation of the yellow colouring matter—mainly xanthophyll.

Though beneficial and indeed commercially necessary, the natural ageing of flour is a process which demands the storage under appropriate conditions of several weeks supply of flour. It has been found that the addition to the fresh flour of minute amounts of ammonium persulphate rapidly brings about 'ageing'. Other oxidizing agents have also been discovered which 'improve' the flour by ageing it artificially. The beneficial effect of improvers is due largely to their direct action on the protein. The protein is present in the form of a three-dimensional network with cross-links between neighbouring molecules. 'Improvers' increase the number of such cross-links, probably by oxidizing contiguous sulphydryl groups on adjacent protein molecules to form new disulphide bonds.

A recent discovery which is the basis of a patent is that the improving and bleaching effects, obtained in several weeks by natural ageing, can be brought about in a matter of minutes by distributing atmospheric oxygen, applied by means of a special high-speed mixer, through a batter made from the wheat flour, in presence of a source of oxidases such as soya flour.

Dr. Amos discussed whether the addition of chemical improvers to flour has any harmful effect either on the nutritional value of the bread or directly on the consumer. There is no significant effect on the vitamins of the B complex, and though flour treated with nitrogen trichloride has been shown to cause hysteria in some dogs, there is no evidence whatever that it harms human beings. Nevertheless, because it could be detrimental to some animals, it is probably unreasonable to quarrel with the decision to discontinue its use. The other oxidizing substances used as flour improvers or bleachers have been thoroughly tested in both animals and man, at a level much higher than that in which they are added to bread (one part in 7,000–65,000 of bread) without any ill effects.

Dr. J. A. Lovern (Torry Research Station, Aberdeen) discussed some modern advances in fish processing. Our knowledge of the chemical composition of fish and the changes which occur in fish tissue subsequent to catching has steadily increased, and we now have a rational background for the introduction of improved methods of storage and processing. There is little doubt that any direct use of new chemicals for the preservation or processing of fish would conflict with existing food and drugs regulations.

It is to be remembered that the greater part of the catch obtained by the British fishing industry is in distant grounds—up to five or more days steaming from the home ports. This period, added to the week or so spent in actual fishing, means that much of the catch has to spend two weeks or more in ice before it reaches the consumer. The ice itself is at times made from water containing antiseptics such as hypochlorite, hydrogen peroxide, etc.; one of the most promising bacteriostatic agents is a high concentration of carbon dioxide in the fish-room atmosphere.

There are three broad phases in the course of changes in fish after stowing in ice: first, the period until the fish passes out of *rigor mortis*, during which no bacterial invasion takes place; second, bacterial multiplication and the conversion of trimethylamine oxide (originally present in the fish, but having no odour) into the strong-smelling trimethylamine; third, the progressive breakdown of fish protein, under the attack of bacteria, with the production of ammonia, indole, etc. For practical purposes the second stage is the important one.

While efficient freezing and cold storage of fish completely stop bacterial attack, other types of spoilage can occur, for example, autolysis and atmospheric oxidation. Cytochrome *c* and other respiratory pigments of the muscle have been found powerfully to catalyse the oxidation of fat in cold-stored fish. This oxidation is most effectively controlled by excluding air from the system, for example, by means of a coating of ice, with or without the addition of anti-oxidants.

The process of fish smoking was also discussed by Dr. Lovern. He said that the constituents of wood smoke, as produced in the usual smouldering fire, are not the same as those resulting from the destructive distillation of wood, since the primary distillation products are extensively hydrolysed in passing through the zone of hot damp wood above the smouldering area. The smoke is rich in polyphenols, presumably derived from the lignin fraction of the wood, which are deposited on the fish. When smoked fish is kept for some time, it is not until the concentration of phenols on the fish begin rapidly to decrease that microbiological attack on the damp fish begins. Present research is being directed to a study of the effective smoke constituents, as deposited on the fish, in relation to microbiological spoilage.

The last of the main contributions to the symposium was that of Mr. P. N. Williams (Unilever, Ltd.) on the processing of fats. He reminded the audience that most of the butter and lard consumed in the United Kingdom is produced overseas, so that the main oils and fats processed in Britain are of vegetable or marine origin. Much of the crude oil reaching the United Kingdom for processing (except the whale oil) is of poor quality.

It seems certain that, if the diet of the increasing population of the world is not to have a diminishing fat content, vegetable oils will have to be produced and processed in increasing quantities. At present, most of the crude vegetable and marine oils imported into Great Britain are first refined to edible quality and then further processed into margarine, or into 100 per cent fat products such as 'shortening' (cooking fat) or 'compound lard'.

In refining crude oils, impurities are removed by neutralization, bleaching and deodorizing. Free fatty-acid is removed by the first of these processes, which consists in the addition of alkali—usually fairly strong caustic soda—removal of the soaps so formed and washing with water. Bleaching is usually achieved by shaking under reduced pressure with activated fuller's earth, and deodorization by passing steam through the oil, also at reduced pressure. Subsequent hydrogenation of the oils, to produce end-products with the requisite physical properties, is brought about commercially by passing hydrogen through the warm oil in the presence of carefully prepared nickel carbonate-plus-hydroxide catalyst. If the oils are highly unsaturated, the heat of reaction with hydrogen is such as to require cooling water to be passed in through coils in the cylindrical hydrogenation vessel.

To prepare margarine, a mixture of the hard hydrogenated fats with liquid oil and separated milk (which has been soured under controlled conditions to produce a desirable flavour) is churned. The resulting emulsion is cooled on a rotating drum, and the cooled flakes obtained are afterwards worked to obtain the requisite rheological properties. An alternative modern method, which has the advantage of being continuous, employs an improved form of the 'rotator'—a refrigerated, stainless-steel cylinder, equipped with an agitating system, into which the fat–milk mixture is poured. After shaking, the semi-solid fat is extruded direct to automatic packers.

At a stage before the final churning, vitamin A in the form of a concentrate prepared from whale liver oil, and crystalline vitamin D, are added to the fat. Since a large part of the margarine sold in the United

Kingdom is coloured by the addition of the natural pigment and vitamin A precursor carotene, further vitamin A is produced in the intestine. The nutritional value of such margarine is at least equal to that of butter, and is constant throughout the year. Mr. Williams's paper, like that of the other speakers in the symposium, was illustrated by lantern slides.

In the subsequent discussion, Mr. F. C. Cooke (Ceylon) stated that if the United Kingdom is to secure a steady supply of vegetable fats from overseas for processing, an economic agreement is urgently required which would give some assurance as to future prices to producers of such fats. Another speaker said that, with the advance in the quality of processed vegetable fats and the steadily rising cost of butter, the future of the latter is becoming highly insecure. While there would doubtless be an increasing trend towards the consumption of liquid milk, of dried whole milk and of cheese, butter can scarcely escape the fate of becoming little more than a luxury product.

OBITUARIES

Prof. F. T. Hill

Frederick Thomas Hill, assistant professor of aeronautics in the Imperial College of Science and Technology, London, died on September 24 within a few days of his retirement.

Prof. Hill was born on November 13, 1886. He was apprenticed to the Great Eastern Railway Company and completed his education at Queen Mary College, London. He then worked on engineering design with the Whitehead Torpedo Co., until he joined the City and Guilds College, Finsbury, as an instructor in 1911. He developed an interest in aeronautics and became the first teacher of that subject in a British institution. During the First World War he joined the Royal Flying Corps as a designer and reached the rank of captain.

He joined the newly formed Department of Aeronautics at the Imperial College of Science and Technology as a lecturer in 1920, and he became assistant professor with special responsibility for design in 1924. For twenty-five years this was the only entirely postgraduate department of aeronautics in Great Britain. It was dominated by Hill and Sir Leonard Bairstow, head of the Department. Few of the senior technical people in the British aeronautical world have not passed through their hands, and many will have had their first experience of wind tunnels in the Imperial College 'channel' designed by F. T. Hill. In later years he fought a losing battle for the recognition of design as a postgraduate university subject. However, the more recent generations of students must have benefited from his documented accounts of earlier mistakes.

His particular interest was in the materials of aircraft construction, and the many editions of his book on that subject have become a classic since it first appeared in 1933. He was working on a new edition at the time of his death.

Hill's life was devoted to his work, and this left time for little else. However, he was a founder member of the Institution of Aeronautical Engineers, a Fellow and sometime Member of Council of the Royal Aeronautical Society and a member of many committees of the University of London and of his College. He is survived by his wife, a son and a daughter.

P. T. Fink

We regret to announce the following deaths:

Dr. W. T. Calman, C.B., F.R.S., lately keeper of zoology, British Museum (Natural History), on September 29, aged eighty.

Dr. Philipp Ellinger, formerly of the Lister Institute, on September 12.

Prof. F. C. Lea, O.B.E., emeritus professor of engineering in the University of Sheffield, on September 30, aged eighty-one.

NEWS and VIEWS

Surgery in the University of Otago: Prof. M. Woodruff

Mr. Michael Woodruff, senior lecturer in surgery in the University of Aberdeen, has been appointed Ralph Barnett professor of surgery in the University of Otago, New Zealand. Mr. Woodruff, who is the elder son of Prof. H. A. Woodruff, formerly professor of bacteriology in the University of Melbourne, was born in Britain but educated in Australia, where he graduated at Melbourne in both electrical engineering and medicine. During the Second World War he served in Malaya with the 10th Australian General Hospital, his experimental work on deficiency diets during the captivity at Changi Camp having been the subject of a recent publication by the Medical Research Council. In 1946 Mr. Woodruff was appointed tutor in surgery and lecturer in surgery to dental students at the University of Sheffield, but went to his present post in Aberdeen two years later. He will take up duty in Dunedin early in 1953.

European Cortina-Ulisse Prize: Prof. E. H. F. Baldwin

The European Cortina-Ulisse Prize of a million lire (about £600) has been awarded to Prof. E. H. F. Baldwin, professor of biochemistry in University College, London, for his book "Dynamic Aspects of Biochemistry". This Prize is promoted by the cultural magazine *Ulisse* for the best publication, produced in Europe during the past five years and written in a European language, dealing with an assigned topic (not necessarily scientific). When the Prize was first instituted in 1949, the set subject was the popular exposition of physics or chemistry, and the winner was Prof. John Read, professor of chemistry in the University of St. Andrews. The topic for 1952 was that of biochemistry considered exclusively in its relation to the human organism and with special emphasis on its application to medicine.

International Laboratories in Latin America

A group of scientific workers recently met in Montevideo under the auspices of the Unesco Science Co-operation Office for Latin America in order to study the possibility of establishing international and regional laboratories in Latin America. The meeting stressed the importance of the special conditions existing in Latin America (geographical situation, flora, fauna, etc.) for research work of international interest, and there was complete agreement that such work could best be done by the common effort of the countries concerned through the medium of the Science Co-operation Office. It was decided that the most urgent need was to create a net-work of laboratories of marine biology. Secondly, a certain number of 'service laboratories' should be organized on a regional scale, in the first place by giving some laboratories now operating on a limited national scale the facilities for extending their services to the whole region; the laboratories so selected are to be those dealing with chemical analysis, conservation of microbiological type-cultures, X-ray analysis and scientific films. Finally, the meeting recommended that an Inter-American Institute for Cosmic Ray Research should be set up, with the task of establishing a net-work of cosmic-ray research stations at appropriate altitudes and latitudes, taking into account the stations already in existence; the Institute would have the responsibility of standardizing the equipment and co-ordinating and facilitating the research work in these stations. Those attending the meeting were: Profs. M. O. de Almeida (Brazil), V. Deulofeu (Argentina), I. Escobar (Bolivia), C. Estable (Uruguay), A. G. Domínguez (Argentina), J. Ibañez (Chile), C. Lattes (Brazil), M. S. Vallarta (Mexico), R. Tálice (Uruguay) and F. De Venanzi (Venezuela).

Science for Peace: Statement on the British Atom Bomb

The National Committee of Science for Peace, 49 Flower Lane, London, N.W.7, has issued the following statement: "The recent announcement that an atomic bomb has been made in Britain has been welcomed in some quarters as an illustration of British scientific and technical skill. As an organization of practising scientists, we feel that it serves rather to provide yet another instance of wasteful and dangerous misdirection of scientific effort. . . . To those who argue the priority of defence, we have an obligation, as students of the technical possibilities of modern warfare, to point to the fact that Britain is the most vulnerable of all the great powers to atomic attack. By permitting the installation of N.A.T.O. atomic bases in this country, successive governments have ensured that in the event of war Britain will become the target for a type of offensive to which we are satisfied there can be no practical defensive answer. . . . We call on our government to abandon the path of the atomic arms race. . . . The only practical defence of Britain to-day lies in a programme, to be undertaken by men who have the moral courage to dissociate themselves from indiscriminate massacre as a military policy, with a twofold aim: the use of scientific resources for the development of our own economy and the raising of world living standards, and the sincere and tireless pursuit of conciliation. This organization has never advocated the unilateral surrender of a legitimate defensive weapon. At the present time, the measure of agreement already reached between the powers is, in our opinion, adequate to enable international renunciation of atomic warfare to be achieved without delay, on a basis of reasonable compromise".

European Seismological Commission: Meeting in Stuttgart

During the week September 21–27 the first meetings of the European Seismological Commission, as constituted by the International Union of Geodesy and Geophysics at Brussels in 1951, took place in Stuttgart. The meetings were attended by representatives from twelve European countries, three being from Great Britain. Seismologists from Algeria and South Africa also attended. The main subjects discussed were the seismicity of the European continent, the structure of Europe, the thicknesses of the continental layers as determined by elastic waves set up by explosions, earthquakes and gravity anomalies, near earthquakes in Europe, the motion at the focus of an earthquake and the determination of the depth of focus, seismological observatory work in various European countries, seismogram interpretation including graphical methods, and wave theory. The meeting, the arrangements for which were in the hands of Prof. W. Hiller, was eminently successful, and it is intended to issue a report in due course.

Mathematical Research Institute of Oberwolfach

The Mathematical Research Institute of Oberwolfach (State of Baden), in the French Zone of Germany, has been functioning regularly since it was first opened in 1945 under its honorary director, Prof. W. Süss, of Freiburg (editor of the German Fiat reviews in mathematics), and a large number of informal conferences have been held there, the most recent being one at the end of September on algebra and number theory. All grades and ages, from newly graduated research students to professors of world renown, from inside and outside Germany, are represented in the visitors' book, and the atmosphere of stimulating homeliness, friendliness and freedom to which all testify is due to the quiet management and personalities of the hosts, Prof. and Mrs. Süss. The Institute is attached to the University of Freiburg and receives a small annual government grant for running expenses and equipment. It welcomes all working mathematicians (and their families, as far as space permits) and offers them, at a minimum charge to cover the cost of food, an excellent library, facilities and leisure for relaxation or work, in a comfortable modern country house which is the gift of the State of Baden. It is open all the year round; but, owing to the prohibitive cost of central heating, only a few rooms are in use during the winter. In summer-time, the typical Schwarzwald scenery makes it very attractive, and many of the meetings are held in the open. Proposals for future work are gladly received. Following a suggestion by Prof. Martin Eichler, of Münster, the ideas of Hecke and his school in the field of automorphic functions, algebraic functions and analytical number theory are to be discussed, probably during the second half of this month.

Museum of Leathercraft, London

Considering the great importance of leather in the past and its not inconsiderable value at the present time, it is strange that only recently has there been established a museum devoted to its study and its relation to the development of civilization. The Museum of Leathercraft has now been founded, and is housed in temporary quarters in the National Leathersellers College, Tower Bridge Road, London, S.E.1. Although the formation of a collection is its main purpose, the scope is much wider. Its aims have been set out in the following terms: "The establishment of as complete a historical record as possible of the preparation and use of leather, in all ages and in all countries, by the acquisition of actual examples and of documents, prints and books. The undertaking and encouragement of research into all historical aspects of the subject. The stimulation of research into the best ways of using leather, into possible new uses and into the production of new and special types of leather. The preservation and encouragement of high standards of craftsmanship and design". During the preparatory period, the Museum staged a comprehensive exhibition entitled "Leathercraft through the Ages", planned by Dr. C. H. Spiers and Mr. J. W. Waterer and shown at many provincial centres as well as in London.

Brotherton Collection of the University of Leeds: Annual Report for 1950–51

The sixteenth annual report of the Brotherton Collection Committee of the University of Leeds covers the session 1950–51 (pp. 9; University, 1951) and records the virtual completion of the cataloguing of those books in the English literature section which had not been incorporated in the new catalogue. A start has been made on cataloguing the Romany Collection. On June 30, 1951, the Brotherton Collection contained some 23,726 books, 15,927 pamphlets, 585 manuscripts, 4,106 deeds, 31,555 letters and 25 maps. The first main exhibition of the session consisted of books, manuscripts and other items from the Romany Collection presented earlier in the year by Mrs. McGrigor Phillips. The second exhibition, of English grammars and dictionaries, designed to illustrate their development from the seventeenth to the nineteenth centuries, drew upon the resources of the whole University library, and a third exhibition of books and other documents of 1851 was planned to illustrate the life, thought and literature of a century ago. Some thirty organized parties were included among the yearly total of more than a thousand visitors to the Collection, and the report includes some details of items presented during the year.

Breeding Biology of the Spotted Flycatcher

Using data on the breeding biology of the spotted flycatcher which he had obtained from observations carried out by different investigators at 548 nests, D. Summers-Smith has shown that the normal laying period for this bird in Britain extends from mid-May until the end of July, a small number of birds being double-brooded (*British Birds*, 45, No. 5, May 1952). The average clutch-size decreases from about 4·5 eggs at the end of May to less than 3 eggs by the end of July. A slightly, but significantly, higher average clutch-size occurs in north England and Scotland than in the rest of England and Wales throughout the breeding season. It is probable that the spotted flycatcher can only successfully rear a brood of five young in Britain when the conditions are very favourable. Summers-Smith also reports that no significant variation in nesting success with season has been detected. The average incubation period is 13·2 days and the nestling period 13·4 days.

An Alternative to Regular Clear-Felling in Forestry

Up to the outbreak of the First World War, at which period the bulk of the woods in Great Britain were on private estates, the general forestry method in force was clear-felling and replanting chiefly with conifers. The true practice of sylviculture and correct forest management, as found in Western Europe and enforced by trained British forest officers in India and a few other parts of the British Empire, was at that time little understood in Britain beyond clear-felling and planting and coppice woods. In a recent issue of *Scottish Forestry* (6, No. 1; 1952), the journal of the Scottish Forestry Society, an article appears entitled "The Alternative to Extensive Regular Clear-Felling", by M. J. Penistan, which shows a considerable departure in practice on a large estate in the south of Scotland. On this estate the management recently decided to limit very extensively the existing policy of clear-felling and replanting, especially in the old hardwood areas. As a result of this decision, an interesting situation arose both from the point of view of instructing the forestry staff and securing enough timber to maintain the estate sawmills—a position which has often faced the trained forest officer overseas in the past over far larger areas than the 650 acres maintained by Mr. Penistan. The difficulties in the management were the outcome of the fellings of the two World Wars. The new treatment is described as mixed forestry, and four so-called new rules are drawn up on sound premises for the existing conditions of the crops: to obtain on every acre a continuous yield of the largest volume of timber; to cut only such timber as is ripe and suitable for conversion; to get rid of all uneconomic growth at an early stage in life and to introduce trees of high quality by natural seed or planting; and to secure conditions for adequate recruitment of timber, that is, enough from which to select fine poles to grow to timber. For a private estate the proposed management is a great departure in forestry practice in Great Britain. Mr. Penistan says that his article, showing how this is to be carried out, has been compiled from the notes made after discussions of the necessary steps to be taken. It is a pity that these notes are not reproduced in a rather more lucid form. To the forester who has been in charge of forest areas managed on professional technical lines they will be understandable; but it may be suggested that some rearrangement would appear to be advisable for those who, though they have not had this experience, may wish to follow Mr. Penistan's admirable departure.

Leicester Museum and Art Gallery: New *Bulletin*

Leicester Museum and Art Gallery is to be congratulated on the issue of the first number of a *Bulletin*. It is envisaged that each number shall be a coherent whole, and that all articles shall be linked by some common and fundamental idea. The present theme is "Origin", and the second will be "Growth". Regular publication is not promised; but future issues will appear as the necessary material is forthcoming. Following a general editorial article, several examples of origin are discussed. These are arranged in order of their natural development, the earth, the animal, the artefact, recorded knowledge, and art. The first paper thus describes igneous intrusions in the county of Leicester and is followed by a description of the pentadactyl limb and the changes it has undergone in mammalian evolution. An archæologist then stresses, with illustrative examples, the importance of origin; knowledge is represented by a paper on the early history of the Town Library, and art by a discussion of a drawing of two horsemen by Sir James Steuart.

Reporting Research in Education

In the second pamphlet published by the University of Manchester School of Education (Manchester Univ. Press. Pp. vii+24. 3*s*. 6*d*. net), Stephen Wiseman has provided some useful information for research students who are preparing their material for publication. The first part of the pamphlet deals with the preparation of a thesis submitted for higher degrees in education and includes useful sections on the length and form of the thesis, the general pattern, outline of the research, statement of the problem, review of the pertinent literature, descriptions of the design of the experiment, description of the techniques, statement of the results, interpretation and discussion of the results, how to summarize the conclusions and the setting out of the bibliography. In the second part of the booklet Wiseman examines how a paper should be prepared for publication and deals with such topics as preliminary planning, the form of typescript to be used, the use of tables and diagrams, the question of proofs, the taking of off-prints and typography. The whole pamphlet is well written and would be of value not only to research students in education but also to those who have investigations to report in any academic study.

Petroleum Films Bureau

The Petroleum Films Bureau has recently published its 1952 list of 35-mm. and 16-mm. documentary and instructional films. It contains certain features not found in the previous 1951 list, and included among the new films are "Oil for the 20th Century", "The Persian Oil Dispute", "Grangemouth Project", "Air Parade", "Highlights of Farnborough, 1951", "Model Flight", "Festival Log Book", "XXIst Monte-Carlo Rally 1951", "An Introduction to the Heat Engine", "Machining of Metals", "The Gas Turbine goes to Sea", "Weed Control", and also some additions to the film magazine series. All 16-mm. films are printed on 'non-flam' stock; the 35-mm. films are on 'flam' stock. As previously, films are available free of charge (return postage to be paid) to educational institutions, societies, clubs and the like, and application should be made to the Bureau at 29 New Bond Street, London, W.1.

Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: E. G. Harmer (senior produce officer, Department of Marketing and Exports, Nigeria), principal produce officer, Department of Marketing and Exports, Nigeria; F. A. Squire (entomologist, Sierra Leone), director of tsetse control, Gold Coast; R. M. Arnold (veterinary investigation officer, Jamaica), deputy director (livestock), Jamaica; K. D. S. Macowan (senior veterinary officer, Kenya), deputy director of veterinary services, Kenya; E. P. Rice (senior veterinary officer, Kenya), assistant director of veterinary services, Kenya; J. G. Ross (veterinary officer, Cyprus), veterinary officer, Uganda; Dr. F. D. Ommanney (principal scientific officer, East African Marine Fisheries), director of the Regional Marine Fisheries Research Station, Singapore; D. R. Brewin and B. R. Tarr, agricultural officers, Tanganyika; E. L. Drake, entomologist, Nyasaland; A. D. S. Duff, plant pathologist, Kenya; L. J. Hart, agricultural chemist, Tanganyika; R. J. Harvie, agricultural officer, Uganda; W. Hirst, botanist (plant pathologist), Uganda; O. T. Roberts and R. A. Sands, agricultural officers, Kenya; A. L. Wharton, plant pathologist, West African Cocoa Research Institute, Gold Coast; A. J. Radford, government chemist, Mauritius; B. Douglas, assistant conservator of forests, Northern Rhodesia; J. A. Seymour, geologist, Somaliland Protectorate; W. Hardie, veterinary officer, Fiji; B. M. Brown, meteorologist, Nigeria; L. J. Dyke, field officer (research), Mineral Resources, Uganda; F. C. F. Wickery, technical assistant, Mineral Resources (Research) Committee, Uganda.

Announcements

Prof. P. A. M. Dirac, Lucasian professor of mathematics in the University of Cambridge, has been awarded the Planck Medal for 1952. This Medal is awarded annually by the Association of German Physics Institutes for special accomplishments in theoretical physics which have a connexion with Planck's work. The Medal was founded some twenty years ago and the first recipient was Planck himself. The award is announced to the recipient each year on Planck's birthday, April 23, and the presentation is made at the autumn meeting of the Association of German Physics Institutes.

A dinner to mark the centenary of Sir William Ramsay (see *Nature*, October 4, p. 554) will be held at University College, London, on October 15. The guest of honour will be H.R.H. The Duke of Edinburgh.

An exhibition illustrating the work on logic of W. Stanley Jevons has been arranged in the Christie Library of the University of Manchester, and will be open during October 15–31. It includes Jevons's original logical machine, loaned by the History of Science Museum, Oxford, and more modern machines.

The Committee of Privy Council for Agricultural Research and Nature Conservation has re-appointed Prof. G. R. Cameron, Sir James Turner and Sir James Scott Watson to membership of the Agricultural Research Council for a further term. The Committee has also appointed, after consultation with the President of the Royal Society, Prof. E. J. Maskell, Mason professor of botany in the University of Birmingham, Prof. P. B. Medawar, Jodrell professor of zoology and comparative anatomy in the University of London, Prof. L. P. Pugh, professor of veterinary medicine in the University of Cambridge, and Prof. J. S. Young, professor of pathology in the University of Aberdeen, to fill the vacancies caused by the death of Prof. F. T. Brooks and the retirement from the Council of Prof. A. C. Chibnall, Sir Thomas Dalling, Sir Alan Drury and Dr. Joseph F. Duncan.

The Manson Lectures for 1952 of the Royal Institute of Philosophy, on the general topic, "Mind and its Place in Nature", will be given at University Hall, 14 Gordon Square, London, W.C.1, on Fridays, at 5.30 p.m., beginning October 17. The speakers will be Prof. J. Z. Young, Dr. C. G. Phillips, Dr. Macdonald Critchley, Dr. O. L. Zangwill, Prof. A. W. P. Wolters and Dr. A. C. Ewing.

The Printing, Packaging and Allied Trades Research Association is holding a conference and exhibition at the Jackson Hall, Westgate Street, Cardiff, on October 27, at which there will be two sessions, on "Research and the Printer" and a "Brains Trust", respectively. The whole programme will be repeated at the Grand Hotel, Bristol, on October 29, where in addition there will be a technical discussion on October 30 and a further viewing of the exhibition. Further information can be obtained from the Association at Patra House, Randalls Road, Leatherhead, Surrey.

ROYAL PHOTOGRAPHIC SOCIETY'S EXHIBITION

THE ninety-seventh annual exhibition of the Royal Photographic Society was opened in London on September 12 for one month and will also be shown in the City Art Gallery of Leeds during October 25–November 23 and in the Art Gallery of Bristol during December 6–31. The exhibition is divided into seven sections: pictorial, scientific, medical, nature, stereoscopic, record and kinematic photography, with a total of 849 exhibits.

Within the Scientific Section, exhibits confined to photographic applications of physics and chemistry are small in number, though not in quality, while entries of biological interest are reasonably well represented. The Aerodynamics Division of the National Physical Laboratory is showing three prints consisting of *Schlieren* patterns of the air disturbances emanating from aerofoils mounted in an air current of Mach number 1·6. Two of these prints are in colour and show the various regions of compression and rarefaction by making use of the familiar technique which employs polarized light for the exposure. P. H. Harris shows an electron micrograph of a sheet of etched aluminium foil in which the etching had eaten away the metal, apparently by boring it out in the form of minute tunnels. A. V. C. Cross is exhibiting a series of photomicrographs in which are shown the gradual erosion of a film of rosin naphtha varnish by sea water. A number of aerial survey photographs by Hunting Aerosurveys, Ltd., principally concerned with the site for a dam in Iraq, are of considerable geological interest. In addition, an aerial photograph of the ruined Palace of Persian Kings of Persepolis gives a strong impression of the beauty and splendour that such a building must have possessed in ages past. One of the biological exhibits by H. J. Howard consists of a series of four photomicrographs of progressively increasing magnification from × 10 to × 350 of the apparently simple bird's feather. First the shafts of the feather, then the barbs and finally the barbules are progressively brought into prominence, the fibres of the last interlocking almost at right angles to produce an intricate and effective protection. The selective absorption of silver on the gills of a freshwater crab is shown in an exhibit by S. F. Bush, yet the particulars of what is clearly a process of considerable interest to the chemist are left unexplained. A good example of phase-contrast microscopy by B. A. Jarrett consists of the micro-organism *Stentor roeselii*, in which it can be seen how movements of the cilia enable the cell to swim. An excellent series of colour transparencies by G. H. McLean shows the effects of five different diseases on the leaves of the sugar-beet plant.

In the Medical Section, many of the exhibits hold more than a morbid interest to the lay spectator, because they adequately describe some cycle or technique rather than illustrate some more-or-less distasteful specimen under an obscure Latin title. For example, a virus culture technique shown by the Institute of Ophthalmology, London, is most clearly demonstrated in a series of pictures in which, starting with an eleven-day old fertile incubated egg, part of the shell has been cut away and the egg inoculated. Incubation was continued for about three days, after which the membrane was covered with virus lesions. Perhaps one of the most noteworthy exhibits is from the Hospital for Sick Children, Great Ormond Street, London, in which photographs of a patient taken as a boy and also as a man forty-seven years later show what was probably the first successful surgical removal of a brain tumour with survival over this period. From the same hospital there is also shown, in another exhibit, the system employed for the identification and recording of the particulars of each patient. The technique employed in testing such antibiotics as aureomycin, chloromycetin, penicillin, streptomycin and terramycin is shown by S. E. Veronique. Small paper disks impregnated with the antibiotic are placed on the surface of agar upon which *Staphylococcus* is seeded, and the clear area around the paper disks in which growth of the organism is inhibited is a measure of the effectiveness of the antibiotic. The Manchester Royal Infirmary is showing how enlargement of a radiograph can prove to be worth while, and illustrates this with × 10 enlargements of pathological bone specimens originally exposed on ordinary commercial fine-grain film. Further exhibits by the Institute of Ophthalmology demonstrate techniques and apparatus for retinography and keratography together with colour prints of the human retina. A series of mounts from Guy's Hospital, London, are interesting in that they record limiting movements of the hand, foot or eye either by taking more than one exposure on the same negative or else registering the pictures showing extremes of movement and making tracings from the separate pictures. Photographs of some of the appliances which come to the aid of a hand deprived of normal movement are also shown by K. G. Moreman.

There are numerous excellent exhibits in the Nature and Record Sections of the Exhibition which make it difficult to review with justice; but perhaps the entries on the life-histories of marsh fritillary, gipsy moth, vapourer moth and emperor moth by S. Beaufoy and J. D. C. Boyes deserve special mention.

MODERN METHODS IN THE TREATMENT OF TUBERCULOSIS

THE figures for tuberculosis mortality (England and Wales) since the end of the Second World War show a marked decline. In 1946 the deaths from respiratory tuberculosis were 19,365; in 1950 they were 14,079. In 1946 the deaths from other forms of tuberculosis (bone and joint disease, meningitis, glandular disease) were 3,485; in 1950 they were 1,890.

The mortality from tuberculosis in England and Wales, moreover (with the exception of temporary set-backs during two World Wars), has been steadily declining since 1912, when the national scheme for combating tuberculosis, now merged in the National Health Service, was established. Even allowing for the potential influence of a hypothetical epidemiological cycle, it is not unreasonable to assume that increased knowledge and wisely directed administration have contributed to this decline.

There are certain methods of prevention, diagnosis and treatment which are powerful allies in the anti-tuberculosis campaign. These are as follows.

(1) *Research.* There is close association of research work in tuberculosis with practical application by clinicians. Important work in this field is done by tuberculosis committees of the Medical Research Council, the Ministry of Health, the Prophit Trust of the Royal College of Physicians, the Papworth Research Institute, the Tuberculosis Association and other research bodies. Studies are being made on immunization with B.C.G.

(2) *Pasteurisation of milk.* It is estimated that 30 per cent of non-pulmonary tuberculosis is due to infection by bovine strains of the tubercle bacillus, almost always conveyed by milk. In England some 80 per cent of liquid milk is heat-treated, and if only the remaining 20 per cent were so treated a further large reduction in these deaths might well follow.

(3) *X-rays.* In the past twenty years the improvement in X-ray technique has helped the diagnosis of pulmonary tuberculosis and the control of collapse therapy. The value of tomography was established by the work of McDougall and Turning in Great Britain. Lastly came mass radiography, which has developed much of late years for the diagnosis of the early case of pulmonary tuberculosis.

(4) *Surgical treatment.* The extended use of artificial pneumothorax from 1920 onwards marked a great advance. It may be associated, however, with certain severe complications, such as air embolism, spontaneous pneumothorax, empyema and bronchopleural fistula. Difficulties also arise in the termination of an artificial pneumothorax, for the lung will not always re-expand. The type of case, a limited lesion, which did well with this treatment is often treated by chemotherapy to-day. Artificial pneumothorax is still of value in appropriate cases, although some practitioners, especially in Holland, have abandoned it in favour of other surgical measures. Pneumoperitoneum is still employed, both as a useful accessory to chemotherapy and as a temporary procedure to prepare a patient for operation; but phrenic crush, which partly paralyses the diaphragm, often permanently limits respiratory function and is seldom advised. R. Laird is of opinion that thoracoplasty (usually done in two stages) has still a definite place in the treatment of pulmonary tuberculosis. In the six years 1944–50, of 580 patients treated in this way there was a mortality-rate of less than 1 per cent per operation, and 72 per cent of these patients were sputum-negative during the two months before their discharge. Various extrapleural and extrafascial operations may be grouped with thoracoplasties. A one-stage operation followed by no deformity is attractive, but the fate of the dead space and its plastic packing has yet to be determined. Cavity drainage is not often done in Great Britain. Excision of diseased lung formerly had a high mortality from the risk of spread of tuberculous infection. Improvement in operative technique and the use of antibiotics, notably streptomycin, have made pneumonectomy, lobectomy, segmental resection and wedge excision safer and of benefit to many patients unsuitable for collapse therapy. In Laird's series, resection of lung gave a sputum-conversion rate of more than 90 per cent, and the mortality among 132 patients so treated was 4·5 per cent. Despite the increased risk, excision in the United States has largely replaced thoracoplasty, and it is an operation which has now a definite place in treatment.

(5) *Chemotherapy.* The clinical application of antibiotics, streptomycin and *p*-aminosalicylic acid is being actively pursued with encouraging results. Many patients with pulmonary tuberculosis are initially thus treated at home, and, consequently, a higher proportion of those admitted to sanatoria for active treatment have become sputum-negative. This favourably influences medical and surgical treatment alike in sanatoria.

Prevention and treatment must go hand-in-hand in the attack on tuberculosis. As infected cases in the community become fewer, so will the prevalence and mortality of the disease further decline. The new methods of treatment here discussed are highly encouraging; but the older and simpler methods of prevention, notification, contact examination, environmental hygiene and good nutrition must be associated with them. ARTHUR MACNALTY

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CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1951

THE thirty-eighth annual report of the Carnegie United Kingdom Trust, covering the year 1951*, refers to the impeding of the village-hall building programme by the general restrictions on capital expenditure: work proceeded on twenty-one schemes throughout Great Britain, and grant instalments amounting to £11,679 were paid; a sum of £30,000 remains available for schemes approved before the end of 1947 but still awaiting a starting date.

Sums of £15,000 were allocated to the Family Welfare Association and to Family Service Units for the quinquennium. The former is conducting an experiment in the approach to personnel problems from the point of view of community relationships and also another experiment involving the employment of a specially trained worker to deal with problem families as part of the case-load at one of the Association's centres. The Family Service Units undertake practical work in the homes of problem families and, as a corollary, practical research in close association with the field-work of the separate units now established in some of the larger cities. A grant of £6,000 to Stanley House, a community centre in Liverpool for coloured people and their friends, is for a development plan involving structural alterations and provision of additional facilities to make the centre a house of friendship for everyone, irrespective of colour, class or creed. The Joint Committee on Museums Policy is surveying several provincial museums which have been selected as potential centres for installing experimental demonstration galleries embodying the most modern ideas of the technique of presentation.

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* Carnegie United Kingdom Trust. Thirty-eighth Annual Report, 1951. Pp. viii+48. (From the Trust, Dunfermline, Fife, 1952.)

The trustees are defraying the cost of twelve small experimental alphabet-into-braille machines, which are to be given an exhaustive trial by the two National Institutes for the Blind and Deaf, and a grant of £2,000 over five years on a diminishing scale has been promised to the newly formed Scottish Institute of Adult Education; also, on certain conditions, £5,000 to the British Association for the Advancement of Science for the adaptation of Down House as a residential centre for scientific work and courses in natural science. The survey of agencies and activities concerned with juvenile delinquency was concluded during the year, and the report is being drafted; Miss E. L. Younghusband's supplementary report on the employment and training of social workers, published in September 1951 under the title "Social Work in Britain", had a very favourable reception. The bulk of the report is devoted to a review of the trustees' policy in regard to music and drama, a field from which they have withdrawn now that it is a statutory responsibility of local education authorities.

ENERGY IN THE SERVICE OF MAN

It is not yet too late to be worth while directing attention to the series of papers presented in Paris last year under the auspices of the United Nations Educational, Scientific and Cultural Organization (Unesco, 19 Avenue Kléber, Paris 16^e). One such theme for discussion is to be proposed annually. The first was "Food and People"; now we have "Energy in the Service of Man", which covers an equally wide field. There is some duplication in the six papers; but this is not very important, as the subject is treated from widely different points of view, the authors being free to express their own opinions.

Sir Alfred Egerton, of the Imperial College of Science and Technology, London, discusses "Civilization and the Use of Energy". This long paper considers energy as a determining factor in the growth of civilization, emphasizing the tremendous effect of the new discoveries in the era following the Renaissance. The extent to which available energy resources are at present utilized is also discussed. There are tables and charts provided, but this very general historical approach does not make easy reading. It provides a background against which the ideas in the other papers can be more usefully assimilated.

Dr. L. C. McCabe, of the U.S. Bureau of Mines, in "World Sources and Consumption of Energy", considers the different forms of energy reserves—those such as coal, oil and nuclear fuels, which will ultimately be consumed, and others like water-power, tides, wind and solar radiation, which are continually renewed. He believes that, even with the present rate of technological advance and ever-increasing energy consumption, the world's annual energy requirements in the year 2000 are not likely to exceed 1 per cent of even the known mineral reserves. There are numerous tables giving precise data.

Dr. G. Eichelberg, of the Federal Polytechnic, Zurich, presents a very thought-provoking paper on the "Utilization of Energy". He emphasizes that solar radiation is the ultimate source of all our energy; the greater part of that which we use is stored as chemical energy, which must be converted to mechanical energy by combustion in a heat-engine plant. Dr. Eichelberg discusses the fundamental thermodynamic relationships and traces the thermodynamic evolution of the steam engine, the steam turbine, the internal-combustion reciprocating engine and finally the internal-combustion turbine. His remark that "for the great air-liners jet-propulsion is therefore scarcely a practical proposition", because of its low fuel-efficiency, is already out-dated. He ends with a mention of the theoretical merits of binary-vapour systems, both with independent and combined circuits, and advocates a more intensive research in the field of solution thermodynamics. There are some revealing statements as to the efficiency of domestic heating and the possibility of greatly improved efficiencies by coupling to industrial plant or the use of heat pumps.

Prof. P. Ailleret, of the National School of Roads and Bridges, discusses "Energy in its International Aspects". Since the geographical distribution of natural sources of energy bears practically no relation to the distribution of human needs, great international exchanges of energy are desirable. He gives very interesting maps which demonstrate world movements of fuel, continental electricity grids and oil and natural gas lines. He gives facts to show the scale on which energy exchanges exist at present. He shows that a continental area is usually adequate to form an economic grid—little gain would accrue from intercontinental linkage. Prof. Ailleret discusses the convenience of different forms of energy from the point of view of transport; the ease of transport of oil and gas and the difficulty of transporting electricity economically over great distances are remarkable. He also considers energy storage: it is, of course, cheaper to carry alumina to the electrical generating station and then transport back the aluminium produced from it than to transmit the electrical power to the mineral source. The aluminium metal, having a higher 'potential' energy content than the alumina, represents a form of energy storage. This paper is full of interesting ideas: it is not so much the facts that are new as the way in which they are presented and their interrelation shown.

Prof. M. S. Thacker, of the Indian Institute of Science, Bangalore, treats "The Role of Energy in the Under-developed Areas". This is also a long paper, and the typographical arrangement is different from that of the remaining contributions. It does not make easy reading, largely because of the author's elaborate prose style. He discusses the comparative development of the countries of the world and the distribution of resources among them, considering the factors responsible for the backwardness of various countries. Finally, he outlines a programme of development, including technical and material assistance. He supports his arguments with many tables and much statistical data.

Prof. F. E. Simon, of the Clarendon Laboratory, Oxford, considers "Energy in the Future". Like Prof. Ailleret's paper, this is a challenging and readable document, which ought to provoke much thought and discussion. This is exactly what was intended of the series. The exposition is masterly in its lucid and scholarly approach, while retaining and exploiting the inherent interest of its theme. After dividing energy into its two main categories of 'free' or ordered energy and 'heat' or disordered energy, Prof. Simon recalls the limitations and difficulties inherent in converting the latter into the former, as determined by the second law of thermodynamics. This leads to a consideration of the heat pump as an alternative use of the refrigeration cycle. He then discusses the present efficiency of energy utilization in domestic heating and in industry: there are some striking and unpalatable truths revealed here—it is a pity that more of those recently engaged in controversy on these topics had not read Prof. Simon's paper. The next section surveys available power sources: the wind, earth and ocean heat, the tides and water-power. A carefully reasoned account is then given of the prospects of obtaining significant quantities of energy from nuclear sources and from solar radiation: the conclusion is reached that, from a 'peaceful' point of view, the prospects of the latter are fully as great as those of the former, and that an equivalent amount of research ought rightfully to be expended upon it. It is a sobering thought to consider what the ratio actually must be. Finally, Prof. Simon summarizes his views on the prospects for the near and distant future.

Each of the papers has a bibliography attached, and a more extensive English bibliography, prepared by the Department of Scientific and Industrial Research, is included as a final contribution. It will be seen that the papers presented vary from the very general to the rather detailed; but the most successful are those which strike a mean between these extremes. It would be valuable if they could be made available in more permanent form at a reasonable price.

R. H. MACMILLAN

PHYSICS IN THE UNITED STATES

ANNUAL MEETINGS OF THE AMERICAN PHYSICAL SOCIETY AND OF THE AMERICAN ASSOCIATION OF PHYSICS TEACHERS

THE annual meeting for 1952 of the American Physical Society was held at Columbia University, New York City, during January 31–February 2. The attendance reached the unprecedented figure of 2,215, and approximately three hundred papers were contributed. The twenty-first annual meeting of the American Association of Physics Teachers took place simultaneously at Barnard College. At the joint ceremonial session of the two bodies held in the afternoon of February 1, the retiring presidential address of the Society was delivered by Dr. C. C. Lauritsen, of the California Institute of Technology, who took as his subject "Some Investigations of Light Nuclei"; the Oersted Medal of the Association was presented to Prof. A. A. Knowlton, who responded by commenting on opportunities and rewards in physics teaching[1]; and the tenth Richtmyer Memorial Lecture was delivered by Prof. E. Fermi, who spoke on "Large-Cyclotron Research at the University of Chicago".

At the joint banquet in the evening the after-dinner speakers were Dr. O. E. Buckley, chairman of the board of the Bell Telephone Laboratories and of the Science Advisory Committee of the Office of Defense Mobilization, who described the relationship of the Advisory Committee with the government departments which it is designed to serve, and Prof. R. E. Peierls, of the University of Birmingham, who spoke about the status of physicists in Great Britain.

At the business meeting of the American Physical Society the following were elected to hold office for 1952: *President*, J. H. Van Vleck; *Vice-President*, E. Fermi; *Secretary*, K. K. Darrow; *Treasurer*, G. B. Pegram. The main business before the meeting was to consider urgently the extremely grave financial position of the Society. The treasurer reported that the surplus had been eaten away to such an extent that within a few months the Society would find it impossible to meet its commitments. This was due to the almost explosive expansion of the *Physical Review*, which again increased in 1951 by a thousand pages to a total of five thousand. The Council agreed to attack the problem not by limiting the size of the *Review* and thus excluding many worthy papers, but by increasing subscriptions, etc. The by-laws have been amended so that increased subscriptions may be obtained from members and fellows of the Society; at a recent meeting of the Council these have been fixed for 1953 at 20 and 30 dollars, respectively. The non-member subscription and the page charge for papers and letters in the *Review* have also been increased. An extra charge has been imposed on members who wish to subscribe to *Physics Abstracts*, and a registration fee for meetings has been imposed. The National Science Foundation has agreed to make a generous grant, and this will help to defray the deficits which the *Review* has incurred during 1951 and is bound to incur this year and next.

Twenty-seven invited papers were contributed at the scientific sessions held during the meeting of the American Physical Society. These included a special symposium of the Division of Electron Physics at which M. A. Biondi, P. Kusch and S. A. Korff spoke, respectively, on ionization and recombination processes in the afterglow, the magnetic moment of the electron, and recent developments in the physics of counters. In another session on electron physics, reports were given of the conference on gaseous electronics, held during October 1951, and of the National Bureau of Standards symposium on electron physics, held during November 1951. In the Division of Fluid Dynamics invited papers included one on flows in the vicinity of Mach No. 1 by a member of the Wright-Patterson Air Force Base. In nuclear physics there were contributions by K. T. Bainbridge and V. C. Weisskopf on nuclei, by members of Columbia University on pions, by J. H. Van Vleck on the significance of microwave spectroscopy for the theory of magnetism, and from Great Britain by R. E. Peierls and E. P. George, respectively, on non-local field theories and cosmic rays underground. Other branches of physics were also represented, with three papers on optical physics and others dealing with shock waves, high centrifugal fields and large molecules in biological systems. The complete list of papers, together with abstracts, is given in the minutes of the meeting[2].

The programme of the meeting of the Association of American Physics Teachers included a session of ten contributed papers and two invited addresses. A symposium of four papers by members of the Oak Ridge Institute of Nuclear Studies discussed various forms of nuclear reactors and accelerators. Another symposium was devoted to a discussion of methodology in the teaching of physics and included an address by J. B. Conant.

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[1] Published in full in *Amer. J. Phys.*, 20, 267 (1952).

[2] Published in *Phys. Rev.*, 86, 579 (1952).

ACTION OF CARBOXYPEPTIDASE ON TOBACCO MOSAIC VIRUS

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THE chemical composition of tobacco mosaic virus has been investigated in considerable detail[1,2]. As a logical expansion of these and other studies, it becomes necessary to investigate the structural characteristics of the nucleic acid and protein moieties of the virus.

Several methods[3-6] are available for the identification of N-terminal groups in peptide and protein molecules, but no generally satisfactory method has been developed for the elucidation of corresponding C-terminal groups. The use of carboxypeptidase for the identification of the C-terminal residue of glutathione was reported by Grassman *et al.*[7], and Lens[8] has attempted to use the enzyme to determine the nature of the C-terminal groups of insulin. Results obtained from a study of the digestion of adrenocorticotropic hormone (ACTH) protein and peptide preparations by carboxypeptidase[9] led one of us[10] to re-investigate the potentialities of this reaction as a general method for the identification of C-terminal groups in polypeptide molecules. In this way the C-terminal groups of insulin, of fractions *A* and *B* derived from oxidized insulin, and of lysozyme were identified[10]; similar results for insulin have been reported by Sanger and Thompson[11], and for lysozyme by Thompson[12]. In the present investigation it has been found that threonine specifically is released by the action of carboxypeptidase on tobacco mosaic virus.

In preliminary experiments, an aqueous solution of a highly purified preparation of tobacco mosaic virus (containing 1·5 mgm. N/ml.) was incubated with carboxypeptidase (0·0028 mgm. enzyme N/ml.) at *p*H 7·0 and 25° for three hours. Enzyme action was terminated by spinning down the virus in the Spinco Model L ultracentrifuge. The presence of 0·8–1·0 per cent of non-protein nitrogen in the supernatant solution suggested that some proteolysis had occurred, and chromatography on paper led to the identification of threonine as the only product of the reaction (Fig. 1,*A*). No further reaction was found to occur when the treated virus was isolated and incubated with higher concentrations of enzyme for 24 hours (Fig. 1,*B*), and no ninhydrin-reacting substances were detected when control supernatant solutions from virus and enzyme, respectively, were chromatographed under the same conditions.

After it had been established that threonine was the only significant product of the action of carboxypeptidase on the virus, experiments were designed to investigate the nature of the reaction and to estimate the amount of threonine liberated. In a typical experiment, an aqueous solution of the virus (containing 1·4 mgm. virus N/ml.) was incubated with carboxypeptidase (0·0028 mgm. enzyme N/ml.) at *p*H 7·0 and 25°. Aliquots of the resulting solution were withdrawn at suitable intervals during a three-hour digestion period, and enzyme action was stopped by addition of 0·1 *N* hydrochloric acid to *p*H 3. After removal of the virus by ultracentrifugation, supernatant solutions were collected and their threonine content estimated by microbiological assay[1] at different dilutions. As shown in Fig. 2, liberation of threonine was essentially complete after 90 minutes and amounted to 74 μgm. threonine/9 mgm. of virus; this corresponds to approximately 7 per cent of the threonine content of the virus. In its initial stages the liberation of threonine appears to be a zero-order reaction with a *K* value of 2·0 (± 0·4) × 10^{-3} mgm./min.

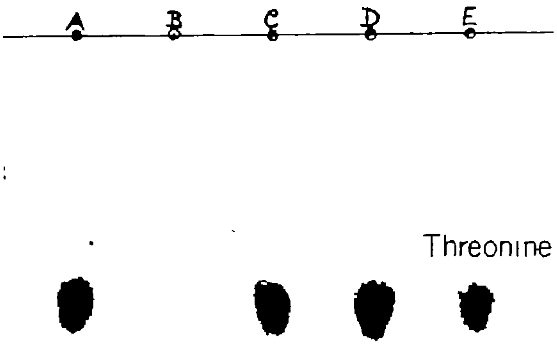

Fig. 1. Chromatography of supernatant solutions from carboxypeptidase-treated virus preparations (butanol/acetic acid/water, 4/1/5) *A*, tobacco mosaic virus-3; *B*, 'dethreoninized' tobacco mosaic virus-3, re-treated; *C*, control progeny; *D*, 'dethreoninized' progeny; *E*, threonine

The tobacco mosaic virus nucleoprotein appears to have a molecular weight of the order of 50,000,000[13]; on this basis it can be calculated that carboxypeptidase liberates more than 3,400 residues of threonine per mole of tobacco mosaic virus. The origin of this threonine is a matter of considerable interest. On the assumption that carboxypeptidase attacks only those peptide bonds adjacent to free α-COOH groups in polypeptide chains, it can be postulated that the protein moiety of the virus complex has more than 3,400 C-terminal threonine groups. As another possibility, one could envisage polythreonine components attached in some way to the virus molecule so that they are readily accessible for stepwise degradation by the enzyme. Several tobacco mosaic virus preparations, and a highly purified preparation of the Holmes's ribgrass (*HR*) strain, have

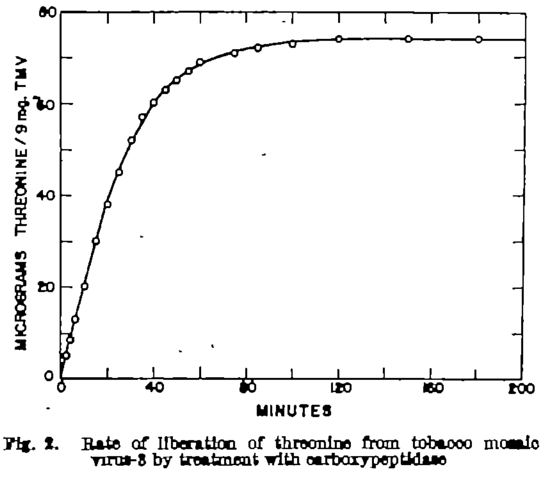

Fig. 2. Rate of liberation of threonine from tobacco mosaic virus-3 by treatment with carboxypeptidase

been found to yield similar amounts of threonine (see table) when treated with carboxypeptidase as described above. Other strains of tobacco mosaic virus and other viruses are currently under investigation. In this connexion, a preparation of tomato bushy stunt virus was examined and found to yield small quantities of several different amino-acids when treated with carboxypeptidase under conditions similar to those described for tobacco mosaic virus.

A tobacco mosaic virus preparation which had been treated with carboxypeptidase until liberation of its available threonine was complete was found to retain full virus infectivity when assayed by the half-leaf method. At the same virus concentrations, the control and 'dethreoninized' tobacco mosaic virus gave 21 and 20 lesions, respectively, as averages for twenty-nine half-leaves. In this respect, the virus resembles insulin and lysozyme, for it has been shown[14,15] that C-terminal alanine and C-terminal leucine, respectively, are apparently not essential for the biological activities of these proteins.

MAXIMUM YIELDS OF THREONINE OBTAINED FROM TOBACCO MOSAIC AND *HR* VIRUS PREPARATIONS BY REACTION WITH CARBOXYPEPTIDASE*

Virus preparations	μgm. Threonine per 10 mgm. virus
Tobacco mosaic virus-1	81
Tobacco mosaic virus-2	86
Tobacco mosaic virus-3†	82
Control tobacco mosaic virus progeny	93
'Dethreoninized' tobacco mosaic virus progeny	92
HR	88

* See text. † See Fig. 2.

It was of considerable interest to see whether the 'dethreoninized' virus represented a laboratory-produced mutant capable of reproduction in its modified form. To test this possibility, two sets of young, healthy tobacco plants were inoculated with high dilutions of 'dethreoninized' and control virus, respectively. The disease symptoms observed on the two sets of plants were indistinguishable, and, after sixteen days, highly purified preparations of virus were obtained from the plants in the usual manner. When these preparations were treated with carboxypeptidase, it was found that threonine was released from both samples (Fig. 1, *C* and *D*) and that it was released in equivalent amounts (see table). Thus it appears that about 7 per cent of the threonine of the virus can be removed without changing quantitatively or qualitatively the host–virus relationship.

This work is being extended and will be published in greater detail at a later date. We are grateful to Miss Theresa Litwin for the microbiological assay results and to Ning G. Pon for valuable technical assistance.

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ISOLATION OF PORPHOBILINOGEN FROM THE URINE OF A PATIENT WITH ACUTE PORPHYRIA

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THERE is, in the urine of patients suffering from acute porphyria, a substance which gives a red colour with Ehrlich aldehyde reagent. This compound, porphobilinogen, is, so far as is known, only present in the urine of such cases and has, hitherto, never been isolated in the pure state. It has been the subject of study by several workers (Waldenström and Vahlquist[1], Prunty[2], Brockman and Gray[3], and Herbert[4]) since it was originally discovered by Sachs[5]. Waldenström and Vahlquist[1] suggested from diffusion measurements made upon partially purified porphobilinogen that it might be a dipyrrylmethane. They produced evidence that it was convertible under suitable conditions into a 'uro-type' porphyrin and/or porphobilin, a red pigment with urobilinoid characteristics. The view that porphobilinogen is a precursor of uroporphyrin has been generally accepted; but recently Hawkinson and Watson[6] have disputed this. In their view, uroporphyrin arises from an Ehrlich-negative substance.

All investigations, so far, have been carried out on porphobilinogen 'concentrates' of varying degrees of purity. Isolation of the crystalline substance has now provided the opportunity of making a further study of its properties.

Preliminary experiments showed that porphobilinogen was retained on a column containing the cation-exchange resin 'Zeo-Karb 215' and could be displaced by dilute ammonia. Similarly, it was held on the anion-exchange resin 'Dowex 2' and could be recovered with dilute acetic acid or ammonium acetate. By utilizing these resins and also acetic acid-treated alumina (Prunty[2]), concentration has been greatly facilitated, but recoveries have been low—partly due to instability of the compound in solution at room temperature and partly to a considerable loss, by degradation, on the 'Zeo-Karb 215' column. It has been found that porphobilinogen can be completely precipitated from urine by mercuric acetate and recovered without loss by treatment with hydrogen sulphide. Such concentrates are readily freed from accompanying bases and ampholytes by anion-exchange resin and alumina columns.

In a typical preparation, crystalline porphobilinogen has been obtained from the urine of a patient (I. McL.) with acute porphyria (admitted to the Metabolic Ward of University College Hospital under Dr. C. E. Dent and Dr. E. A. Blake Pritchard). 20 l. were adjusted to *p*H 4·5 with glacial acetic acid and shaken with 400 gm. of talc to remove preformed porphyrin. After filtration, warm, saturated, mercuric acetate solution was added in slight excess. The precipitate was washed twice with 1 per cent w/v mercuric acetate. The mother liquor and washings gave no red colour with Ehrlich's reagent (20 gm. *p*-dimethylaminobenzaldehyde in 500 ml. of 36 per cent w/v hydrochloric acid and 500 ml. of water). The precipitate, suspended in 2 l. of water, was saturated with hydrogen sulphide. The filtrate and washings from the sulphide were aerated and an assay carried out which showed that the solution contained 53·5 units/ml. (Vahlquist[7]) of porphobilinogen. The solution was then passed through a system of columns containing the prepared anion-exchange resin 'Dowex 2'. This set was made up of three glass tubes of decreasing size connected in series with narrow glass tubing (Westall[8]). When all the solution had passed on to the columns, water (500 ml.) was applied, and this was followed by 0·1 *M* ammonium acetate at a rate not exceeding 200 ml./hr. Under these conditions, the coloured substances, which had been carried down with the mercuric acetate precipitation, were firmly held by the resin, while the effluent containing porphobilinogen was practically colourless. This was collected in 50-ml. fractions which were assayed (Fig. 1). The total recovery was 86,000 units (80 per cent). Paper chromatography of the main fractions revealed the presence, besides porphobilinogen, of two unknown substances, one giving a bright blue and the other a green fluorescence in ultra-violet light.

The richest fractions were combined, and the porphobilinogen was again precipitated with mercuric acetate. After removing mercuric sulphide and hydrogen sulphide as before, the solution (300 ml.) was applied to an alumina column previously treated with acetic acid (Prunty[9]) and washed with water. The column (diameter 3·5 cm.) contained 80 gm. of alumina (Savory and Moore, Ltd.). A narrow dark band of porphobilin remained at the top of the column, and just below this a yellow band (the green fluorescent substance) was observed. The substance which gave the blue fluorescence in ultra-violet light passed quickly through in the effluent, and by following the original solution with several applications of water this substance was completely eluted before porphobilinogen was detected in the effluent. 0·1 *N* ammonia was run on to the column, and porphobilinogen was eluted, contaminated only with ammonia and ammonium acetate. On adjusting the solution to *p*H 4 with acetic acid, the free base crystallized immediately. After standing overnight at 0° C., the crystals, which were faintly pink in colour, were filtered, washed thoroughly with water and dried over phosphorus pentoxide. The first crop yielded 210 mgm., and a further crop of 90 mgm. was obtained by rechromatographing the tail fractions which were contaminated by material from the yellow band. The final yield was approximately 40 per cent of that calculated to be present in the original urine.

Properties of porphobilinogen. The pinkish-white crystals (Fig. 2) darkened on heating to 120–130° C. and decomposed with evolution of gas at 175–180° C. Microanalysis gave the following—found: C, 52·75; H, 6·80; N, 12·08 per cent; $C_{10}H_{16}N_2O_4$ requires C, 52·64; H, 7·02; N, 12·28 per cent. Approximately one-half (6·5 per cent) of the total nitrogen was liberated as nitrogen by nitrous acid in the Van Slyke apparatus, and a similar amount (5·9 per cent) was obtained as free ammonia on distillation in phosphate buffer (*p*H 8·5) at 100° C. No ammonia was obtained, however, when the distillation was carried out at 40° C.

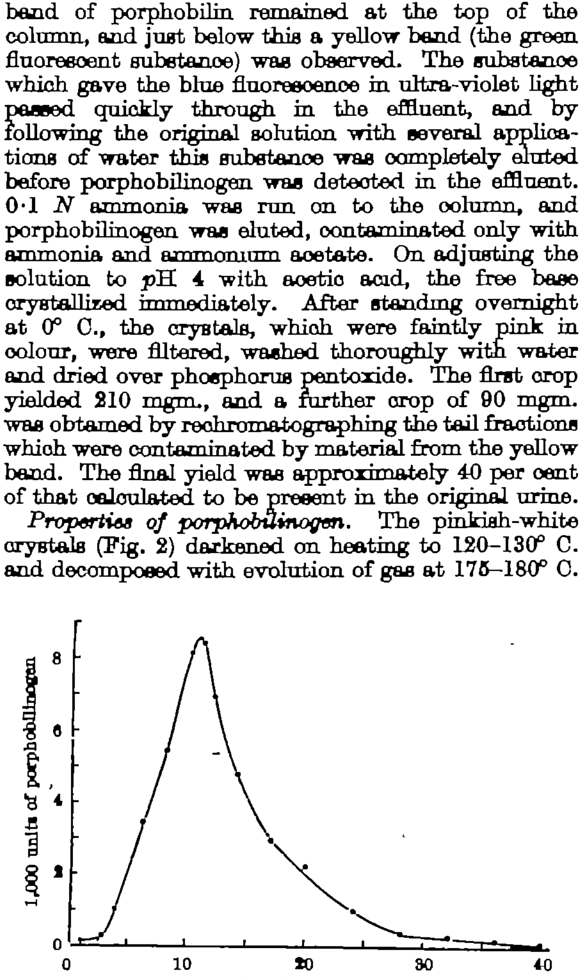

Fig. 1. Porphobilinogen content of fractions displaced from a column of 'Dowex 2' resin by 0·1 *M* ammonium acetate

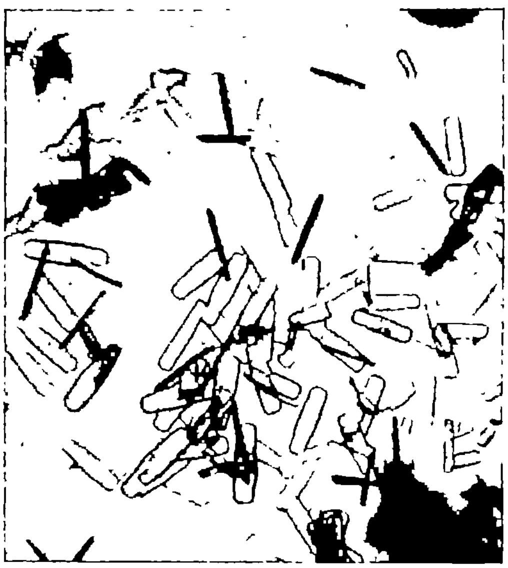

Fig. 2. Porphobilinogen crystals. × 480

Porphobilinogen crystals were almost insoluble in cold water and in the common organic solvents; they dissolved readily in dilute ammonia and could be recrystallized by bringing the solution to *p*H 4 with acetic acid. The use of sodium or potassium hydroxide instead of ammonia and subsequent neutralization with hydrochloric acid or acetic acid caused the solution to darken quite rapidly. Using Vahlquist's[7] technique and definition, the crystals were assayed at 130 units/mgm. On dry-heating a few crystals to 170° C. and dissolving the residue in dilute hydrochloric acid, the red fluorescence typical of porphyrins was observed under ultra-violet light, and paper-chromatographic analysis using lutidine (Nicholas and Rimington[8]) revealed a slow-moving spot due to 8-carboxyl porphyrin together with faster-moving weaker spots probably due to other partially decarboxylated porphyrins. Porphobilinogen formed a readily crystallizable hydrochloride which was soluble in water but less soluble in 2 *N* hydrochloric acid, m.p. 165–170° C. (decomp.).

Uroporphyrin formation from porphobilinogen. Solutions of porphobilinogen in inorganic buffers darkened on standing in the light at room temperature with the formation of a purplish-red pigment which, on reaching a critical solubility, formed a black deposit. This material gave the typical absorption band of porphobilin and a positive biuret but negative Ehrlich aldehyde test; there was no evidence of any trace of uroporphyrin. If, however, similar porphobilinogen solutions were boiled, with or without the presence of buffers at any *p*H between 1 and 8, a proportion of uroporphyrin was formed and was identified chromatographically as an 8-carboxyl porphyrin. Herbert[4] maintained that the maximum

TABLE 1. CONVERSION OF PORPHOBILINOGEN TO UROPORPHYRIN

Solutions containing 202 μgm. porphobilinogen heated for 20 min. at 100° C. (vol. 2 ml.)	Uro-porphyrin formed (μgm.)	Conversion (per cent)	Conversion allowing for loss of ammonia (per cent)
Sodium acetate buffer			
pH 4·2	27·3	13·5	14·8
0·05 *N* HCl	49·2	24·4	26·8
0·1 *N*	63·4	31·5	34·8
0·2 *N*	70·1	34·6	38·2
0·5 *N*	78·7	39·0	42·8
1·0 *N*	62·1	30·8	33·8
2·0 *N*	48·6	24·1	26·5
5·5 *N*	17·1	8·5	9·4

uroporphyrin yield was obtained by boiling porphobilinogen solutions in the presence of 0·05–0·2 *N* hydrochloric acid and that the presence of buffer salts led to lower yields. This view has been confirmed in the present work, except that it would appear that slightly greater strength of hydrochloric acid (0·3–0·5 *N*) is required for optimum conversion to uroporphyrin (Table 1).

In an early experiment, using a 'Dowex 2' resin for separating porphobilinogen, a number of serial fractions containing this substance were assayed for the colour given by Ehrlich's reagent and also for the uroporphyrin developed by boiling with acetate buffer at *p*H 4·2 for twenty minutes (the optimum conditions were then unknown). These results, which are presented graphically in Fig. 3, indicated that a constant ratio existed between the Ehrlich colour and the uroporphyrin yield throughout the fractionation. If some substance other than porphobilinogen was yielding uroporphyrin, some variation, however slight, of this ratio would have been expected.

Paper chromatography of porphobilinogen. Porphobilinogen can be detected on paper chromatograms (Consden, Gordon and Martin[10]) in amounts as small as 0·25 μgm. by spraying with Ehrlich's reagent. By this means it has been possible to assess the purity of the various fractions obtained during the isolation procedures. It is also possible to demonstrate the formation of uroporphyrin from porphobilinogen by heating the paper strips for fifteen minutes at 100° C. in a vessel containing acetic acid vapour and then viewing under ultra-violet light. This test, however, is not as sensitive as the Ehrlich reagent, and it is necessary to use 3–4 μgm. of porphobilinogen. A number of fractions containing porphobilinogen and also solutions of the pure substance have been run on duplicate paper strips using different solvent mixtures. After drying, one strip was sprayed with Ehrlich reagent, while the other was heated for uroporphyrin development. In all, six different solvent mixtures have been used, and in every case the position (R_F value) of the Ehrlich-reacting spot has coincided with the position of the uroporphyrin (Table 2).

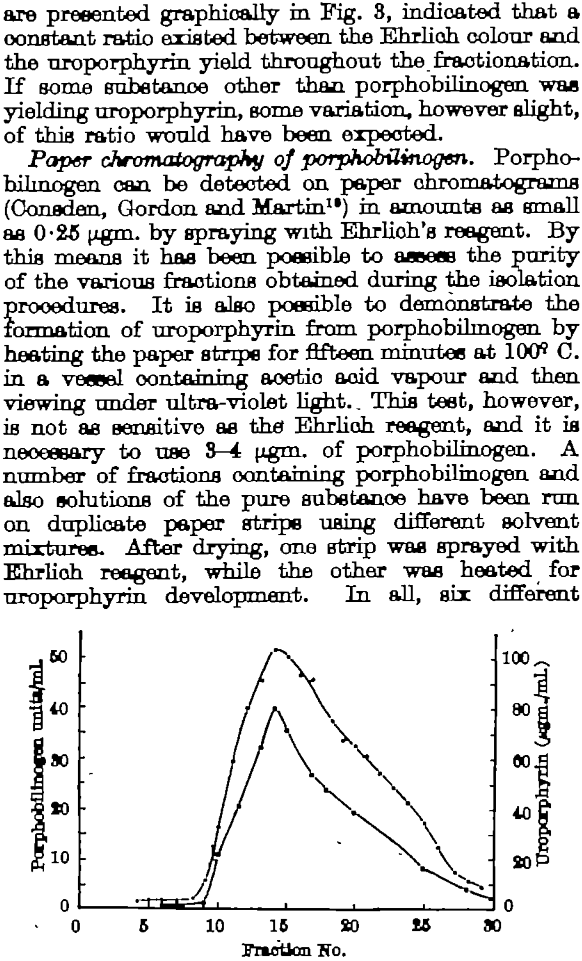

Fig. 3. Comparison of the Ehrlich colour reaction with the yield of uroporphyrin obtained on fractions containing porphobilinogen displaced from a column of 'Dowex 2' resin by 0·1 *N* hydrochloric acid. Upper curve, porphobilinogen; lower curve, uroporphyrin

TABLE 2. DEVELOPMENT OF PAPER CHROMATOGRAMS FOR PORPHOBILINOGEN (EHRLICH'S REAGENT) AND, AFTER HEATING, FOR PORPHYRIN (FLUORESCENCE)

Solvent mixture			R_F Ehrlich reagent	R_F Fluorescence (ultra-violet)
Phenol–ammonia			0·50	0·50
Collidine–lutidine			0·08	0·08
*Ethyl acetate Pyridine Water	50 ml. 22·5 ml. 50 ml.	top layer	0·17	0·17
*Propanol Ammonia (0·880) Water	60 ml. 30 ml. 10 ml.	miscible	0·38	0·38
Ethyl acetate Acetic acid Water	25 ml. 5 ml. 20 ml.	top layer	0·27	0·27
†Butanol Acetic acid Water	40 ml. 10 ml. 50 ml.	top layer	0·51	0·51

* Hanes and Isherwood[11]. † Partridge[12].

Discussion. While the results recorded above concerning the elementary composition of porphobilinogen, its basic properties, reaction with nitrous acid and its conversion to uroporphyrin, etc., when taken in conjunction with established facts concerning the biosynthesis of protoporphyrin, obviously suggest certain structural possibilities, it is felt that any present discussion of these would be premature. Porphobilinogen, the excretion of which represents the main apparent metabolic error of the acute porphyria patient, is not necessarily a normal step in the biosynthesis of uroporphyrin, and *in vitro* yields of uroporphyrin from it have not, so far, exceeded 40 per cent; moreover, some conversion also occurs, under the same conditions, to porphobilin, a pigment having urobilinoid rather than porphyrin characteristics.

A molecular weight cannot yet be assigned to porphobilinogen, so the question of its pyrrolic or dipyrrylmethane character must remain open. The substance is unstable, and experimental work with it presents many difficulties. The investigation is proceeding along both chemical and pharmacological lines in collaboration with Prof. C. Rimington and Dr. W. D. M. Paton, and a full account will be published in due course.

I wish to thank Prof. C. Rimington for advice and encouragement and for carrying out the Ehrlich and uroporphyrin assays. I am also indebted to Mr. J. Smiles and Mr. J. Harmer, of the Optical Department of the National Institute for Medical Research, for the photograph of crystalline porphobilinogen. The microanalyses were made by Mr. F. H. Oliver, of the Microanalytical Laboratory of the Organic Chemistry Department, Imperial College of Science and Technology, London.

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LETTERS TO THE EDITORS

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Motor End-Plate Differences as a Determining Factor in the Mode of Action of Neuro-Muscular Blocking Substances

In consequence of the results obtained with decamethonium in the cat[1,2] and in human beings[3], we felt justified in putting forward the thesis that decamethonium produced a neuromuscular block in mammals only through a persisting depolarization of the motor end-plate. But work undertaken with other mammalian species (monkeys, dogs, hares) during the past few months reveals that decamethonium can produce in these three a neuromuscular block which differs in many ways from the block produced by pure depolarization. Thus in these species the tetanus is poorly sustained, and antagonizes the block, which is also antagonized by anticholinesterases. The white muscles show an acute decreasing sensitivity to decamethonium, a second injection of a dose which at first produced almost complete paralysis failing to produce any effect. If one records simultaneously from a red muscle and a white one[4], a transition from a depolarizing type of block to a block by competitive inhibition is seen.

Succinylcholine, a pure depolarizing substance, when used on the cat, gave similar results to decamethonium on the monkey and the dog. These findings clearly indicate that decamethonium and succinylcholine can no longer be described as purely depolarizing substances in these species. What, then, are they ? Undoubtedly they are not just competitive inhibitors, because in the first place they produce features of a depolarizing substance, and in the second place the muscles of the species under consideration show an acute decreasing sensitivity to decamethonium and to succinylcholine. Such a result is never obtained from a competitive inhibitor like *d*-tubocurarine. The impression resulting from the study of these facts is that the picture obtained in the monkey and the dog is similar to that obtained in the cat when an injection of *d*-tubocurarine is interposed between the first and subsequent doses of decamethonium.

A tentative suggestion I should like to put forward is that there may be a dual mode of action of decamethonium and succinylcholine upon the muscles of these animals. It seems possible that, while the molecules at first adhere in the specific way necessary to produce a depolarization at the end-plate, their grip eventually changes, with the result that from depolarizing substances they become competitive inhibitors.

This idea is strengthened by two other observations. A higher member of the same series as decamethonium, tridecamethonium, produces in the cat a similar picture to that produced by decamethonium in the monkey and in the dog. This shows that if the polymethylene chain is lengthened, the molecule loses the specific property required to produce a neuromuscular block by pure depolarization even in the cat. The other observation relates to the action of these substances on avian muscle[5]. In birds, *d*-tubocurarine produces the usual paralysis, whereas decamethonium and succinylcholine produce a pure contracture characterized by extension of the limbs and retraction of the head[5]. If the dose is small, recovery is abrupt ; if large, the animal dies in contracture and never exhibits paralysis. But when an injection of tridecamethonium is given, a completely different picture is produced. First contracture appears ; but slowly, while the legs are still extended, the head drops forward in paralysis and finally the paralysis extends to involve the muscles of the leg so that the whole animal becomes flaccid. In the bird, as in the monkey, we start with a decamethonium picture and finish with a *d*-tubocurarine one.

Hitherto it has generally been assumed that results obtained from experiments upon one mammal could safely be regarded as typical for mammals in general. It is now clear that results obtained from the muscle of any one mammalian species are valid only for this species, and perhaps for the particular muscle upon which the experiment was made.

These findings seem to provide an explanation for the varying sensitivity of different species to decamethonium. In species where depolarization is the only mode of action of decamethonium, sensitivity is great. But immediately the dual mode of action comes into play, the muscle becomes more resistant to decamethonium, most probably because these two modes of action are antagonistic.

The variations of the cat, monkey and dog muscles in response to substances like decamethonium and succinylcholine show that there must be distinct physical differences between the muscle membranes of these mammalian species, in spite of the similarity of their reaction to acetylcholine— a fact revealed so far only by such pharmacological analyses. These normally occurring differences in certain species may appear as pathological changes in the muscles of any one species. Taking into consideration results obtained by Churchill-Davidson and Richardson (see succeeding communication), we may reasonably conclude that the myasthenic syndrome is due to changes developing at the motor end-plates of these subjects ; these changes make them react to their own acetylcholine as if acetylcholine were a competitive blocking substance.

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The exact mechanism responsible for the muscle weakness and rapid fatigue characteristic of myasthenia gravis remains unknown, although it has long been recognized to be associated with a failure of neuromuscular transmission. Three main factors have been suggested as the possible cause of this neuromuscular block: first, a reduction in the amount of acetylcholine liberated at the myoneural junction ; secondly, an excessive rate of its destruction due to increased esterase activity; and thirdly, the prevention of its depolarizing action on the motor end-plate by a curare-like substance.

There is no adequate evidence to indicate an abnormality in the production or destruction of acetylcholine in myasthenia, and one could not explain on such a basis the properties of the neuromuscular block found in this condition. This block exhibits the properties of one due to competitive inhibition in that it is greater at high rates of neuromuscular stimulation and reversed by substances having only an antagonism for competitive block in common; for example, neostigmine, tetraethylpyrophosphate, adrenaline and potassium salts. Direct evidence for the presence of a curare-like substance is based on the claim of Wilson and Stoner[1] to have detected it in blood samples obtained from myasthenic patients. Their claim, however, remains unconfirmed.

Recent investigations into the action of decamethonium salts on voluntary muscles indicate that another mechanism must be considered as a factor in this abnormal neuromuscular transmission of myasthenics. In normal human muscles decamethonium (*C*.10) has been shown to produce neuromuscular block by depolarization[2], such as it does in certain other species; for example, the cat[3,4]. Electromyographic recordings taken from normal human muscles show that the characteristic features of such a decamethonium block are that it is potentiated by anti-cholinesterase substances; twitch and tetanus are equally well sustained; a steady but progressive fall in the height of the action potential follows the administration of the drug, and finally, muscle twitches and tightness are a marked feature, especially in the jaw and calf muscles.

The muscles of myasthenic patients, however, show a very different response. We have previously demonstrated that they exhibit a diminished sensitivity to the neuromuscular blocking action of decamethonium which is most marked in those muscles showing little clinical weakness[5]. We have now carried out further investigations into the neuromuscular block that can be induced in the clinically weak muscles of myasthenic patients by decamethonium and have observed that it differs radically from that induced in the muscles of normal subjects under identical conditions. The block in myasthenic muscle is rapidly and completely reversed by anti-cholinesterase substances; tetanic rates of stimulation are not so well sustained as twitch; there is often a marked and prolonged rise in the height of the action potential following decamethonium, and muscle twitching and tightness are absent in this group of subjects. These changes in the mode of response of myasthenic muscle to decamethonium can only be explained by the production of a neuromuscular block due to competitive inhibition by this compound. They are in contrast to the depolarizing block induced by decamethonium in normal subjects.

The conception of decamethonium acting as a competitive inhibitor in myasthenia could be accounted for in two ways: first, by an alteration in the composition of the drug, and secondly by a change in the mode of response of the receptor—the motor end-plate. Biological assays of the urine of our myasthenic patients and normal control subjects show that in both groups the decamethonium is excreted at identical rates and unchanged. It must be concluded, therefore, that in cases of myasthenia gravis the affinity of the motor end-plate for decamethonium changes, so that its threshold is raised for this compound and a block characteristic of competitive inhibition results.

A dual mode of action of decamethonium is suggested by Zaimis in the preceding communication. Her observation that tridecamethonium, decamethonium and succinylcholine exhibit this dual action in different species and, indeed, in different muscles of the same species, leads us to suggest that acetylcholine—a depolarizing substance for all normal muscle—may under certain conditions exhibit this dual mode of action. When it does so in the human species, the result is the weakness and fatigue characteristic of myasthenia gravis.

We believe that the production of competitive inhibition of neuromuscular transmission by decamethonium and acetylcholine in myasthenia can result from changes in the motor end-plates. This hypothesis would explain our results and all the features of the disease, including notably the involvement of isolated muscles.

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An Antifungal Polypeptide produced by *Bacillus subtilis*

DURING work on cultures of *Penicillium roqueforti*, a contaminant was isolated which caused pronounced inhibition of the growth of that mould. The contaminant, when purified and characterized according to Bergey[1], proved to be *Bacillus subtilis*.

The isolate, when grown in shallow broth cultures on the medium used in the production of mycosubtilin[2], produced active solutions. Activity was determined according to the procedure described by Turner-Graff[3], with *P. roqueforti* as test organism. The optimum temperature was 25°–30° C., and maximum yield was obtained in four to six days. The cell-free fluid was active up to a 1 : 10 dilution.

The following procedure was developed for the preparation of the inhibitor. The cell-free fluid from cultures grown as described above was extracted with half its volume of *n*-butanol. The butanol layer was separated and vacuum-distilled at 60°–70° C. A viscous brown residue was obtained which was taken up in water and treated with hydrochloric acid until there was no further precipitation. The precipitate was separated and dissolved in a minimum amount of sodium hydroxide. The solution was diluted with water and reprecipitated with hydrochloric acid. The precipitate was rinsed with water and dissolved in a small volume of ethanol. The solution was then treated with an excess of ethyl ether, and a voluminous white-to-brown precipitate was obtained. Further purification was accomplished by repetition of the above alcohol–ether procedure. The ether precipitate was filtered and dried at 105° C. to a yellow-brown substance.

The inhibitor proved to be a non-dialysable heat-stable polypeptide. It gave positive biuret and xanthoproteic reactions. The Molisch test was negative. The nitrogen content of the dried product was 11–11·5 per cent.

A single counter-current distribution run with 25 tubes, in the system *M*/10 phosphate buffer *p*H 8·7 and *n*-butanol, indicated that the peptide was homogeneous. It is an acid polypeptide with a *p*K of about 5·5 and an equivalent weight of approximately 1,000 when titrated with sodium hydroxide. The polypeptide is insoluble in distilled water, soluble above *p*H 6. It dissolves without difficulty in methanol, ethanol and *n*-butanol.

Paper-partition chromatography of an acid hydrolysate with a phenol – water system using the capillary ascent method of Williams and Kirby[4] showed the presence of seven amino-acids. Glutamic acid predominated. The other amino-acids identified were aspartic acid, serine, alanine, valine, leucine and phenylalanine.

The antibiotic spectrum of this compound is now being investigated. Results obtained so far indicate that it is active against *Penicillium roqueforti* at concentrations of 0·05–0·1 mgm./ml., and against *Aspergillus niger* at 0·2 mgm./ml. At these concentrations, there was no effect on *Staphylococcus aureus*, *Klebsiella pneumoniæ*, *Escherichia coli*, *Streptococcus fæcalis* and *Streptococcus lactis*.

The inhibitor is therefore mainly antifungal. A comparison of its properties with those of the other two known antifungal polypeptides produced by *B. subtilis*, mycosubtilin[2] and fungistatin[5], shows it to be different.

A more detailed report of this work will be published elsewhere.

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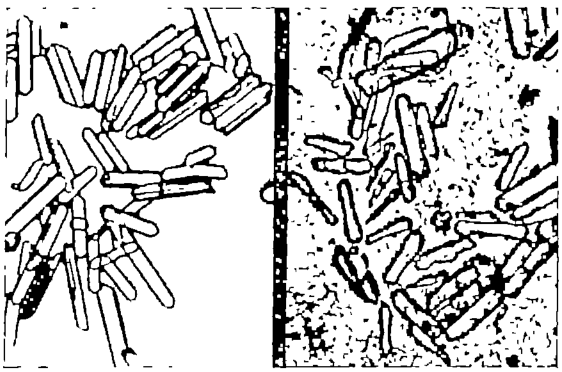
Lipoid Solubility as a Factor in the Toxicity of Contact Insecticides

Contact insecticides as a class are lipoid-soluble, and it is reasonable to surmise that the first step in their uptake or pick-up by the insect might be generally their dissolution in the epicuticular waxes. All the same, experimental evidence of this phenomenon does not seem to exist, and relative solubility of insecticidal chemicals in cuticular waxes of insects has not been studied so far as known to us. Recently, it has been possible to develop a fairly handy technique for such studies and to collect thereby some experimental evidence of the existence of correlation between lipoid solubility and insecticidal action.

Lipoid solubility. Cuticular waxes were extracted from the larval exuviæ of two species of insects, namely, *Euproctis lunata* Wlk. (Lymantridæ, Lepidoptera) and *Trogoderma granaria* Everts. (Dermestidæ, Coleoptera), which had been found in earlier experiments to show very wide differences in their susceptibility to suspensions of DDT crystals. The extract from *E. lunata* formed 2·95 per cent of dry weight of the exuviæ and was a grease-like wax with a deep yellowish-green colour and a melting point range of 47–54° C. That from *T. granaria* formed 3·93 per cent of the dry weight of the exuviæ and was hard brittle wax, light yellow in colour and with a melting point range of 77–83° C. Both were readily soluble in cold chloroform, benzene and xylol, and were sparingly soluble in alcohol and acetone. In order to study the solubility of DDT in these extracts. they were dissolved separately in chloroform, giving a 0·05 per cent separate solution of each. Then 1 c.c. of this solution was spread uniformly on a glass cover slip (2·25 cm. square) and the chloroform allowed to evaporate, leaving a more-or-less uniform wax film on the cover slip. Taking the relative density of insect waxes as 0·96 gm./c.c.[1], the approximate thickness of this wax film was about 10 µ. The films thus made from the two cuticular extracts were uniformly sprayed under a spraying tower with a suspension of DDT crystals (8 × 32 µ in size), in acetone – water medium, and examined under the microscope. Particular areas on the film were marked out, and the fate of the DDT crystals in those areas observed at very short intervals. It was observed that: (*a*) as soon as the crystals settled on the wax films they started sinking into the wax; this process was very rapid in the case of *Euproctis* wax, the crystals being completely covered by wax in about one minute, whereas the same process took 15–30 minutes in the case of *Trogoderma* wax; (*b*) DDT crystals started showing signs of dissolution (see accompanying illustration) within five minutes and completely disappeared in 30–45 min. on *Euproctis* wax, whereas very few crystals showed any sign of dissolution on *Trogoderma* wax during the corresponding period; (*c*) a few crystals which were left undissolved on *Euproctis* wax were found on close examination to be enveloped in a film of water which obviously hindered their dissolution. No such reason could be adduced for DDT crystals not dissolving on *Trogoderma* wax.



(*a*) (*b*)

DDT crystals: (*a*) on glass slide, and (*b*) on film of *Euproctis* wax showing signs of dissolution in losing their shape, and dwindling in size. The respective enlargements of (*a*) and (*b*) are not the same

Relative susceptibility. Correlated with the difference in the relative solubility of DDT in the cuticular extracts of the two species, there was a great difference in their relative susceptibility to suspensions of DDT crystals as shown in the accompanying table.

When sprayed grubs of the resistant species *T. granaria* were observed under the high power of a binocular microscope, the DDT crystals could be easily detected even after a week with their outline more or less intact on the insect body, indicating that the DDT crystals were not being absorbed quickly.

TOXICITY OF DDT CRYSTALS TO *E. lunata* AND *T. granaria* LARVÆ UNDER ALMOST IDENTICAL CONDITIONS

% concentrations	Mortality % in *E. lunata* 4 days after spraying				Mortality % in *T. granaria* 50 days after spraying			
	S	*M*	*B*	*C*	*S*	*M*	*B*	*C*
0·125	80	80	64	73	26	22	28	30
0·0625	62	64	44	56	20	18	8	14
0·03125	44	44	31	38	4	8	2	6
0·0156	31	33	24	27	0	2	0	2
Control	4				0			

S, DDT crystals 2 × 10–12 μ in size; *M*, the same, 4 × 12–16 μ; *B*, same, 8 × 30–32 μ; *C*, same, of nearly colloidal dimension.

Effect of temperature. This film technique also made it possible to have some idea about the effect of temperature on the solubility of DDT crystals in these waxes. Films with DDT crystals on them were kept at 32° C. and in a refrigerator (10–15° C.). It was found in the case of *Euproctis* wax that all the crystals were dissolved within one hour at 32° C., but only a very small number did so even in 24 hours at 10–15° C. The crystals on *Trogoderma* wax showed only slight change at both these temperatures.

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Oxidative Degradation of Testosterone by Adaptive Enzymes

THE study of steroid synthesis by micro-organisms and certain oxidations and reductions of reactive groups at positions 3 and 17 of the steroid skeleton have been previously reported[1]. Turfitt[2] has studied more extensive degradations of cholesterol by bacteria and has isolated products in which the side-chain has been removed and ring *A* opened. We should like to report the application of adaptive bacterial enzymes to the study of the oxidative degradation of steroid hormones.

An unidentified, Gram-negative, flagellated bacillus (probably a non-fluorescent *Pseudomonas*), which can utilize testosterone as its sole source of carbon, has been isolated from the soil by enrichment cultures. Colonies growing on agar plates in which testosterone has been finely dispersed produce extensive zones of 'clearing' at some distance from their margins (Fig. 1). When testosterone is the only source of organic carbon in the medium, relatively poor growth of this micro-organism is obtained. We have grown cells as a routine in well-aerated liquid cultures at 30° C. in a medium containing 2·5 mgm. per ml. of finely dispersed testosterone and 2·5 mgm. per ml. water-soluble yeast-extract, in addition to ammonium sulphate and requisite mineral salts (magnesium sulphate, sodium chloride and potassium mono- and di-hydrogen phosphate). Washed cell suspensions of organisms grown in this manner carry out vigorous and extensive oxidations of testosterone. These oxidations may be conveniently studied manometrically with 1–2 μ*M* of steroid suspended in 0·03 *M* phosphate buffer *p*H 7·2 at 30° C. in air. Under such conditions, the activity of oxidation may vary in different preparations from $Q = 60$–200 μl. oxygen/mgm. dry weight/hr., whereas the endogenous respiration amounts to 20–25 per cent of this. The total oxygen consumption is proportional to the quantity of testosterone added, and usually amounts to 40–60 per cent of the theoretical amount for complete oxidation to carbon dioxide and water. In the presence of critical concentrations of 2,4-dinitrophenol, the total oxygen consumption may approximate to the theoretical for complete oxidation.

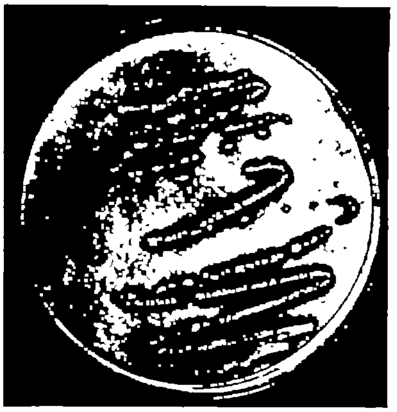

Fig. 1. Colonies growing on agar containing finely dispersed testosterone, ammonium sulphate and mineral salts

The enzymes involved in these oxidations are adaptive, as the organism grown on yeast extract alone will not immediately oxidize testosterone. Washed cells grown on yeast extract, when placed in Warburg vessels in phosphate buffer at *p*H 7·2 and 30° C. in air, will, in the absence of an exogenous nitrogen source, become adapted to oxidize testosterone after a lag period of 8–10 hr. The specific activities obtained during *in vitro* adaptation are considerably lower ($Q = 5$–10 μl. oxygen/mgm. dry weight/hr.) than those achieved by growing the organism in the presence of the steroid.

Testosterone-adapted cells will also vigorously oxidize a series of related 19-carbon steroids, such as androst-4-ene-3,17-dione, androstane-3,17-dione, 17-epitestosterone, dehydroepiandrosterone, epiandrosterone, and dehydroandrosterone. The presence of a side-chain at carbon 17, for example, methyltestosterone, precludes oxidation. Natural œstrogens, such as œstrone and œstradiol, as well as synthetic œstrogens, such as *bis*dehydrodoisynolic acid methyl ether and diethylstilbœstrol, are not attacked by this micro-organism. Adrenal cortical steroids (compound *E*, compound *F* and deoxycorticosterone) are likewise resistant to oxidation.

The terminal oxidative pathway appears to be by way of the tricarboxylic acid cycle, as the oxidation of testosterone is inhibited by tricarboxylic acid enzyme inhibitors (malonate and fluoroacetate), and certain of the cycle enzymes (*iso*citric dehydrogenase and fumarase) have been demonstrated in cell-free extracts of the organism.

Cell-free extracts prepared from washed testosterone-adapted cells by grinding with alumina[3] will carry out the initial oxidation step of testosterone, whereas extracts of unadapted cells grown on yeast fail to do so. The adapted extracts contain a diphosphopyridine nucleotide-specific enzyme which will oxidize testosterone and dehydroepiandrosterone. This enzyme is distinct from ethanol dehydrogenase. The steroid oxidations can be studied spectrophotometrically by measuring the appearance of

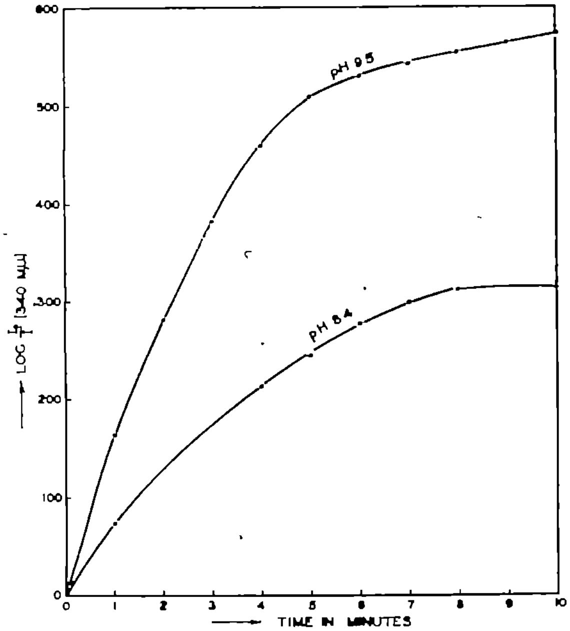

Fig. 2. Reduction of diphosphopyridine nucleotide by enzyme extract of testosterone-adapted cells in presence of testosterone at 25° C. and pH 8 4 and 9·5. Optical density readings at 340 mμ, corrected for endogenous reduction of the nucleotide (c. 15 per cent of total). System: Phosphate buffer 0·03 *M*, 0 05 ml. enzyme, 0·1 ml. diphosphopyridine nucleotide (0 34 μ*M*), 2·0 ml. aqueous testosterone (0·1 μ*M*). Total volume 3 ml. Reaction started by adding the nucleotide

reduced diphosphopyridine nucleotide at 340 mμ (Fig. 2).

The rate and equilibrium are markedly sensitive to *p*H, the rate being greater at *p*H 9·5 than at lower *p*H, and the equilibrium shifts in favour of the complete oxidation of testosterone as the *p*H of the reaction medium increases. The product of testosterone oxidation has been isolated by paper chromatography (using formamide-impregnated paper and a moving phase consisting of a mixture of equal parts of hexane and benzene) and behaves chromatographically like androst-4-ene-3,17-dione.

A few micrograms of testosterone can be detected by measuring the reduction of diphosphopyridine nucleotide with the aid of this enzyme extract, and fractionation of the latter is being undertaken in the hope of developing a sensitive, specific assay for testosterone and related steroids. Full experimental details will be given in a future publication.

This work was supported by grants from the American Cancer Society, recommended by the National Research Council Committee on Growth and the Jane Coffin Childs Memorial Fund for Medical Research. We are indebted to Chemical Specialties, Inc., New York, and Schering Corporation, Bloomfield, New Jersey, for generous gifts of a variety of steroids.

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Enzymes of *Vibrio choleræ*

BURNET'S discovery[1] of an epithelium-desquamating enzyme in *V. choleræ* filtrates has opened up a new line of approach in the investigation of the pathogenesis of cholera.

Using pure collagen prepared by the method of Highberger[2] from buffalo tendo Achillis, we have been able to demonstrate, in culture filtrates of *V. choleræ*, a collagenase with an optimum *p*H of 8·0. This enzyme could not be detected in culture filtrates of *B. coli*. The method employed for this study was as follows. 4-ml. quantities of a Seitz filtrate of an 18–20-hr. culture in 1 per cent nutrient agar of *V. choleræ* (Inaba), after being adjusted to *p*H's ranging from 4 to 9 and made up to the same total volume of 6·4 ml. with distilled water, were treated with 0·2 gm. each of the collagen preparation and incubated for 48 hr. at 37° C. A boiled cholera filtrate – collagen control was also run in parallel. At the end of the incubation period, the undigested collagen was separated off and samples from the clear solution were taken out in duplicate for nitrogen analysis by micro-Kjeldahl method. The average nitrogen content in mgm. per ml. of the solution of closely agreeing duplicates is given in the accompanying table.

Nature of filtrate	*p*H	Nitrogen per ml of supernatant	Increase in nitrogen/ml of fresh filtrate incubates over control
V. choleræ, type Inaba	4 0	0 66	0·0
	5 0	0 814	0·154
	6 0	0·941	0 281
	7 0	0·947	0 287
	8 0	0·961	0·301
	9 0	0·918	0 258
Boiled *V. choleræ* filtrate (control)	6 0	0 66	
B. coli filtrate	7·0	0 972	0·013
	8 0	0 995	−0 015
Boiled *B. coli* filtrate (control)	7·0	0 959	
	8·0	1 01	

The increase in the dissolved nitrogen of the collagen–cholera-filtrate incubates over that of the control, with a maximum at *p*H 8·0, shows the presence of a collagenase in *V. choleræ*. This enzyme is capable of acting over a wide range, optimum effect being at *p*H 8·0.

Further work on vibrio enzymes is in progress. The evidence collected so far shows that collagenase is also present to some extent in culture filtrates of vibrios of non-choleragenic origin. Details of these investigations will be published shortly.

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Chromatographic Isolation and Estimation of the Natural Œstrogens from Tissue

THE separate isolation and estimation of the three œstrogens in tissue at present entails the use of a large amount of material, with a separation by partition in solvents which is by no means perfect. The resulting product is very impure and has to be assayed biologically rather than chemically. Various chromatographic and other techniques have been tried to find a method of purification and separation[1-3], all of which for various reasons were found to be unsatisfactory for tissue extracts.

To avoid streaking, and to give reproducible R_F values for the œstrogens when run on paper chromatograms in the presence of the large amount of greasy impurity found in tissue extracts, it has been found essential to use an elevated temperature under the carefully controlled conditions recently described by Bush[4] for adrenal steroids. On this basis, and utilizing a new spotting technique, a method has been evolved for complete isolation and estimation.

Fresh human placenta has been used for these experiments, and extracts of up to 200 gm. were taken for a single run. The tissue was minced and extracted in a Soxhlet apparatus with methanol, which was removed *in vacuo*; the remaining sludge was extracted with ether. Where a hydrolysate was required, this was obtained by refluxing with 1·5 *N* hydrochloric acid and subsequent extraction with ether. The ether was washed with 9 per cent sodium bicarbonate, removed *in vacuo*, and the residue taken up in benzene. At this stage œstriol was separated from œstrone and œstradiol by thorough extraction of the benzene with water. The water was extracted with ether, and one volume of carbon tetrachloride added to 18 volumes of ether, which was then extracted with *N* sodium hydroxide. The sodium hydroxide was brought to *p*H 9 with sulphuric acid[2] and extracted with ether, which was evaporated to give the œstriol fraction. The œstrone and œstradiol fraction was obtained by extraction of the benzene with *N* sodium hydroxide and subsequent treatment as for the œstriol fraction.

The final extracts dissolved in ethanol were placed on strips, 5 in. by 18 in., of Whatman 541 filter paper, the ethanol being evaporated by a stream of air directed under the paper. (For quantitative work the paper must be extracted with methanol in a Soxhlet apparatus for several hours to remove impurities soluble in methanol.) The chromatograms were run overnight (16 hr.) by the descending technique in glass tanks in a uniformly heated cabinet containing an efficient fan, at 32° ± 0·5° C. The precautions described by Bush[4] regarding saturation of the atmosphere in the tanks must be taken. Equilibration is complete after 1–1¼ hr.

The mobile phase for œstrone and œstradiol was made from 1,000 ml. petrol ether (b.p. 100–120° C.), the stationary phase being methanol (1,000 ml.). For œstriol these were, respectively, benzene (1,000 ml.) and a mixture of methanol (500 ml.) with water (500 ml.).

The œstrogens were shown up as blue spots (minimum detectable, 0·5 μgm./sq.cm.) by spraying the paper with Folin and Ciocalteu's reagent[5] freshly diluted with five volumes of water, and hanging in a tank, the bottom of which was covered with 0·88 ammonia solution, until the spots reached maximum intensity (about 5 min.). The papers were dried at room temperature to give permanently stable chromatograms.

The œstrogens in the tissue extract are shown as sharply defined spots with no streaking after a 16-hr. run. The spots are well distributed over the paper, and the R_F values in the respective systems are œstrone 0·2, œstradiol 0·07 and œstriol 0·13.

Quantitative removal of the œstrogens from the paper was achieved by hanging the paper containing the spot at the base of a condenser, and refluxing with methanol for 15 min. In this case, the spots have to be found by running the extracts parallel with pure standards, and spraying only the standard strips so formed. The identity of the substances removed was proved by measuring their absorption spectrum, coupling with azo dye[1] and bio-assay. The amounts of œstrogens present have been determined by fluorimetry, bio-assay and absorption spectrophotometry, with good correlation of results. From 100 gm. of hydrolysed placental tissue, 3 μgm. œstrone, 1 μgm. œstradiol and 10 μgm. œstriol were obtained. Provisional recovery experiments, excluding the action of the hydrolysis, give results for the respective œstrogens of 80, 40 and 60 per cent. Most of this loss may probably be accounted for by trouble with emulsions, and fatty impurities disturbing the distribution coefficients. This is being investigated.

These figures agree with those obtained by Huffman *et al.*[6], who worked with more than 400 kgm. of placenta. The small amount of material required for the above method (minimum 50 gm.), and the comparatively short time taken for complete purification and chemical estimation, should now facilitate work in the field of œstrogen metabolism.

I would like to thank Dr. R. E. Davies for his help, also Prof. H. A. Krebs and Dr. C. G. Paine for interest and encouragement.

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Transplantation of Mouse Sarcoma with Small Numbers of Single Cells

Although transplantation of leukæmia has been secured by the intravenous inoculation of a single leukæmic cell[1], transplantation of a solid tumour by a single malignant cell has not, so far as is known, been demonstrated. The fact that a leukæmic cell can normally exist as an isolated viable cell in a fluid environment is a special feature which has left open the possibility that single cells of a solid tumour may not so well survive the manipulations required for transplantation.

Single-cell suspensions of a spindle-cell sarcoma which arose in this laboratory in a transplantable mammary carcinoma of *C3H* mice have been prepared by prolonged sedimentation under gravity of tumour mince suspended in Tyrode solution containing 0·5 per cent gelatine. It has been found that between 80 and 90 per cent of the cells in such suspensions can be presumed to be non-viable, as indicated by diffusion of trypan blue into the nuclei[2] and by other evidence of degeneration apparent in phase-contrast microscopy. In recording the cell density of a suspension, therefore, account is taken only of the cells of which the nuclei fail to take up dye in the presence of 0·2 per cent trypan blue. 0·1-ml. volumes of serial dilutions of a single-cell suspension were inoculated subcutaneously into *C3H*

Dilution factor	Calculated number of cells in inoculum	Number of inoculations	Number of tumours	Positive inocula (per cent)
100	1,200	12	10	83
300	400	12	10	83
900	133	12	10	83
2,700	44	12	7	58
8,100	15	12	4	33
24,300	5	12	4	33

mice of between two and four months of age. The accompanying table shows the percentage of inocula, containing various numbers of viable cells, which gave rise to progressively growing tumours within the 40-day period of observation. The cell numbers given in the table are calculated from the viable cell density in the original suspension and the dilution factor.

From the table it will be seen that tumours arose from one-third of the inocula containing a calculated number of five cells. When the percentage of tumours arising from the various cell doses is calculated from the accumulated results according to the method of Reed and Muench[3], and plotted against the logarithm of the numbers of cells in the inocula, a sigmoid curve is obtained which approaches zero for both ordinate and abscissa. The number of cells required to give 50 per cent of positive inocula, read from the graph, is 14.

The technical error most likely to result in gross under-estimation of the number of cells in the most dilute inocula is contamination by cell clumps. This possibility is considered to be ruled out by the observations that (1) the viable cells showed no tendency to clump even in the most dense suspensions, and (2) no cell clumps could be seen in a volume of the undiluted suspension which contained 12,000 viable single cells. Other technical considerations, such as the possibility that a proportion of the cells not taking up trypan blue may nevertheless not be viable, and that some cells may be lost or damaged in the course of inoculation, make it probable that less than five cells was in some cases responsible for starting a fresh tumour. Since the volume of the inocula was 0·1 ml., it must be presumed that the single cells in the most dilute inocula were deposited in the tissues at some distance from one another. Assuming that such cells have no influence on one another, it must be concluded that fresh tumours arose from single isolated cells.

The necessity of absolute criteria for the exclusion of cells from the inoculum in experiments intended to demonstrate cell-free transmission of tumours is made clear when it is realized that, as implied by the results here reported, a tumour can result from the inoculation of 10^{-4} c.mm. of tumour tissue.

Similar experiments to the above have shown that about 2,000 viable cells of sarcoma 37 are required to give 50 per cent of positive inocula in a colony of mice uniformly susceptible to massive grafts. No successful transplantations have resulted from the inoculation of single-cell suspensions of transplantable *C3H* mammary carcinoma into *C3H* mice.

A more detailed report of these investigations will be published elsewhere in due course.

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Possible Identity of 'Lactobacillin' with Hydrogen Peroxide produced by Lactobacilli

STRAINS of lactobacilli were recently isolated from Gruyère cheese which gave zones of inhibition against *Staphylococcus aureus* 20–30 mm. in diameter. This inhibition appeared to be antibiotic in nature, perhaps similar to that described by Grossowicz, Kaplan and Schneerson[1], and the active principle was called 'lactobacillin'[2]. The tests were done on agar buffered to *p*H 7·0 with 1 per cent phosphates to avoid false positive effects due to lactic acid[2,3]. Ritter has described similar experiments[4]. His strains were isolated in Switzerland from Emmenthal cheese and through his kindness they were included in this investigation. Most of our cultures have now been identified serologically by Dr. M. E. Sharpe as *Lactobacillus lactis*.

It was known from previous experience that inhibition observed on agar media needs to be confirmed by dilution assay, because toxic metabolic by-products are less likely to interfere with this type of assay[5]. The lactobacilli, which were initially cultured in milk, were therefore 'trained' to grow in a peptone–glucose medium supplemented with 'Tween 80' and malt extract. These culture fluids could not be sterilized without loss of activity, so that a dilution assay against *Staph. aureus* was devised by culturing the test organism in plain nutrient broth in which the lactobacilli failed to grow[2]. Average titres of 1/1,280 were obtained in these assays, and in similar assays against *Cl. butyricum* titres of 1/100 were frequently obtained.

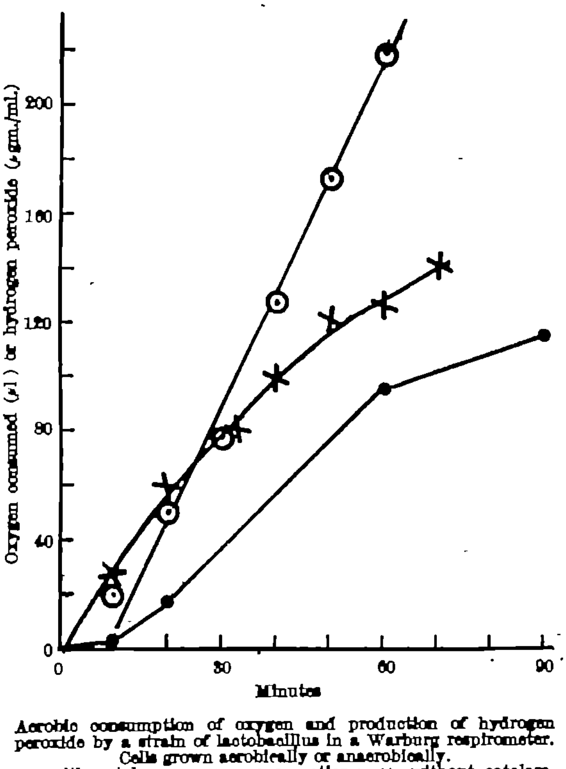
Hydrogen peroxide was not at first suspected. The culture fluids which were obtained in the malt extract medium were tested for the presence of hydrogen peroxide by a modification of the method of Main and Shinn[6]. In our hands, this method detected as little as 0·0002 per cent hydrogen peroxide (2·2 μgm./ml.). The sensitivity of *Staph. aureus* to hydrogen peroxide was given as 10 μgm./ml. by Coulthard *et al.*[7]; our test organism was slightly more susceptible, being inhibited by 4 μgm./ml. Moreover, when the assays were done in freshly boiled media and each tube was placed under a seal of alkaline pyrogallol, titres of about 1/640 were still obtained.

Two strains were then selected for further work in an endeavour to obtain the inhibitory substance free from cells. A wide range of organic and inorganic solvents at different *p*H's was used, but without success. Later, we attempted by physical and chemical means to disrupt the cells. Microscopic examination showed this to be very difficult; but whenever some measure of success was obtained the antibiotic activity was lost. It then became clear that the activity was always associated with living, though not necessarily multiplying, cells. In an experiment designed to check this point, the number of viable organisms was progressively decreased by alternate freezing and thawing at decreasing temperatures (refrigeration, solid carbon dioxide and liquid air). A parallel decrease in the assay titres was observed. It thus appeared that the cells produced the inhibitory substance, possibly hydrogen peroxide, during the assay.

Catalase prepared from *Micrococcus lysodeikticus* by the method of Herbert and Pinset[8] and a commercial pig liver preparation both abolished the antibiotic effect when 0·001 per cent was included in a dilution assay. However, catalase inactivated by adjusting to pH 2·5 and incubating at 42° C. for 2 hr. had no effect on the assay. Similarly, when catalase or fresh serum was included in the agar, no zones of inhibition were obtained. Pyruvate (0·01 per cent) also abolished the titre. In the 'anaerobic' assays which were done with tubes under a seal of alkaline-pyrogallol, all these substances were equally effective. It appears, therefore, that hydrogen peroxide is very readily produced by these strains of lactobacilli, even when only traces of oxygen are present. Hydrogen peroxide estimation in the actual assay tubes further confirmed these findings. In the last tube of these assays showing no growth, 4 μgm./ml. hydrogen peroxide was usually found, whether the assay was set up aerobically or 'anaerobically'. This figure agrees well with that previously found for the sensitivity of the test organism to hydrogen peroxide.

At this point all our strains were re-assayed by the dilution method against *Staph. aureus* with and without catalase in the medium. In all cases catalase abolished the inhibition.

It was still difficult to understand why the lactobacillus was some twenty-five times more resistant to hydrogen peroxide than the staphylococcus, being inhibited by 100–200 μgm./ml. As there is no catalase in lactobacilli, their much greater resistance could be attributed to destruction of hydrogen peroxide similar to that described by Seeley and Rio-Estrada with *Str. fæcalis*[9]. They found that aerated cultures of this organism developed a mechanism for utilization of hydrogen peroxide through riboflavin. In this case, however, we did not succeed in developing the adaptive mechanism, although in one series twenty-three consecutive sub-cultures were grown at 37° C. with vigorous shaking. When tested in a Warburg respirometer, the resting cells produced hydrogen peroxide from glucose whether they were grown on the shaker or under an anaerobic seal (see graph). In both cases catalase was stimulatory. At intervals estimations were made of the hydrogen peroxide in the contents of the Warburg flasks. In the absence of catalase, self-inhibitory levels of hydrogen peroxide (*c.* 120 μgm./ml.) were quickly reached and the rate of respiration declined. Further confirmation was obtained when hydrogen peroxide was added to resting cell suspensions and this was not decomposed. Finally, the sterile malt extract broth, but not other media, was found to contain an unidentified mechanism either for removing added hydrogen peroxide or masking the test. This explains the failure to find hydrogen peroxide in the culture fluids without affecting its presence in the assays, which were done in a simple nutrient broth.



Aerobic consumption of oxygen and production of hydrogen peroxide by a strain of lactobacillus in a Warburg respirometer. Cells grown aerobically or anaerobically.

○, with catalase, oxygen consumption; ×, without catalase, oxygen consumption; ●, hydrogen peroxide produced.

Each flask contained 0·8 ml. of a cell suspension, 1 ml. M/15 phosphate buffer (pH 7·0), 0·2 ml. of catalase (0·1 per cent) or 0·2 ml. distilled water. 0·2 ml. 5 N potassium hydroxide in centre well and 0·5 ml. M/10 glucose in side arm. Total volume, 2·7 ml.

It is possible that where these lactobacilli may naturally predominate, for example, in cheese, the hydrogen peroxide produced may have a beneficial effect. This part of the work is still in progress and full details will be published in due course. Meanwhile the evidence suggests that hydrogen peroxide is involved in the inhibitory mechanism and the name 'lactobacillin' is withdrawn.

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Relationship between Reduced Glutathione Content and Spontaneous Hæmolysis in Shed Blood

Many enzymes contain sulphydryl groups essential to their activity; they are readily inactivated by oxidation. It is known that reduced glutathione protects them against oxidation[1]. In this respect hæmoglobin behaves in a similar manner to the 'SH-enzyme' in that its spontaneous oxidation to methæmoglobin is inhibited by glutathione[2].

It has been found that red cells in which all the hæmoglobin has been converted to methæmoglobin by sodium nitrite contain no reduced glutathione. When stored in the cold they hæmolyse spontaneously in apparently a shorter time than the normal cells[3]. These observations suggest that the hæmolysis of shed blood may be connected with methæmoglobin formation or with glutathione oxidation.

This communication gives an account of experiments which support the hypothesis that there is a relationship between the rate of spontaneous hæmolysis and the extent of oxidation of glutathione, and that this relationship is not influenced by methæmoglobin formation. The spontaneous hæmolysis was studied in samples of whole horse blood (pH 7·4–7·5) or in horse red blood cell suspensions in Ringer solution containing glucose (pH 7·0). The samples were exposed to air, or an oxygen and nitrogen–carbon dioxide (6 per cent) mixture, at 20° C. or at 37° C. during a period of time ranging between 1 hr. and 24 hr. The concentration of extra-cellular hæmoglobin (converted to cyanmethæmoglobin) was determined spectrophotometrically (at 540 mμ), at intervals of time. Parallel determinations of reduced and, in some experiments, total glutathione were made by Woodward and Fry's method[4].

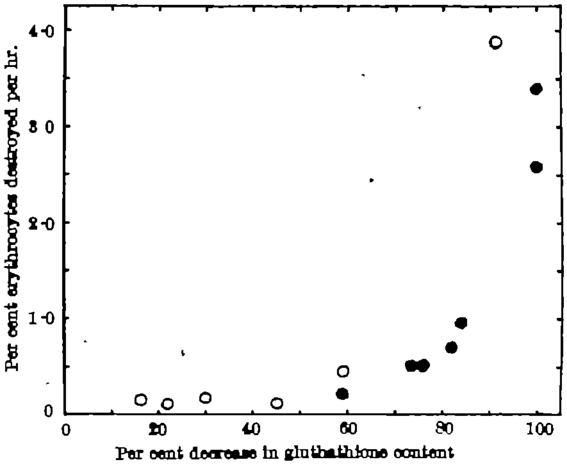
Blood exposed to oxygen for a period of time, ranging between 1 hr. and 6 hr., showed a more distinct hæmolysis than the blood exposed for the same period of time to air. The extent of hæmolysis in air or oxygen was increased on exposure to a temperature of 37° C. Under similar conditions, blood exposed to a nitrogen – carbon dioxide mixture showed no determinable concentration of free hæmoglobin.

In samples exposed to air or oxygen, the reduced glutathione gradually decreased during the period of observation, and the extent of its oxidation for the same period of observation was distinctly greater in samples exposed to oxygen. Exposure, for the same period of time, to air or oxygen at 37° C. produced a more marked decrease in the glutathione content than exposure at 18° C. In deoxygenated samples, the amount of glutathione present after exposure of 15 min. was greater than that in aerated or oxygenated samples and did not change with further exposure.

No significant change in the total glutathione was found in blood exposed to air, oxygen, or to a nitrogen – carbon dioxide mixture. The amount of methæmoglobin found at the end of an observation period did not exceed 3 per cent of the total hæmoglobin content.

Another series of experiments was carried out to determine whether the elimination of reduced glutathione by oxidation with iodine would increase the rate of spontaneous hæmolysis. It was found that: (*a*) no immediate hæmolysis was produced by the addition of iodine in final concentration of 0·6–6·0 μM in 1·0 ml. of blood or red blood cell suspension; (*b*) the decrease in glutathione content caused by iodine is related to the concentration of iodine added, and the glutathione reaches its lowest concentration (corresponding to the amount of iodine added) almost immediately after the addition of the iodine; (*c*) a complete oxidation of the glutathione could be achieved by the use of iodine, without any extensive formation of methæmoglobin (not more than 3 per cent of total hæmoglobin content); and (*d*) the rate of hæmolysis bears a certain relation to the extent of oxidation of the reduced glutathione.

The results of the six experiments in which iodine (solid circles) was used and the six experiments in which exposure to air or oxygen was employed (open circles) are given in the accompanying graph, in which the percentage decrease in reduced glutathione is plotted against the rate of hæmolysis determined from graphs.



The graph shows that there is no marked increase in the rate of hæmolysis until the glutathione content drops to about 40 per cent of its mean initial value, when a further decrease in glutathione content is connected with a rapidly growing rate of hæmolysis. This relationship applies to hæmolysis in blood exposed to oxygen as well as to the blood treated with iodine. This suggests that in both procedures the spontaneous hæmolysis has a similar mechanism.

The results of these experiments suggest that glutathione plays an important part in the maintenance of the integrity of the structure and function of the erythrocyte and, perhaps, of all tissue cells.

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Improvements to the Melted Emulsion Technique of Autoradiography

THE method whereby autoradiograms are obtained by covering histological sections with photographic emulsion[1] has been improved or modified for specific needs[2-7]. In our laboratory, the inversion technique[3] has gained considerably in definition and ease of operations by substituting the emulsion from Kodak High Contrast Positive film for that of Matrix film (Eastman Kodak Co.) which contains a yellow dye.

The emulsion from Kodak High Contrast Positive film is unstained. It is removed easily from the base under the relatively bright Series 0*A* 'Yellow-Green Safelight'. It is very fluid at 38° C. and does not retain air bubbles. It can be processed and washed at the usual temperature (20° C.). It has a better resolution (165 lines per mm.); shows fewer background artefacts, and can be used for contact, for coating stained specimens[1,3,5], or for unstained sections which are inverted and stained after the photographic processing[3].

The technique at present in use for tracer studies of the mineralization of bones and teeth is as follows. For contact autoradiograms, strips of 35-mm. film are cut to appropriate size and placed in contact with the histological preparation, previously coated with 1 per cent celloidin in alcohol-ether. These are placed between two glass slides bound with cellulose tape and exposed in the dark at 4° C. After processing, the film strips are again bound between two glass slides with cellulose tape. This makes handling, storing, inspection and identification easy. In the melted emulsion technique, strips of 35-mm. film are cut to appropriate size (6–8 in.) and hydrated for a few seconds in distilled water, at room temperature. Each strip is then laid down on a glass plate, emulsion face up, and the emulsion is scraped from the central area with a glass slide. The emulsion is collected in a small beaker at 38° C. and, when melted, is picked up with a clean medicine dropper and transferred to the celloidin-coated microscope preparation. The practice of coating with a 'Blanchard brush'[3] has been altogether abandoned because it produces uneven coats and favours the production of air bubbles. The emulsion is then gelled and dried on a levelled glass plate, under a gentle air stream. The dry specimen is exposed in the dark at 4° C.

Development can be carried out at 20° C., but the cold bath (10° C.) for 10 min. gives less background fog and fewer artefacts. The formulæ *D*11 or *D*19, diluted 1 to 1 with distilled water at the time of use, give a more accurate picture than the previously used *D*72 ('Dektol').

The preparations are then rinsed in distilled water at 10° C., fixed for 10 min. in Kodak acid fixer with hardener also at 10° C. and finally washed under a gentle stream of tap water for 30 min. They can be dehydrated, cleared and mounted at this stage or inverted under water[3], remounted on a glass slide, section face up, and dried under a gentle air stream. For staining these inverted preparations, a 0·02 per cent aqueous solution of basic fuchsin is used, after passing through fresh oil of origanum and down-graded alcohol solutions to distilled water. Basic fuchsin solutions keep well and seem to gain strength when stored in glass-stoppered brown bottles; an older solution will stain well in 5 min., while a fresh one will require up to 10–15 min. Sections are transferred rapidly through 95 per cent alcohol, which differentiates and removes excess stain from the background. They are then passed through three baths of absolute alcohol. For clearing, oil of origanum is preferred to xylene or other light oils; it is messy but minimizes artefacts. Two baths are used and the preparations are finally mounted in 'Permount' (Fisher), using liberal amounts.

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Determination of Yeast Carbohydrates with the Anthrone Reagent

A PAPER on this subject by Fales[1] has recently appeared; almost simultaneously, we described a more extensive fractionation of yeast carbohydrates, using also the anthrone reagent for colorimetric determinations of total cell carbohydrate as well as of the individual fractions[2]. Considerable interest has been shown in this technique, as judged by the volume of correspondence we have received. As the original procedure was adapted to the small amounts of yeast used in manometric experiments on fermentation[3] and requires considerable manipulative skill and time, we wish to put on record the following adaptation which can be used when larger quantities of yeast are available for analysis. The dilutions of the various fractions are designed to give about the same optical density in the anthrone reaction as a standard solution containing 100 µgm. glucose/ml., when D.C.L. baker's yeast is used; other yeasts may require some adjustment in this respect.

The yeast to be analysed is suspended in water (50 mgm. wet weight/ml.).

Total carbohydrate: dilute to 1 mgm./ml. and determine as described[3].

Extracellular carbohydrate: centrifuge 10 ml. suspension (500 mgm.) and determine carbohydrate in the supernatant.

Acid-soluble carbohydrate (trehalose): suspend the residue in 3 ml. trichloroacetic acid (100 gm./lit.). After five minutes, transfer the suspension to a volumetric flask and make up to 50 ml. Mix, and stand for 5 min. Centrifuge 10 ml. (100 mgm. yeast) in a 15-ml. conical tube and determine trehalose on a 1 : 1 dilution of the supernatant. The residue from the alkaline extraction (see below) is not easily centrifuged, hence the use of the small conical centrifuge tube at this stage.

Alkali-extractable carbohydrate (mannan plus glycogen): wash the residue in the centrifuge tube with water twice. Suspend the washed acid-extracted cells in 1 ml. potassium hydroxide solution (300 gm./lit.) and heat 30 min. in a water-bath at 100° C. Cool, centrifuge, and pour the supernatant into a 10-ml. calibrated flask or cylinder: wash the residue by successive suspension in water and centrifuging, and make supernatant and washings to 10 ml. Dilute an aliquot 1 : 1 with water and determine mannan plus glycogen extractable by alkali.

Mannan: add 2 ml. Fehling's solution to 5 ml. of the alkali extract (≡ 50 mgm. yeast) contained in a 15-ml. conical centrifuge tube. Warm in the water-bath, and shake until the mannan copper complex is precipitated. After standing an hour or so, centrifuge and wash with dilute alkali (0·1 *N* sodium hydroxide). Dissolve the copper complex by adding sulphuric acid (few drops 10 *N* acid), transfer to a volumetric flask and make to 10 ml. When carrying out the colorimetric determination use two standards: glucose 100 µgm./ml., mannose 150 µgm./ml. in order to correct for the lower chromogenic value of mannose[4].

Acid-extractable polysaccharide (glycogen): suspend the residue from the alkali extraction in 2 ml. 2 *N* sulphuric acid, and heat 15 min. on the water-bath at 100° C. Cool and centrifuge; wash the residue with water, and make supernatant and washings to 15 ml. (6·67 mgm. yeast/ml.).

Glucan: add dropwise sulphuric acid (2 acid : 1 water) to the well-drained and chilled residue, stirring with a fine glass rod. As soon as the material dissolves, instantly dilute with a large volume of cold water, and transfer the milky fluid, making to 15 ml. with water (6·67 mgm. yeast/ml.).

It will be seen that the alcohol precipitation steps of the previous procedure[3] have been eliminated, saving time; and that the glucan is obtained in aqueous solution or fine suspension, which is more easily pipetted than the anthrone reagent used in the original method[2]. Results obtained by the two procedures are in agreement.

Note added in proof. A simpler method of treating the glucan precipitate is to add a few drops of potassium hydroxide solution (300 gm./lit.) and stir with a glass rod, when the glucan disperses and can be diluted to give a stable suspension suitable for direct pipetting.

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[2] Trevelyan, W. E., and Harrison, J. S., *Biochem. J.*, 50, 298 (1951).

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Refection in the Common Shrew

REFECTION or 'coprophagy' has been observed in the rabbit[1] and in certain other rodents, including the house-mouse and brown rat[2]; but there appear to be no records of its occurrence in the Insectivora. The habit has now been observed in juveniles and adults of both sexes of the common shrew, *Sorex araneus* Linn.

The animal adopts a curled-up position upon its side or back, within the nest, parts the hind-limbs and begins to lick the anus. Some individuals grip the hind-limbs with the forefeet in order to maintain this attitude. After a few seconds a rapid series of abdominal contractions brings about the gradual eversion of the rectum. It emerges as a stout firm tube, 5–10 mm. long, which curves slightly forward towards the mouth. The open end of the everted rectum is nibbled and licked for a period which has not been observed to exceed ten minutes. Inversion into the body, like eversion, is effected by abdominal movements. If the animal is picked up without warning, the everted rectum may lose its 'erected' condition and become flaccid.

When the animals are dissected immediately after refection, the stomach and the first few centimetres of the intestine are found to be filled with a milky fluid containing numerous fat globules and small fragments of undigested food. The remainder of the intestine and the rectum are completely empty. It is evident that refection does not commence until the gut is entirely free of fæcal matter. Possibly the brief anal lickings frequently observed prior to refection are directed towards sampling the rectal contents.

Harder[2] reviews present knowledge of refection in rodents, and proposes the term 'cæcotrophy' to replace 'coprophagy', in view of the cæcal origin of the ingested material. While refection in the shrew may imply analogous nutritional consequences, the mechanism involved must be quite different as no cæcum is present. The process may be a relatively simple one, brought about by a periodic cessation in the flow of digestive fluids. Its occurrence in recently weaned juveniles and in adults soon after capture suggests that it is a normal physiological process rather than one occasioned by diet deficiency in captivity.

These observations were made while engaged on an ecological study of the species at the Bureau of Animal Population, Department of Zoological Field Studies, University of Oxford.

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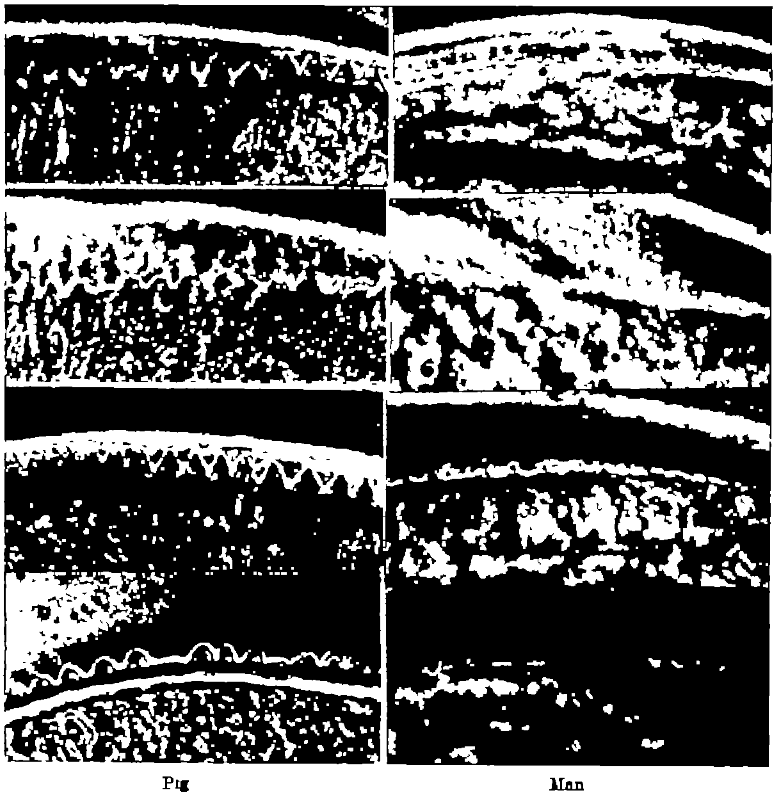
Anatomical Distinction between Human and Pig Strains of *Ascaris*

IT has long been a matter of uncertainty whether the ascaris parasite of the domestic pig is specifically identical with *Ascaris lumbricoides* L. 1758 from the



Denticles of *Ascaris* of pig and man. × 750 intestine of man. The evidence, as brought forward by epidemiological observations and by experimental infections, appears on the whole to indicate that there is a difference in these two parasites; but no morphological feature has been discovered which distinguishes them as separate species.

Through the kind co-operation of Dr. P. C. Beaver, of Tulane University, U.S.A., I have recently examined, while working at the Ontario Research Foundation, about fifty well-preserved specimens of the human ascaris removed from the intestine of a child at operation. The denticles of the dentigerous ridges were compared with those of the pig ascaris obtained from an abattoir in Toronto. Comparisons were made of *en face* and internal views of the lips both in the glycerine- and creosote-cleared specimens. Both sexes were examined in about equal numbers.

The photographs (reproduced herewith) show that the denticles of the pig ascaris (Figs. 1–4) form a conspicuous row of more-or-less equilateral triangles and that the edges of the denticles are straight. In contrast, the denticles of the human ascaris are considerably less conspicuous, being smaller and having concave edges (Figs. 5–8). In some specimens of the pig ascaris the points of the denticles are rounded, possibly by wear, but the difference is still apparent (Figs. 2 and 4). In some specimens of the human ascaris, the denticles appear to be worn away, only the ridge being evident.

The purpose of this communication is to suggest that specimens from other parts of the world should be examined with regard to their denticles, so that the taxonomic value of these structures may be ascertained.

I should be grateful to receive any ascaris material.

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An Improved Electrophoresis Cell for the Analyses of Several Sera Simultaneously

AN electrophoresis cell which enabled two sera to be analysed simultaneously was described in a previous communication[1]. In this apparatus two 'Cellophane' membranes were inserted between the top and the bottom of the standard analytical cell and the electrode vessels.

A new apparatus embodying the same principle but giving diagrams identical with those obtained by the conventional method is depicted in Fig. 1. *A* and *B* are 'Perspex' adaptors connected to the electrode vessels, *C* is the central part of a standard Longsworth cell and *D* is a slotted 'Perspex' slide which can cut off communication between *A* and the cell when desired. Prior to assembly, the ground surfaces of the 'Perspex' and glass are well greased and a 'Cellophane' membrane *M* is clamped between *B* and the cell *C*. The balance of the apparatus is then assembled and the sera to be analysed introduced via the slots in the bottom of adaptor *A* and the levelling section. The levelling section is then moved to the cut-off position, the excess serum removed and the rest of the cell filled with buffer and a saturated solution of potassium chloride.

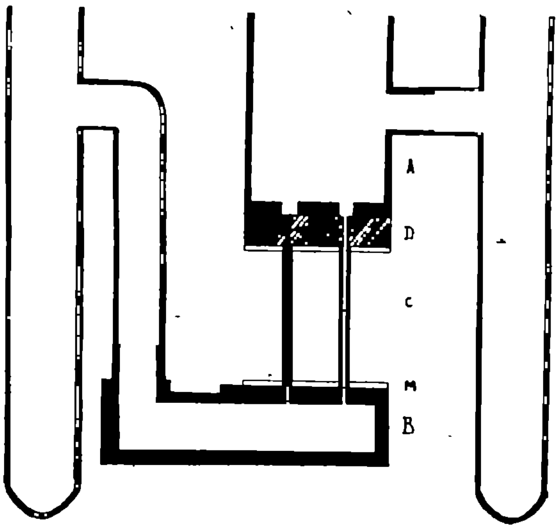

Fig 1 Electrophoresis cell. The two electrode vessels are connected via the adaptors *A* and *B* to the standard Longsworth cell *C*. *D* is a 'Perspex' slide which can cut off communication between *A* and *C*. *M* is a 'Cellophane' membrane clamped between *C* and *B*

After temperature equilibrium has been established in the electrophoresis bath, a fine Pasteur pipette with its tip bent horizontally is lowered, through chamber *A* and the slots in the levelling section, into the cell, and fluid is drawn off at the required level. A very sharp interface is thus established at this position between the serum and the buffer. This method of boundary sharpening has previously been used in electrophoresis and diffusion measurements[2,3]. The current is now switched on and electrophoresis performed in the usual way.

As mentioned in the previous communication[1], there is no theoretical limit to the number of compartments which can be introduced into the analytical section, and consequently to the number of analyses which can be performed simultaneously.

Electrophoresis diagrams obtained with the new apparatus are shown in Figs. 2,*a* and *b*. Fig. 2,*a* is the diagram of normal serum and is free from the anomaly found in diagrams made with the earlier form of the apparatus. Fig. 2,*b* shows diagrams of

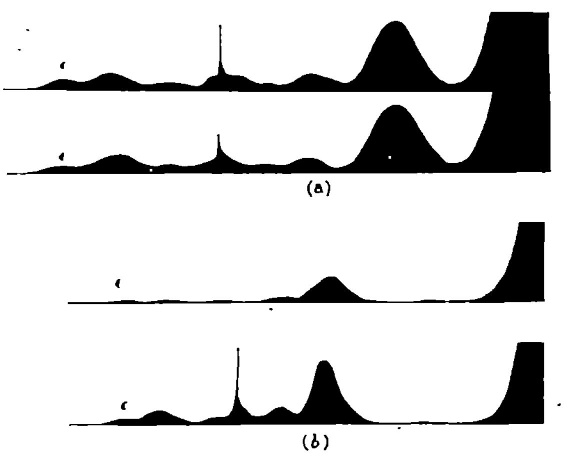

Fig. 2 (*a*) Two electrophoresis diagrams of the same serum run simultaneously in the two limbs.
(*b*) Electrophoresis diagrams of the serum and urine of a patient with orthostatic albuminuria run simultaneously The urine was concentrated eight times before electrophoresis

the serum and urine of a patient with orthostatic albuminurea.

An electrophoresis cell is now under construction which will allow four electrophoretic analyses to be performed simultaneously. With this type of cell the sera may be removed by a long pipette after a run and immediately replaced by a second batch of four samples. In this way we hope to be able to analyse at least eight sera during the course of a normal working day.

The Virus Research Unit in which this work was carried out is financed by the South African Council for Scientific and Industrial Research with additional grants from the Nkana-Kitwe and Chingola Poliomyelitis Research Funds.

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Structure of White Phosphorus : Single Crystal X-Ray Examination

SEVERAL attempts to obtain X-ray diffraction patterns of crystalline white phosphorus have been made[1]. It is claimed by some that the ready reversion of the white to the red form under irradiation with X-rays prevents any pattern being obtained, while others suggest that the high degree of thermal motion in the crystal lattice will render it impossible to obtain anything but a few very diffuse rings. Natta and Passerini[2], however, state that they obtained a well-defined powder photograph of white phosphorus with 22 lines, using iron $K\alpha$ radiation at − 35° C. They claim that the substance is cubic with $[a] = 7 \cdot 17$ A., containing four molecules of P_4 per unit cell, but give no other data.

By using copper $K\alpha$ radiation at − 30° C., we have obtained X-ray diffraction patterns from single crystals of white phosphorus. Our results do not confirm those of Natta and Passerini. Sticks of highly purified white phosphorus were sealed in glass tubes under vacuum and crystals grown by slow sublimation. A wide variety of crystalline habit was observed. Needles, rectangular plates and various polyhedra were obtained, all of which gave similar X-ray patterns. It was found that these single crystals would remain stable, usually for two or three days, if they were given a thin coating of methanol–shellac solution. The crystals were cooled in a stream of dried air at − 30° to − 35° C. during exposure, and well-defined oscillation and rotation photographs were obtained on a standard camera of 3 cm. radius. Attempts to obtain powder photographs using Natta and Passerini's technique[2] were unsuccessful.

The X-ray photographs indicated a body-centred cubic lattice with $[a] = 18 \cdot 51 \pm 0 \cdot 03$ A. Systematic absences of the reflexions were $\{hkl\}$ when $\{h+k+l\}$ was odd. A Laue photograph revealed the presence of a fourfold axis of symmetry, and this meant the space group was probably $I432$, $I\bar{4}3m$ or $Im3m$. The crystal density at − 25° C. was found to be 1·84 gm./c.c. A unit cell containing 56 P_4 molecules gave a calculated density of 1·82 gm./c.c. The general features of the photographs included, in addition to single crystal spots, weaker diffuse rings corresponding to spacings of roughly 4·3, 2·5 and 1·7 A. Evidence for a high degree of thermal motion in the structure was afforded by the very rapid decrease of the intensities of the diffraction spots after a value of about $\rho = 1 \cdot 0$.

It is reasonable to suppose that the structure is built out of discrete tetrahedra similar to those which exist in the vapour[3], with $P - P = 2 \cdot 21 \pm 0 \cdot 02$ A. and angles $P/P/P = 60°$. Preliminary structural studies with the aid of similar tetrahedral models indicated that 56 P_4 molecules could not be arranged in the unit cell without appreciable mutual overlap, if the non-bonded radius of the phosphorus atom was taken[4] to be 1·9 A. An explanation of the structure may be found in some peculiar effect of the thermal motion on the packing arrangements. Space group $Im3m$ could be rejected as very improbable on general crystallographic grounds, and $I\bar{4}3m$ seemed a more likely choice than $I432$. Further examination of the crystal structure is proceeding and detailed results will be published elsewhere.

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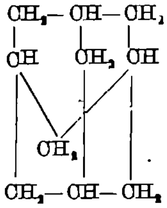
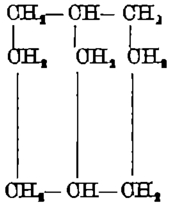
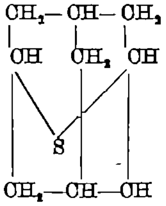
Thiaadamantane

THE investigation into the composition of the sulphur bodies present in the kerosene boiling-range of a Middle East crude oil distillate (Agha Jari, South Iran) has indicated that the sulphuric acid-soluble neutral compounds consist mainly of fully hydrogenated mono- and bi-cyclic sulphides with smaller amounts of alkylated thiophenes. A solid sulphur-containing compound is also present which collects as a sublimate in the column head during the fractionation when the column head reaches 78° C. at 3 mm. mercury pressure. This solid can be purified by sublimation or recrystallization, and forms sweet-smelling crystals which melt in a sealed tube at 320° C. with decomposition. Analysis gives the empirical formula $C_9H_{14}S$.

The general character of this interesting compound together with its chemical reactions, which include the formation of a sulphone and a mercuric chloride complex, suggests that it is a doubly bridged *cyclo*-paraffin in which a sulphur atom forms one bridge. In its physical properties this compound resembles the hydrocarbon adamantane isolated by Landa and Macháček from a Hodonin naphtha[1]. The structure of this hydrocarbon, confirmed by synthesis (Prelog and Seiwerth[2]), is that of a doubly bridged *cyclo*-octane ring (I). Confirmation that our sulphur body contains a basic structure resembling that of adamantane is shown by the fact that, on desulphur-


(I)


(II)


(III)

ization with Raney nickel, it yields *bicyclo*-1.3.3-nonane (II).

While it is possible that the sulphur occupies alternative positions in the adamantane structure and that desulphurization still yields the same *bicyclo*nonane, from the general character of our compound it appears highly probable that the sulphur forms the second bridge spanning the 3.7-carbon atoms (III). An attempt is being made to confirm this structure by synthesis. The isolation of this compound together with that of the bicyclic sulphides and thiophenes which accompany it will be fully reported in due course elsewhere.

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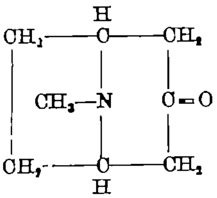
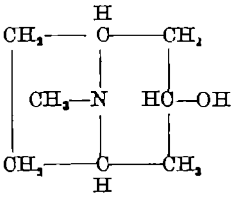
Reduction of Tropinone with Lithium Aluminium Hydride

The reduction of the keto group in tropinone (I) to the secondary alcoholic stage gives the two internally compensated stereoisomerides tropine and ψ-tropine (II). The nature of the reduction product depends on the reducing agent used. When the reduction is done electrolytically or with zinc and hydriodic acid, tropine is the main product[1]. However, the reduction product is always contaminated with small amounts of ψ-tropine. With sodium amalgam tropinone is reduced to ψ-tropine only[1]. As the formation of tropine and ψ-tropine from tropinone involves the reduction of a ketone to a secondary alcohol, it could be foreseen that lithium aluminium hydride would be a specific reagent for it[2]. However, the interest lay in knowing the exact nature of the reduction product (or products) obtained.

Reduction of tropinone was studied in ether solutions. In all the experiments ψ-tropine was obtained and the yield was quantitative. Difference in the concentration of the solution, in the rate of addition, or reverse addition, made no change in the nature of the reduction product. A range of temperatures from −10° to the boiling point of ether made no difference. In all the experiments, the product was isolated in the form of the picrate to ensure the separation of tropine and ψ-tropine[1,3].


(I)


(II)

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Feb. 17.

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[1] Willstätter, *Ber.*, 33, 1167 (1900).

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A New Province of Igneous Ring-Complexes in Southern Nyasaland

Recent examination of air photographs of Southern Nyasaland taken by the Royal Air Force has revealed that almost certainly this area forms a province of igneous ring-complexes, vents and dykes comparable with the British Tertiary igneous area of West Scotland, the White Hart Mountains region of New Hampshire and the more recently described region of ring intrusions in Nigeria. Indeed, it seems probable that the number of vents and ring-complexes in Southern Nyasaland and the adjoining parts of Portuguese territory will exceed that of any previously reported area.

From Dr. F. Dixey's work[1] on the Nyasaland Geological Survey, it has long been known that vents filled with agglomerates and the much-discussed carbonatites exist in the region of Lake Chilwa, and it now appears likely that these form one manifestation in a complete igneous episode involving, in order of time, great outpourings of lava, the explosion of volcanic vents, probable cauldron-subsidence and the intrusion of ring-dykes and great syenite stocks and, lastly, the injection of basic dykes. The Stormberg period at the close of Karroo times was characterized by the extrusion of tremendous lava flows over a very large area in Central and South Africa, and Dr. Dixey has been able to date the volcanic vents of Southern Nyasaland as being post-Karroo and pre-Cretaceous. Further, it is known that the nepheline syenite intrusions into the vents are later than the agglomerates and carbonatites and, while the great ring-dyke complexes now reported have not yet been dated, there is very good reason to suppose, from analogy with other areas, that they follow on, in time, after the explosive vents and were themselves followed by the dyking phase.

One very spectacular ring-dyke complex forms Chambe Plateau in the north-western part of the Mlanje Mountains; it is thought to comprise four successive ring-dykes about the same centre and with a common vertical axis. The external diameter of the outermost dyke is just over four miles. From the plains at the foot of the mountains the two outer 'rings' rise almost sheer for 6,000 ft. in places, while the two inner 'rings' form a central circular depressed region some 2,000–2,500 ft. below the outer 'rampart'.

The facts observed on the photographs and the hypotheses formed therefrom must, of course, be checked in the field before this potentially important region can be discussed in detail; but the recognition of the ring complexes and dykes from air photographs forms a striking example of the value of photogeological interpretation. Work on the photographs continues at the headquarters of the Directorate of Colonial Geological Surveys.

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April 17.

---

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Rapid Estimation of Standard Deviations

WHEN a series of numbers can legitimately be regarded as random samples from a normal distribution, the mean range within small sub-groups, multiplied by a factor depending only on group-size, gives a very good and easily calculated estimate of the standard deviation of the parent distribution, not much inferior in precision to that obtainable from the mean squared deviation[1]. A specially simple computation is obtained when the sub-group size is two.

Let the successive individual readings be A, B, C . . . X, Y, Z. The sum is required of all the ranges between adjacent numbers. This means that all the differences, $(A - B)$, $(B - C)$, and so on, are to be given a positive sign and added together. If B is greater than both A and C, it will have a positive sign twice. If B is less than both A and C, it will have a negative sign twice. But if B is bigger than one neighbour and smaller than the other, it will take one positive sign and one negative sign, and so will cancel out. The sum of the sub-group ranges, therefore, is twice the sum of the peak numbers (bigger than both neighbours) minus twice the sum of the trough numbers (smaller than both [illegible]ou[illegible]s). This rule obviously breaks down for
[illegible]al numbers A and Z. To deal with this,
[illegible] series as an endless cycle, going back to
[illegible]aching Z, and write the first two numbers
[illegible]he end, thus : X, Y, Z, A, B. It is then
[illegible] see whether Z and A are peaks, troughs
[illegible]liate, and to add, subtract or ignore them
[illegible]. When two or more adjacent numbers
[illegible]l, disregard all except the first and treat
[illegible] regular rule. If there are N items in
[illegible]here are also this number of sub-ranges.
[illegible]or converting range into standard devia-
[illegible]ry groups is 0·886, which can be taken
[illegible]hs. Hence the following rule :

[illegible]te the standard deviation of a random
[illegible]a normal distribution, add all the peak
[illegible]d subtract all trough numbers in the
[illegible]the first two members repeated at the
[illegible]by $\frac{1}{2}N$, and take off one-ninth.

[illegible]-minus-trough values can usually be
[illegible]lly, and may be written down and added.
[illegible]ne, the peak and trough totals can be
[illegible]taneously, and the difference between
[illegible]en be obtained.

[illegible]thods for standard deviation have been
[illegible]ntinue to give quite good approximations
[illegible]the distribution differs markedly from
[illegible] But the estimate may be seriously dis-
[illegible] data are not in random order. Any
[illegible]d, whether upwards, downwards or cyclical, or any circumstance which causes adjacent values to be more closely alike or more unlike than would happen by chance, will produce bias in the estimate. In doubtful cases, there is a useful simple test of randomness. For large N, the number of peaks (or troughs) in a random series may be regarded[2] as normally distributed with mean $N/3$ and standard deviation $(N/22\frac{1}{2})^{1/2}$. The difference between actual and expected number of peaks is tested for significance in the usual way. If the discrepancy is D, there is no evidence, at the 95 per cent probability-level. of departure from randomness so long as D^2 is not larger than $N/5{\cdot}86$, or, to a sufficient approximation, not larger than $N/6$. When there are many 'ties' between adjacent observations, the number of these should be subtracted from N before the test for randomness is applied.

In practice, moderate departures from randomness do not invalidate the estimate of standard deviation, provided this method is recognized as giving only a quick approximation. It will often suffice to settle questions of significance without need for recourse to the maximally efficient but much more laborious computation based on sums of squares. It may also be used as an independent check of standard deviations calculated in the orthodox way. If this is done, the computer will soon gain experience of the effect of departure from randomness on the estimate of standard deviation. When the departure from randomness is serious, the method may still be applicable provided it is not difficult to shuffle the data so as to get nearer a chance order. It may suffice, for example, to read the data across rows instead of down columns. The method is specially useful for data recorded on control charts. It can also be used to get a pooled estimate from sets of observations presumed to have the same standard deviation though their means may differ, such as arise in biological assay. The peak-minus-trough figures are totalled over all the series, and treated as if they came from one series with ΣN observations.

To obtain the mean, make a separate total of the intermediate numbers (neither peak nor trough) and add to the peak and trough sums to get the grand total. All three totals can be computed simultaneously on the usual kinds of machine. An easier method, which gives the mean and a rather less precise estimate of the standard deviation, is to take the observations in non-overlapping pairs and to add separately the larger and the smaller numbers. Thus A and B would first be considered, then C and D, and so on, the smaller of each pair being accumulated on the left, and the larger on the right, of the machine. If N is even, the sum of the totals divided by N gives the mean, and the difference, divided by $\frac{1}{2}N$ with one-ninth deducted, gives the estimate of the standard deviation. If N is odd, the last observation may be omitted for computation of the standard deviation, or it may be paired with the first, the divisors being respectively $\frac{1}{2}(N - 1)$ or $\frac{1}{2}(N + 1)$. For computing the mean, every observation is, of course, taken once.

The methods described above are specially rapid on key-driven adding machines.

B. WOOLF

Institute of Animal Genetics,
West Mains Road,
Edinburgh 9.
March 17.

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[1] Cf Pearson, *Biometrika*, 37, 88 (1950).

[2] Kermack and McKendrick, *Proc Roy Soc. Edin*, 57, 228 (1937).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, October 13

University of London (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Prof. Adrien Albert: "Ionisation and Biological Activity".* (Further Lectures on October 20 and 27.)

Physical Society, Acoustics Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Mr. A. T. Pickles: "Acoustics in America".

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. D. Mackay: "An Artefact's Approximation to Voluntary Behaviour".

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. E. M. Landis: "Movement of Fluid and Dissolved Substances through the Capillary Wall", 1.* (Further Lectures on October 15 and 17.)

University of London (in the Botany Department Lecture Theatre, Imperial College of Science and Technology, Prince Consort Road, London, S.W.7), at 5.30 p.m.—Prof. G. Melchers: "Physiology of Flower Formation".* (Further Lectures on October 15 and 17.)

Society of Chemical Industry, Fine Chemicals Group (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 7 p.m.—Prof. F. E. King: "Synthesis of Simple Peptides".

Tuesday, October 14

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. A. Armitage: "Copernicus and the Reformation of Astronomy".*

Zoological Society of London (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

Institution of Chemical Engineers (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. D. M. Newitt, F.R.S., Dr. J. F. Richardson, Dr. R. H. Clark and Mr. D. H. Charles: "Pneumatic Conveying, Part 1, The Pressure Drop during Horizontal Conveyance".

Illuminating Engineering Society (at the Royal Institution, 21 Albemarle Street, London, W.1), at 6 p.m.—Dr. W. J. Wellwood Ferguson: Presidential Address.

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of Chemistry to Engineers" (to be opened by Dr. J. E. Garside).

Wednesday, October 15

Royal Sanitary Institute (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. W. F. B. Shaw: "The Efficiency of Domestic Solid-Fuel Appliances".

Physical Society, Colour Group (at the Institute of Ophthalmology, Judd Street, London, W.C.1), at 3.30 p.m.—Dr. E. N. Willmer: "Central Foveal Colour Vision": Mr. R. A. Weale: "Colour Vision in Extrafoveal Regions".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. Howel Williams: "Progress and Problems in Volcanology" (William Smith Lecture).

Royal Society of Medicine, Comparative Medicine Section (at 1 Wimpole Street, London, W.1), at 5 p.m.—Dr. O. L. Oakley: "The Sites of Production of Antibodies" (Presidential Address).

Textile Institute, Lancashire Section (joint meeting with the Newcomen Society, at the Textile Institute, Manchester), at 6.30 p.m.—Mr. W. A. Hunter: "James Hargreaves and the Invention of the Spinning Jenny".

Thursday, October 16

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Helen Spurway: "Is Man a Domestic Animal?"*

Society of Chemical Industry, Microbiology Group (at the Medical Society of London, 11 Chandos Street, Cavendish Square, London, W.1), at 2.30 p.m.—Mr. H. Proom and Dr. A. J. Woiwod: "The Application of Paper Chromatography to Microbiology".

Institution of Mining and Metallurgy (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. J. B. Richardson. "Graduates in Metal Mining—Notes on their Status, Training and Vocation"; Mr. R. S. Cooke: "Recovering a Flooded Shaft in the O.F.S. Goldfield".

Physical Society, Low-Temperature Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Dr. A. J. Barnard: "Gas Compressors".

Society of Chemical Industry, Road and Building Materials Group (at the Building Centre, Store Street, London, W.C.1), at 6 p.m.—Dr. A. C. Whiffin and Mr. W. I. J. Price: "Road Problems arising from Snow and Ice".

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the Institute of Biology and the London and Home Counties Branch of the Institute of Physics, at the City of London School, Victoria Embankment, London, E.C.4), at 6.30 p.m.—Discussion on "The Place of the Scientist in Civil Defence".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Dr. D. H. R. Barton: "The Stereochemistry of *cyclo*-Hexane Derivatives" (Tilden Lecture).

British Institute of Radiology (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 8 p.m.—Mr. J. W. McLaren: "Some Aspects of Soft Tissue Radiography" (Presidential Address).

Friday, October 17

British Mycological Society (in the Physics Lecture Theatre, Birkbeck College, Malet Street, London, W.C.1), at 10.45 a.m.—Papers on "The Physiology of the Host-Parasite Relationship in Fungi and Bacteria".

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting; Rear-Admiral A. Day: "Navigation and Hydrography" (Presidential Address).

University of London (in the Chemistry Department, University College, Gower Street, London, W.C.1), at 4.30 p.m.—Seminar on "Polymer Science".* (Further Lectures on October 24, 31, November 7, 14, 21, 28, and December 5.)

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Sir David Pye, F.R.S.: "The Art of the Practical Engineer" (Presidential Address).

Royal Institute of Philosophy (at University Hall, 14 Gordon Square, London, W.C.1), at 5.30 p.m.—Prof. J. Z. Young, F.R.S.: "Mind and its Place in Nature" (Manson Lectures, 1). (Further Lectures on October 24 and 31, November 7, 14 and 21.)

Institute of Physics, Industrial Radiology Group (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Dr. L. Mullins: "The Physics of the Radiographic Image".

World Calendar Association, British Section (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 7.30 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Calendar—Past, Present and Future".* (Admission by ticket from 20 Buckingham Street, London, W.C.2.)

Saturday, October 18

Nutrition Society (at Bedford College, Regent's Park, London, N.W.1), at 10.15 a.m.—Conference on "Unusual Foods for Human Consumption".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned.

Honours Graduate (first- or good second-class) for cytogenetical research on tuberous species of Solanums, and an Assistant Experimental Officer (woman) for investigations of Late Blight and general maintenance of potato collection, at the Potato Genetics Station, Cambridge—The Secretary, Agricultural Research Council, 15 Regent Street, London, S.W.1 (October 17).

Assistant Lecturer in Electrical Engineering, to teach light current electrical engineering to H.N.C. and, possibly, final B.Sc standard—The Principal, Royal Aircraft Establishment Technica
College, Farnborough, Hants (October 18).

Experimental Officer to undertake research work connected witl
the application of strain gauge techniques to agricultural engineerin
problems, and in particular, to investigate with the aid of mobil
strain recording equipment the dynamic forces within implements an
tractors working on hillsides—The Secretary, Scottish Machiner
Testing Station, Howden, Mid Calder, Midlothian (October 18).

Principal Lecturer in Electrical Engineering—The Regi
trar, Military College of Science, Shrivenham, Swindon, Wilts (Oct
ber 18).

Head of the Department of Biology—The Princi pal,
Polytechnic, Manresa Road, London, S.W.3 (October

Pathologist at the Equine Research Station, Ne
Pathologist at the Canine Research Station, near Ne
Pathologist at the Poultry Research Station, St. Ives,
logist at the Canine Research Station, a Parasitolo
Equine Research Station, an Experimental Surgeon a
Research Station, a Field Officer at the Farm Live
Station, and a Nutritionist at the Poultry and Fa
Research Station—The Scientific Director, Animal H
232–235 Abbey House, Victoria Street, London, S.W.1

Senior Administrative Officer (experience of co
mittee work is essential, and preference will be given t
natural science)—The Assistant Secretary, Royal Soci
House, Piccadilly, London, W.1 (October 21).

Biochemist (non-medical) (with a university degre
science qualification)—The Group Secretary, Dur
Management Committee, Dryburn Hospital, Durham

Lecturer in Natural Philosophy—The Secretary,
Edinburgh (October 25).

Scientist III (with a good honours degree, or eq
fication, in a science subject, preferably with a sound
geology and chemistry) in the Coal Survey Laborato
The National Coal Board, Establishments (Personnel),
Grosvenor Place, London, S.W.1, quoting TT/538 (O

Assistant Lecturer or Lecturer in the D
Metallurgy—The Registrar, The University, Liverpo

Lecturer in the Department of Botany at the
Cape Town—The Secretary, Association of Universitie
Commonwealth, 5 Gordon Square, London, W.C.1
November 15).

Lecturers in Physiology at the University of Q
Secretary, Association of Universities of the British
5 Gordon Square, London, W.C.1 (November 15).

Assistant Silviculturist (with a degree in fore
experience in silvicultural research and biometry
qualifications) in the Wattle Research Institute of th
Natal, Pietermaritzburg—The Secretary, Association
of the British Commonwealth, 5 Gordon Square,
(November 30).

Chief Scientific Officer in the Fisheries
attached to the Department of Biology, University
The Secretary, Association of Universities of the
wealth, 5 Gordon Square, London, W.C.1 (Decembe

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OVERSEAS INFORMATION SERVICES

THE question whether the overseas services of the British Broadcasting Corporation should continue to be grouped with broadcasting in the United Kingdom, and with television, as the monopoly of a single corporation, was placed by the Beveridge Committee as the second of the fundamental issues it was asked to resolve. Nevertheless, overseas broadcasting was manifestly regarded as a secondary issue by the Committee, and its comments have received little attention. Mr. John Coatman has argued cogently for placing the overseas services under organizations in appropriate relation with the British Broadcasting Corporation, and for restoring the Corporation to its old position as the broadcasting authority for the people of the United Kingdom alone. Since overseas broadcasting was intended to be a projection, not of the government of the day in Britain, but of Britain and of the nature of the British way of life and liberty, the Beveridge Committee admitted that overseas broadcasting should be a function of some body independent of the Government, but was not prepared to recommend division or devolution. It recommended instead continuance of the existing arrangements for division of responsibility for overseas broadcasting between the government and the British Broadcasting Corporation, and this recommendation was accepted by the Government in a White Paper issued last May.

The cost of the overseas services of the B.B.C. will thus continue to be borne by a grant-in-aid from the Exchequer, and the cost will be calculated as the definable additional expenditure incurred on account of the overseas services. This arrangement does not, however, meet one important criticism made by the Beveridge Committee, the report of which directed attention to the different line taken by the Government in fixing the deduction to be made by the Post Office from gross licence revenue to cover the costs of collecting the fees and of the interference service. The Post Office includes in those costs a share of the total overheads of the Post Office, a practice for which there is every justification in view of the liability of the discharge of the proper and normal functions of the Post Office to be obstructed by the multifarious duties it undertakes for other Departments of State. The Beveridge Committee was unanimous that the charge made by the Corporation to the Government for overseas services should in future be calculated on the same principles and include overheads.

The silence of the White Paper on this point, coupled with the dubious honesty, to say the least, of the fifteen per cent deduction from the net licence revenue, gives point to the Beveridge Committee's remark that in the financial arrangements for overseas broadcasting the Government has been attempting to obtain benefits without paying for them. On this parsimony and its consequences the Ninth Report from the Select Committee on Estimates* turns a searching light, and the Government emerges from this scrutiny with little credit. The Estimates Committee has grave doubts whether the present procedure is any longer an appropriate method of ensuring, on one hand, that the Corporation has the necessary freedom to carry out its task, and on the other that Parliament has the requisite control over the directions in which public money is spent.

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* Ninth Report of the Select Committee on Estimates. Session 1951–52. Overseas Broadcasting. Pp. xxvii+146. (London: H.M.S.O., 1952.) 6s. 6d. net.

When the B.B.C. was designated as the chosen instrument for broadcasting overseas, the government was anxious that the freedom of the Corporation should be curtailed as little as possible. This was fully appreciated by the Beveridge Committee, and was one reason for its recommending the continuance of the existing arrangement. The Estimates Committee, however, is now convinced that the real control exercised by Departments of State, especially the Foreign Office, the Service Departments and the Colonial Office, has considerably increased. With such increased departmental influence, closer Parliamentary control must obviously be exercised.

It must be borne in mind in considering this report from the Estimates Committee that its functions are limited to the examination of the estimates, and to reporting on the form in which they should be presented or on possible economies. Nevertheless, the Select Committee has taken a wide view of its responsibilities, and its outspoken comments may do something to stimulate action to remedy the damage already caused by short-sighted parsimony.

Virtually the sole income of the British Broadcasting Corporation for its overseas services is the grant-in-aid, amounting to £4,750,000. The overseas programmes of the Corporation are sent to countries and in languages prescribed by government departments through the Postmaster-General. They include the General Overseas Service broadcast entirely in English and designed primarily for British communities abroad, including troops stationed overseas, and for the Commonwealth and Empire, and two main groups: the European Services and the Overseas Services, the latter comprising the North and Latin American, Eastern, Far Eastern, Pacific and South African and Colonial Services. The transcription studios in London provide a universal service of transcriptions in English running to six hundred programmes a year. The value of this service lies in the furtherance of the purpose of 'projecting Britain'. But to obtain the full value of the service the Corporation believes a local representative is needed; withdrawal of the Corporation's officers from South America is expected to result in a considerable curtailment of the use of B.B.C. recordings there.

Besides this, the 'external' services of the B.B.C. include the 'monitoring' service, developed in wartime, of listening to and reporting on the broadcasting services of other countries. Although carefully co-ordinated with the Americans, this monitoring service, to which the powers of prescription have been extended by the new licence, has a staff of 572, out of the 3,307 employed by the external services, and is estimated to cost £454,000; nor does there appear to be any prospect of reduction here.

The parsimony of the Government outlook, however, is shown by the unrealistic hope of the Treasury, in spite of the evidence of this report, that economies in overheads will avoid the need for a supplementary estimate. To this attitude the Estimates Committee in its examination of the purpose of external broadcasting supplies a wholesome and much needed corrective. It notes, naturally, the general lowering of morale resulting from successive cuts in the grant and consequent reduction in staff, as well as the resignations of foreign staff and increasing difficulty in recruiting suitable staff from abroad. It emphasizes the long-term character of broadcasting to other countries. A reputation for objectivity is only built up over a period of years, and once a service is abandoned it is difficult to restore. Wave-lengths unused, even for part of a day, are quickly snapped up by other broadcasters. Thus the Committee cites the abandonment of the Latin American services over the past two years.

In this connexion the Estimates Committee expresses surprise that the Board of Trade is not a prescribing department. Manifestly, British overseas trade must play a major part in providing the resources necessary to win the 'cold war', and this depends largely upon prestige. Broadcasting is directed to peoples, not to governments, and in the free world it is the peoples far more than governments that buy. It is thus not enough for the Board of Trade to be represented in regard to overseas broadcasting by the Foreign Office; and one of the Estimates Committee's most important recommendations is that the Board of Trade should be more closely associated with the external services and should be designated as one of the prescribing departments.

The Estimates Committee rightly observes that the influence of broadcasting on backward peoples is potentially great, and that the Colonies are likely to continue to rely to a large extent upon the services offered by the Corporation. "In fact," it is remarked, "broadcasting has become one of the main links of the Commonwealth." But it is not the only link, and the expenditure on broadcasting for such purposes needs to be reviewed in the light of other expenditure directed towards the same end, whether in the field of education or in other ways.

What is obviously required is a wider outlook than has characterized either the present Government or its predecessor. There must clearly be, as the Select Committee rightly indicates, a continuing watch over all such external services, to ensure that no service once instituted is allowed to run on after its marginal usefulness in the national interest has passed; but such a scrutiny must be informed by clear conceptions of what overseas broadcasting can contribute to the maintenance of British needs and interests, and by accurate knowledge of what is being done by other agencies in influencing the minds of peoples. It has, in fact, to take account of what is being done not merely by the British Council and the Colonial Office in the field of overseas education, but also of the work of bodies such as the United Nations Educational, Scientific and Cultural Organization.

In all this, science is only one facet, but an important one; and scientific men should consider how closely they are affected, and in what ways they could assist the more efficient and effective projection of the mind of Britain and of her achievements in science, no less than in other matters of the mind, so as to promote international understanding and provide a firmer basis for world peace. The greater freedom of scientific intercourse, whether it be by the exchange of publications, or the interchange of visits between individuals or institutional staff, depends in part on such mutual understanding as overseas broadcasting is designed to encourage. Even in the free world, much remains to be done in the way of the removal of restrictions before travel between one country and another is as free as is desirable for the advance of science itself; and such barriers are unlikely to be removed purely by unilateral action.

The Estimates Committee's report also makes it manifest how closely this question bears on that of technical assistance to the under-developed areas. That point is argued more closely in an article, "Science and Foreign Policy", by E. M. Friedwald, in a recent issue of *Impact of Science on Society* (Paris: Unesco). Mr. Friedwald urges that scientific and technical assistance is likely to become a major element in international relations and a powerful instrument for promoting goodwill between nations. It can only be fully effective, however, when political obstacles have been removed by the appropriate means; in this work overseas broadcasting and agencies such as the British Council count for much.

What seems to follow, therefore, from this inquiry of the Select Committee on Estimates into overseas broadcasting is that some further measures, which it was not within the scope of that Committee to suggest, are required. It recommends a system of quinquennial grants for the overseas services of the B.B.C., in order to enable the Corporation to plan ahead for reasonable periods in providing what is essentially a long-term project. The administration of such a grant and the continuing scrutiny of the appropriateness of particular services to changing conditions may well call for the establishment of an independent body with a wide purview and responsibility, possibly analogous to the University Grants Committee, and competent to survey not merely the external services of the British Broadcasting Corporation but also other activities by which British ideals and institutions are made known to the world and British prestige is maintained. Such a body might, for example, not merely eliminate any overlap existing between the work of the British Council, the external services of the British Broadcasting Corporation and the work of the Central Office of Information; it might equally eliminate much of the ill-informed and sometimes carping criticism to which all these activities are frequently subject. It could help to bring to the work of the British Council a stability which that body no less than overseas broadcasting needs if its work is to be planned and co-ordinated reasonably.

The first step in that direction, however, would seem to be the institution of an investigation, as was suggested by Mr. John Coatman some eighteen months ago. Besides inquiring into the opportunities for achieving greater economy and efficiency in this field, on which it is estimated some £11,000,000 is at present expended annually, by co-ordinating the work of the B.B.C., the British Council and the Central Office of Information, Mr. Coatman suggested that such a committee should inquire into the desirability of relieving the B.B.C. of all responsibilities in connexion with the political warfare type of broadcasting by transferring it to an appropriate government department or agency. The safeguard to objective overseas broadcasting which such transfer would give is obvious, and Mr. Coatman argued the point more fully in a subsequent article in *Public Administration* (29, 160; 1951), in which he also developed further reasons for a third suggestion which he would have the proposed committee consider, namely, replacement of direct transmissions of certain overseas services by a transcription service of British Home Service programmes.

Under the federal system which Mr. Coatman proposes he believes that such transcriptions would truly represent the life and culture of the whole nation. Moreover, by broadcasting on the national services, better reception conditions would be secured as well as much larger audiences than are at present reached, while two more medium wave-lengths would be made available for home broadcasting. The small committee envisaged by Mr. Coatman as competent to examine and report on these questions should be competent to examine the wider issues, and conduct the continuing surveillance suggested above if it is eventually constituted a permanent body with appropriate powers. The Estimates Committee's report strongly supports the arguments already advanced by Mr. Coatman, and the inquiry suggested appears to be the first step necessary to ensure both economy and effectiveness in interpreting the mind of Britain to the world, with all the possibilities that such activities hold for the advance of science itself and for enabling science to make its full contribution to the growth of international understanding.

HEAVY WATER

Physical Properties and Analysis of Heavy Water

By Isidor Kirshenbaum. Edited by Harold C. Urey and George M. Murphy. (National Nuclear Energy Series, Manhattan Project Technical Section, Division 3, Vol. 4A.) Pp. xv+438. (London: McGraw-Hill Publishing Co., Ltd., 1951.) 45s.

THIS new volume of the National Nuclear Energy Series is devoted to a topic which is of importance to a growing number of research workers who are using non-radioactive isotopes in tracer investigations. Much has already been published on the physical properties and analysis of heavy water; but in earlier publications there is a measure of disagreement. The subject was studied in great detail during the Second World War, particularly by a team working at Columbia University, and it is this new material which constitutes the main part of the present volume. The author and editors have, however, avoided the disjointed effect which was apparent in some earlier volumes of the series. The subject has been treated as a whole, and a coherent review is given both of the work done during the War and of other work published in the open literature.

The first chapter, on the physical properties of heavy water, deals with determinations of such properties as specific gravity, the melting and boiling points, vapour pressure, viscosity and refractive index, and with thermodynamic data. All the more important precise determinations appearing in the literature are reviewed, and full experimental details of new work are given. The author then proceeds to a discussion of exchange reactions involving heavy water, commencing with the calculation of the equilibrium constant for the reaction $H_2O + HD \rightleftharpoons HDO + H_2$ and its experimental investigation. A similar treatment of exchange reactions involving ammonia and carbon dioxide follows.

The large section of the book on mass-spectrographic analysis falls into two parts, the first devoted mainly to instruments and general techniques of measurement, and the second to problems connected with the isotopic analysis of heavy water by the mass spectrograph. In both parts there is much that is new, and many techniques are described in great ail. These include both methods for decomposing to obtain hydrogen for analysis, and also ls for equilibrating water samples with or deuterium gas in the presence of a The ways of analysing water for the e content are also described.

ner methods have been applied from time analysing heavy water for its deuterium Of these the author has chosen those ng density determinations by means of a float alling drop, and the refractometric method, for iled discussion. The existing literature is ewed, and a good deal of very precise work done ng the War is described. These methods are cularly useful for detecting small variations in bundance of hydrogen and oxygen isotopes in ral waters. Results in this field, which are ibed in the last chapter, may be of great value y future hypothesis concerning variations in the ic ratio of terrestrial materials.

great value of this book lies in its critical h. The author and editors have themselves sely concerned with much of the outstandingly li perimental work described. Their many rel ts of technique, and the careful assessment of tl ults of their experiments and those of others, consti a major contribution to the subject.

H. J. EMELÉUS

A PHYSICIST LOOKS FORWARD

The Next Million Years

By Sir Charles Galton Darwin. Pp. 210. (London: Rupert Hart-Davis, Ltd., 1952.) 15s. net.

WHENEVER Sir Charles Darwin sets out to write, we know he will produce something both unusual and interesting, and in this book he has not disappointed us. He is looking forward. But unlike most of his predecessors in this kind of writing, he is not limiting himself to a period of a cent when people very much like ourselves will on developments with which we are famil have started: instead he is trying to long-range "average history" of the worlc

Instead of the classical cause-and-effe Sir Charles adopts the statistical methoc the laws of probability. He points out that of an individual human being are as un as the movements of an individual molecu in a containing vessel; but the average duced by an enormous number of molecu predicted with great accuracy because, as of chances becomes larger and larger, th any single event become less and less imp they tend to cancel out. In statistical dy says, an enormous superstructure can be confidence out of a foundation that migh be very narrow. Pursuing the analogy fi may, he thinks, reasonably hope to find law controlling those unpredictable molecu beings, if we can find internal conditions to the condition of being a conservative system, and external conditions analog containing vessel.

The latter presents the lesser difficulty taining vessel is the earth, about which know a great deal—probably enough forecasts. The internal conditions analogo of conservative dynamical systems are the and characteristics of human nature, and generalities seem to emerge which hold fc however widely individuals may devia properties and characteristics change, sufficiently large numbers of events only and on analogy with the past, Sir Charl that it will take about a million years have gone far enough to make man so dif what he is now that he will become a n He does not think that these changes expedited by some dictator or ruling hormones or eugenic methods such a speedily produced changes in domesticate such differentiation into specified types improbable by the fact that man is "w than "domesticated". The necessary rulin thinks, could never emerge. Man as a will always multiply up to the limit available food supplies, and in consequen greatly these may be increased, there persist a large starving marginal populat increasing scientific control natural selecti some significance as a factor in deter chances of living, and some physical d may well follow its elimination.

Our present political systems are li modified. Democracy lacks survival v state of parasitism on the community eng modern social conditions is impermanent the end the parasite destroys its host anc perishes: the process is likely to be hast concomitant reduction of the more intell being now driven to have few or no child be the non-parasitic communities that v and those that multiply most will domina by sheer numbers. For this reason the au that world agreement to control popul never be attained: an aggressor nation o never permit their people to restrict the and other nations that wished to survive to follow suit. Government would pos some "hero" who has sufficient sense to adapt himself to a society of dense population. Here intellect will count, but morality may not, since "in a highly competitive world, the sinner has many advantages over the saint". Desire for children there must be, however, or the increased population could not eventuate, and *Homo sapiens* may well change into *Homo paediphilus*. Man, however, is a thinking being, and the author discusses the potent effect of creeds on his life and action—using the word "creed" to denote the whole body of tenets derived from teachers the surrounding society and direct personal experience. He instances China, where the belief in ancestor worship imposes on each man the duty of leaving descendants to continue the practice. As the children of abler people are more likely to survive in a population where many are on the verge of starvation, the creed has a strongly eugenic effect. Rome, with a different creed, collapsed under the attacks of the barbarians, while China, equally attacked, after two generations has absorbed and assimilated its Mongol conquerors and continued its course unperturbed: its people now form one-fifth of the human race. But in the long run and over great periods of time, Sir Charles is sceptical about the permanent effects of creeds.

Space does not permit an adequate summary of the author's forecasts: his final picture is, as he admits, rather gloomy. He foresees a densely crowded world with a permanent starving margin, where the people, looking back regretfully on the prodigious stores of energy and other natural resources that we have so lavishly wasted, are compelled to a harder existence than ours and set a lower value on human life. Conditions of work will become more severe for the less efficient, and the only mitigation will be for the more intelligent. There will be more discontent, and no notable addition to the sum of human happiness. Periodically there will come better times, "Golden Ages"—probably the greatest of these will have been the nineteenth century. Civilization is unlikely to be ended by war; but there is the chance that some irresponsible individual might blow up the whole planet with a sufficiently large hydrogen bomb when the secret of making such potent instruments is discovered.

Given the premises, the conclusions follow logically. The premises assume a universe where events fall out as in statistical dynamics, without intervention by a Deity as postulated by the Christian religion: a universe without a plan.

It would be interesting to compare this forecast with some of its predecessors. H. G. Wells used the cause-and-effect method, and with his marvellous gift of extrapolation was able to predict changes which, apparently fantastic at the time, nevertheless came about later. His picture, too, like that of Sir Charles, is depressing. Both forecasts are immeasurably remote from the radiantly optimistic visions of the nineteenth-century writers such as Edward Bellamy, whose "Looking Backwards", with its blissfully happy people progressing onwards and upwards for ever, was accepted by even so realistic a Victorian as Sydney Webb—who once told me more than sixty years ago that that was what the world would be like when we got Socialism.

The book is extremely interesting, and it will serve a useful purpose if it leads politicians to look forward more than the usual five years, and to try thinking out the long-term result of their policies.

E. JOHN RUSSELL

ORGANIC CHEMISTRY OF PHOSPHORUS

Organophosphorus Compounds

By Prof. Gennady M. Kosolapoff. Pp. vii+376. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 60*s*. net.

FROM the early days of systematic organic chemistry, organic compounds of phosphorus have been the subject of considerable investigation. Beginning in the late 1860's, the eminent German chemist Michaelis devoted a long and illustrious lifetime to their study, and he and his school were responsible for laying the foundations of the chemistry of phosphorus compounds. There followed the classical researches of Arbuzov in Russia, and more recently British chemists have made outstanding contributions. The names of F. G. Mann and W. C. Davies are associated with valuable studies in the phosphine field, and to A. R. Todd we owe the development of several new methods of phosphorylation, elegant syntheses of substances related to nucleic acids, and notably the first authentic preparation of adenosine triphosphate.

Several organophosphorus compounds have to-day acquired industrial status for diverse applications as solvents, plasticizers, insecticides, surface-active agents, flame-proofing compositions, lubricating-oil additives and warfare agents. Schrader pioneered the use of phosphorus compounds as insecticides, and the discovery of systemic activity in certain derivatives has led to important developments. But undoubtedly the main interest in organophosphorus compounds derives from their biological significance. One need only mention the nucleic acids, phospholipids, phosphoproteins and amino-acids, various coenzymes, nucleotides, phosphorylated derivatives of sugars and the fact that two of the more recently discovered vitamins—vitamin B_{12} and pantothenic acid—seem to function biologically as phosphate derivatives, to realize the importance of phosphorus compounds in the manifestations of life phenomena. Yet it is not unusual to find but scant reference to the organic chemistry of phosphorus in standard text-books even to-day. The appearance of this first treatise on the subject in English is therefore particularly welcome.

The author, Prof. G. M. Kosolapoff, who is of Russian extraction, has been able to draw on the fund of valuable information available in the scientific literature of that country. For more than a decade he has himself carried out researches in this field, originating and improving syntheses of organophosphorus compounds. Written from the point of view of an organic chemist, the book is intended primarily for organic chemists. Its scope is strictly limited to a review of preparative methods for various types of phosphorus compounds with discussion of their general characteristics. The interesting subject of the naturally occurring phospholipids, for example, is considered outside the scope of the volume, and biochemists will regret that no attempt has been made to treat biochemical aspects. Even so, Prof. Kosolapoff has rendered a signal service to the chemical community by filling a significant gap in the literature.

A serious difficulty in compiling this book was the confusion arising from lack of a universally adopted system of nomenclature for phosphorus derivatives. In his classification of compounds into types the author has departed from current practice in some respects, and he has eliminated as far as possible specific names which have been needlessly perpetuated. The term 'phosphinic' acids (R_2P(O)OH) has been abandoned, the acids being regarded as derived from phosphoric and phosphorous acids by replacement of hydroxyl groups by the radicals. The use of 'chloro-phosphonate' has also been rejected in favour of chlorophosphate.

Each chapter follows a general pattern: a brief introductory statement about the class of compounds dealt with, followed by detailed consideration of preparative methods applicable to compounds of that type, discussion of their general characteristics, a compilation (up to January 1950) of known authentic compounds with their physical constants and mode of synthesis and, finally, all pertinent references. Individual compounds with properties not typical of the group are noted. To avoid ambiguity owing to the several systems of nomenclature now in common usage, the tabulations of known compounds are based on structural formulæ in progressive order of complexity. These take the place of a comprehensive index of names at the end of the book. While this feature has the merit of permanency, it makes it a little more difficult for the non-specialist to trace any specific compound.

Laboratory workers in this branch of chemistry will value this book not only as a source of information on synthetic methods but also as a complete dictionary of organophosphorus compounds. J. IDRIS JONES

ANTHROPOLOGICAL STUDIES OF ARAB LIFE

Birth and Childhood among the Arabs

Studies in a Muhammadan Village in Palestine. By Dr. Hilma Granqvist. Pp. 289. 1947. 25 Danish kr.

Child Problems among the Arabs

Studies in a Muhammadan Village in Palestine. By Dr. Hilma Granqvist. Pp. 336. 1950. 30 Danish kr. (Helsingfors: Söderström and Co.; Copenhagen: Einar Munksgaard.)

DR. HILMA GRANQVIST'S earlier two-volume work in English, "Marriage Conditions in a Palestinian Village" (Helsingfors: Academic Bookstore, 1931–35), aroused, and merited, quite unstinted praise. Its excellence from a methodological point of view, its manner of presentation and its penetrating thoroughness are repeated in the two books now under review. During 1925–31 she spent three years in Palestine for the purpose of attaining "an objective knowledge of the Arab people in order to help us to understand the culture of Bible times, and therewith the sources of Christianity". To achieve such an aim, she wisely decided to concentrate on a detailed study of a small community, that of the village of Artas, bordering the desert south of Bethlehem, in preference to a large-scale but less intensive survey of Muhammadan Arabs as a whole. She has succeeded in a brilliant fashion and has permanently enriched anthropological and sociological literature by revealing a microcosm of Arab—one might fairly say Semitic—values and sentiments that have persisted since the days of the Prophets and still endure. Specialists in other fields have suggested 'Eber or Heber as the eponym of both 'Hebrew' and 'Arab', and here is a mass of evidence for the supremacy of custom in the very area from which the two ancient peoples (now, alas, so deeply at odds with each other) have made their most profound impress on Western civilization. The emphasis that recent students have laid on institutional factors in the determination of culture seems nugatory when compared with this predominance of custom, and, to judge from the quality of Dr. Granqvist's field-work, her sympathetic insight into Arab life and ambitions has shown that she combines to an extraordinary degree the dual role of anthropologist and philanthropist.

"Birth and Childhood among the Arabs" does not follow the tenets of one contemporary psychological school in stressing early toilet habits as decisive in the formation of a child's personality. Dr. Granqvist's net is far more widely cast, but the draught of ethnographical fishes brought up by it is in no sense less miraculous. The main topics comprise pre-natal and post-natal observances, the paraphernalia of pregnancy and birth—how little significance, incidentally, does the caul seem to possess in Palestinian folk-belief—as well as nursing, children's games and work, education and the development of character and, finally, circumcision. It may be thought that Dr. Granqvist was particularly fortunate in choosing as her principal informant the blind widow Alya, and in securing the good offices of the daughter of the Alsatian missionary family of Baldensperger, resident in Artas since 1840, in whose house she lodged; but this would do scant justice to the erudition she herself brings to the treatment of her subject and the wealth of comparative material she cites from Biblical and other sources in support of her own findings. These confirm her contention that the possible influence exercised by the child on the religion and language of the Bible has been underestimated, and they put theologians and anthropologists alike in her debt.

The second volume, "Child Problems among the Arabs", moves from the sphere of custom and the artless to that of the largely, if not wholly, more sober one of genealogical data and statistics. Here, too, Dr. Granqvist displays an impressive grasp of method which will be the envy of those concerned with population studies, and it is difficult to evaluate the careful inferences she draws from her observations in other than superlative terms. The first chapter is devoted to an analysis of names. Teknonymy, a word introduced by Tylor to denote the calling of parents after their children, is restricted to the eldest son in the Near East, where the practice is known as *kunya*. Once more the whole subject is illuminated by abundant documentation from literary sources. The scope of the remaining parts of the book includes sex-ratio, fecundity and fertility, child mortality and the *dits* relating to it, the treatment of ailing children by therapeutic and supernatural means, the position of children in a patriarchal society, child–parent relationships, and the importance of the social and familial environment to a child's upbringing. An extensive bibliography, a list of Biblical parallels and a detailed index to both volumes complete the contents.

It may be remarked without exaggeration that Dr. Granqvist's researches establish a new standard in ethnographical technique. Seldom does one come across investigators so completely at ease with the minutiæ of their inquiry, and in the present instance the author has evidently profited from the previous studies she made of purely religious problems, which, together with her work on family life among the

Arabs ("Arabiskt Familjeliv" (Stockholm: Åhlen and Soners forlag, 1939)), were written in Swedish. In common with other Scandinavian scholars, the Finns have developed the recording of their indigenous folk-culture to an extent that, in its literary aspect, is unmatched elsewhere, except perhaps in Ireland. (On the situation in Great Britain it is better to maintain an embarrassed silence.) Dr. Granqvist has equalled her fellow-countrymen's achievement in the superb contribution she has made to the study of a culture alien to her own. J. C. Trevor

FOUNDATION OF GOOD ROADS AND RUNWAYS

Soil Mechanics for Road Engineers

(Department of Scientific and Industrial Research: Road Research Laboratory.) Pp. xxiv+541+90 plates. (London: H.M. Stationery Office, 1952.) 30s. net.

The work of the Soil Mechanics Section of the Road Research Laboratory can be followed by interested persons in the many excellent publications issued, for example, in its 'technical papers' on compaction, soil survey procedure and pavement design, or in its 'road notes' on frost and drought damage, to quote only a few. In the volume under notice, these appear to have been collected together and carefully edited to form the most authoritative book on soil mechanics for road engineers at present available.

The book gives a complete picture of the soil mechanics knowledge that might be of use to a road engineer, from soil identification and classification, mechanical and chemical testing, soil stabilization and compaction, on to the ultimate goal of pavement design, each chapter being supplied with adequate references for further information. There are particularly interesting chapters on the movement of soil moisture and the investigation of foundation failures.

Each paragraph of the book is numbered, and this would lead one to suppose a good deal of cross-referencing. In fact, virtually none exists, except in broadest terms, and this is one of the weaknesses of the book. Each chapter can almost stand on its own, and this has led to a certain amount of repetition. For example, in one of the final chapters on bearing capacity, shearing resistance, Coulomb's equation and Mohr circles are referred to as if they had not been previously mentioned, whereas, in fact, there is a very full chapter devoted to shear strength, after which it is gratuitous to be told that "granular soils are more capable of carrying load if they are confined than if they are not".

The chapter on consolidation more logically comes before that on shear strength: then the $\varphi = 0$ result for undrained shear tests becomes more understandable. Similarly, it would be more logical to treat bearing capacity before pavement design. These criticisms could be met easily by efficient cross-references.

It would have been helpful if, in the section on the determination of specific gravity, typical values for soils had been given. Later on, an implicit value of 2·65 is used indiscriminately for clays and sands alike.

The effect of pore water pressures on shear strength, although initially correctly stated, does not appear to have been fully understood. For example, in saying that "the greater the drainage attained during a test, the greater will be the shearing resistance", the effect of the decrease in pore water pressure which takes place during an undrained test on a dilating soil has been overlooked.

Each chapter has its introduction, telling what is going to be said in it, and a summary telling what has been said. This is convenient for a technical journal where a number of different topics are treated; but here it would appear unnecessary. Again, the nine pages at the front devoted to figure titles seem unnecessary.

The diagrams and photographs are of a high quality, and the book is well produced apart from numerous printing errors which ought to be corrected before the next edition appears. K. L. Nash

BIRDS OF GREENLAND

Grønlands Fugle (The Birds of Greenland)

Text by Finn Salomonsen; Plates by Gitz-Johansen. Part 3. Pp. 349–608+plates 37–52. (København: Ejnar Munksgaard, 1951.) 3 vols., 42 dollars; £14 15s. 0d. Map of Greenland, prepared for The Birds of Greenland by Geodetic Institute and Finn Salomonsen. 40 cm. × 60 cm., 10 Danish kr.

This is the final part of an interesting work (for Vols. 1 and 2 see *Nature*, 167, 744 (1951) and 169, 48 (1952), respectively) and deals with the auks, birds of prey, owls and passeres. There is some evidence that the great auk bred in south-east Greenland in the sixteenth century. According to Greenland chronicles of Bjørn Jonssøn, Lutra Clemens, an Icelander, on a voyage to Greenland between 1580 and 1596, landed at Gummborjarn's Skerries, north-east of Angmagssalik, and loaded his boat with great auks. At a much later period, during 1768–74, this bird was a regular visitor in small numbers to west Greenland, and Fabricius tells us that they were killed for food by the Greenlanders, and the Danish inhabitants made blankets out of the skins. The last bird to visit Greenland was killed at Disko Island in 1821. The little auk, in contradistinction to its large namesake, is reputed to be the most numerous bird in the world, and Dr. Finn Salomonsen quotes one authority who estimates that in the Scoresby Sound district alone there are five million pairs. All the large breeding colonies are in the north, and those in the south are much smaller, sometimes only a few pairs. When the auk comes ashore to breed, they are preyed on by foxes, glaucous gulls and gyr-falcons, to say nothing of the numbers netted by Greenlanders for winter food. When at sea they run the gauntlet of seals, fish, and even whales, according to Salomonsen. Nevertheless, in spite of all this, there does not appear to be any signs of the birds becoming reduced in numbers.

Of the three birds of prey breeding in Greenland, the most interesting is the gyr-falcon, a circumpolar species. In the heyday of falconry the white form of this bird was in great demand and was usually only in the possession of kings, or very important people. Actually, in the pursuit of game it had not the dash of the peregrine, and Dr. Salomonsen's notes on the food and manner of hunting of these two birds is of great interest. He remarks also that the gyr-falcon is easily driven away by a pair of long-tailed skuas, or a pair of ravens, which would not be the case with the peregrine. The classification of the gyr-falcon has always been a matter of dispute owing to the differences in colour, which fall into three phases—white, grey and dark. The author follows Schiøler and other Danish ornithologists, and divides the forms in Greenland into two races, *Falco r. candicans*, the white bird breeding in the north, and *F. r. obsoletus*, breeding in the sub-Arctic and low Arctic zones, and which may be either grey or dark in colour with many intermediate coloured birds.

Among the passeres, the field-fare calls for attention, since it first began to nest in Greenland in 1943 and is now a regular breeder; this is an interesting case of colonization. From the systematic list at the end of this part we learn that 224 species and subspecies have been recorded from Greenland, and, out of these, 64 breed regularly, 58 have only occurred once and most of the remainder are casual visitors.

There are a very good bibliography and map. It is to be hoped that Dr. Salomonsen will see his way to bring out in the near future a cheaper and smaller edition, without plates, of this important fauna.

N. B. KINNEAR

LIFE OF THE WESTERN ATLANTIC COAST

The Living Tide

By N. J. Berrill. Pp. xi+256+16 plates. (London: Victor Gollancz, Ltd., 1951.) 16*s*. 6*d*. net.

PROF. N. J. BERRILL'S excellent contribution to the ever-growing number of popular books about life in the sea is concerned mainly with the inshore life of the east coast of the United States. There are occasional excursions elsewhere, particularly to Salcombe and the coasts of Cornwall—scenes of the author's youth—but for the most part the theme is distinctly North American, though quite a number of the species described are common to both sides of the Atlantic. From Loggerhead Key in the Dry Tortugas northwards to Maine a number of outstanding examples of the marine flora and fauna are described with a bare minimum of technical words. The writing, never dull, presents a depth of sound biological knowledge in a light and entertaining manner that is wholly delightful. Especially noteworthy are the accounts of the breeding of the turtle, of the upside-down jellyfish *Cassiopeia* in the moat of Fort Jefferson, of *Limulus*, and of the skull and breeding of the crucifix fish (a species of cat-fish). There are first-rate chapters devoted to the lobsters, squids and seals of Maine.

It is a pity that Prof. Berrill, in his endeavour to eliminate all technicalities, leaves the biologist on the eastern side of the Atlantic to puzzle out the identity of some of the animals he mentions. There is need for an appendix giving the scientific equivalents of such popular appellations as the sea potato, the grey snapper, the blue crab, the quahog and the soft-shelled clam. The last-named, we are assured, is "sand-gaper" in an English fish-market. There are occasional lapses of style, as in the sentence about the fanning feet of the barnacle pulling in a handful of water and food; and there are occasional errors of fact, as in the statement that *Zostera* is a terrestrial grass which has invaded the sea. But to dwell on these rare slips would be to give a false impression of a most readable and accurately written book.

Compared with the text, the photographic illustrations are disappointing. Two of the pictures are from habitat groups in the New York Natural History Museum; but the fanciful captions may lead the unwary to assume that they are photographs from life (unless, indeed, the wires suspending the trigger-fish happen to be noticed). The remaining photographs are from life and are of very mixed quality. The best, a good one, is of living squids; a few photographs are not in proper focus and should not have been included.

D. P. WILSON

THE SUGARCANE

Botany of Sugarcane

By Dr. C. van Dillewijn. Pp. xxiii+371. (Waltham, Mass.: Chronica Botanica Co., 1952.) n.p.

THE author has produced this considerable volume for the best of reasons, namely, that he wanted to do so and because he felt that such a volume, which relates to a major tropical crop, if not overdue, would certainly be timely. In contrast to other works on the sugarcane, which have been mainly practical, technological, historical or economic in their conception and outlook, this book is what its title declares it to be: essentially a work of botany. In it, on the basis of a bibliography of some 617 titles, the author has produced an account of the sugarcane plant in all its phases of germination, growth, development and reproduction. As perhaps might be expected, the data available to the author are somewhat uneven: some aspects have been the subject of intensive research, while others have remained comparatively neglected, those aspects which stand in a close relation to agricultural or technological aspects being most amply documented. Thus photosynthesis occupies thirty-two pages, respiration less than four.

The first section is devoted to a detailed illustrated account of the morphology and anatomy of the stem, buds, leaves, inflorescence and roots, and the second to physiological aspects, including germination, tillering, growth, chemical composition, nutrition, water relations, photosynthesis and respiration. In a contemporary work it is perhaps surprising that the genetical and cytological aspects are not included, though a chapter is devoted to the evaluation of vegetative characters in the classification of varieties, while the part played by the introduction of new varieties in safeguarding the industry is fully recognized.

The author rightly considers that cane-growing should be treated as a science, and with due emphasis he directs attention to the fact that there is a great gap between the relatively low efficiency in the field and the high efficiency in the factory. This he attributes to lack of knowledge, to failure to make use of knowledge that is available, and to dependence on tradition, local opinion and empiricism rather than on knowledge of the botany of the sugarcane and the related principles of its cultivation. In the present volume an attempt is made to remedy these defects and to make available to workers in all countries a comprehensive work of reference. The author and his publishers are to be congratulated on their achievement, and the hope may perhaps be expressed that the Chronica Botanica Company will regard this present volume as but one of a series of monographs on the botany of important crop plants.

C. W. WARDLAW

Advanced Five-Figure Mathematical Tables

By C. Attwood. Pp. v+69. (London: Macmillan and Co., Ltd., 1951.) 4*s*. 6*d*. net.

THIS book is intended as a continuation of the same author's "Practical Five-Figure Mathematical Tables", published in 1948. The collection of tables provided, however, is complete in itself, but the material might well seem strange to anyone unacquainted with the more elementary volume.

The trigonometrical tables are expressed in decimals of a degree, rather than in the usual intervals of six minutes, and an alternative set is also available with arguments in radians. As before, with emphasis on interpolation, small-interval tables have been supplied for the critical ranges, where the method of mean proportional parts is no longer adequate.

The tables of hyperbolic functions, which follow, include the hyperbolic tangent, not normally featured in books of this kind. Very detailed exponential tables for both positive and negative arguments between 0 and ± 7·5 (which incidentally render the presence of logarithm tables unnecessary) are followed by tables of the factorial function for intervals of 0·001 in the range from 0 to 1. In these, the author uses the symbol $x\,!$, instead of the more classical $\Gamma(x + 1)$, for $\int_0^\infty e^{-t}t^x dt$, with consequent minor modifications in the recurrence formula.

The final tables should prove most useful, containing as they do complete elliptic integrals of both kinds (with k^2 as argument) and ordinates and areas of the normal probability curve. In conclusion, a very comprehensive set of explanatory notes and formulæ, together with several numerical examples illustrating the correct use of the tables, serve to complete a book which is well produced and clearly printed.

J. H. PEARCE

Selective Toxicity with Special Reference to Chemotherapy

By Prof. Adrien Albert. (Methuen's Monographs on Biochemical Subjects.) Pp. xii+228+5 plates. (London. Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1951.) 7*s*. 6*d*. net.

MESSRS. METHUEN'S "Monographs on Physical Subjects" have long provided the student of moderate means with authoritative and modestly priced treatments of subjects not generally well covered by the orthodox text-books, and it is gratifying to know that similar provision is now being made in biochemistry. It is significant of the progress made by biochemistry in recent years that what might have been the first in the new series, namely, the late Dr. N. U. Meldrum's "Cellular Physiology", actually appeared in a series of monographs on biological subjects, and the publication of a series of monographs on biochemical subjects is a fitting tribute to the mature status to which biochemistry has now attained.

In this volume, based on a series of lectures delivered at University College, London, in 1949, students of biology and chemistry, coming fresh from their respective trainings in fundamental science to the hybrid subject of selective toxicity, will find much food for thought. While the choice of material in places emphasizes Prof. Adrien Albert's personal research interests and points of view, illustrations are drawn from a wide range of fields as far removed from each other as selective herbicides and local anæsthetics. After defining selective toxicity and describing applications, Prof. Albert discusses physicochemical aspects with reference to drug-receptor interactions, the role of ionization in the acridine antiseptics, chelation and trace metals. Chemotherapy is then reviewed, and various pharmacological themes are adumbrated in the closing chapter.

Chemical Indicators

By Prof. O. Tomiček. Translated by A. R. Weir. Pp. x+258. (London: Butterworths Scientific Publications, Ltd., 1951.) 21*s*.

THE subject of chemical indicators is of interest to many workers in the fields of pure and applied chemistry and biology, and, since advances are steadily reported in all its branches, a modern treatment is always welcome. The present volume, by an authority in the field, should be valuable to many kinds of workers.

The treatment is modern, the general theory of acids and bases being used throughout, and the fundamental equations are clearly deduced and their use explained in such a way that they should be easily understood by non-specialists. This is an important feature, since a proper use of indicators depends on a knowledge of recent advances in the theory of electrolyte equilibria which are not easy to follow unless simply presented. The equations are illustrated by numerical examples, which aid in elucidating their meaning.

The book includes a full account of apparatus and experimental methods, is provided with useful tables, and is very complete, since it deals not only with acid-base indicators but also with oxidation-reduction indicators, adsorption indicators, and fluorescent indicators. Full references to the literature are given. In every way this is a most useful and attractive book, which may be warmly recommended.

Theoretical Aerodynamics

By Prof. L. M. Milne-Thomson. Second edition. Pp. xx+414. (London: Macmillan and Co., Ltd., 1952.) 40*s*. net.

A REVIEW of the first edition of this treatise appeared in *Nature* of May 8, 1948. The fact that a second edition has been called for so soon is evidence of public appreciation of the book and of the vitality of aeronautical science.

The second edition is substantially identical with the first, except for the very notable addition of a chapter, running to 51 pages, devoted to supersonic 'conical flows'. By a conical flow is meant one in which the velocity vector, pressure and temperature are all constant on each straight line through a fixed origin. Such flows lend themselves to theoretical treatment of a relatively simple nature and there are many useful applications, for example, to wings of 'delta' plan form which are now being used on some high-speed aircraft. The new chapter is a valuable and welcome addition to the book. Some eccentricities of nomenclature have been amended in this edition; but the treatment of the mechanics of flight and of stability remains as before and is too short to be adequate.

In spite of the substantial increase in the size of the book and of the notorious increase in costs in recent years, the price of the book has not been raised. The author and publisher are to be congratulated on producing a book which, from all points of view, is good value for money.

W. J. DUNCAN

BEHAVIOUR OF SOCIAL INSECTS

THE social insects have for a long time attracted the attention of biologists, and, undoubtedly, the epoch-making discoveries of Prof. K. von Frisch and his colleagues have led to a great revival of interest in these groups, more especially perhaps in the bees and ants. At the recent meeting of the British Association in Belfast a part of Section D (Zoology) devoted a day to papers and discussions on the behaviour of ants, bees and termites; it was unfortunate that wasps could not be included.

During the morning session, under the chairmanship of the president of the Section, Prof. A. D. Peacock, members considered certain aspects of the behaviour of ants and termites. The behaviour of honeybees was the subject of the afternoon session, when Prof. G. C. Varley took the chair.

Ants and Termites

In his paper, Dr. J. H. Sudd (University College, Dundee) described a number of experiments on the possibility of forming colonies of Pharaoh's ant (*Monomorium pharaonis*) with various numbers and proportions of queens, workers and pre-adults, and discussed the significance of these results in the spread of natural infestations of this ant, which has established itself in such places as kitchens and bakeries. High humidity and temperature, and darkness in the nest cell, are necessary for successful culture of colonies of this ant in the laboratory.

Wheeler thought that, in general, ants could found colonies in one of two ways. Most commonly a sexual couple or a fertilized queen left the parent colony and raised brood, thus forming the nucleus of a new colony. In other cases some kind of swarming took place in which a sexual couple together with a number of workers left the parent colony and founded a daughter colony. Wheeler considered that swarming was uncommon in temperate species. In *M. pharaonis*, which is probably a tropical species, there is no sign of swarming. Mating takes place in the nest; but experimental attempts to found new colonies with sexual forms alone have always failed. This is not, however, because queens will not feed themselves, nor because isolated queens refuse to lay eggs.

What is even more remarkable is that attempts to found colonies with a population of one or more queens and a number of workers have also failed, although eggs were laid and in some cases larvæ were produced. In order to found colonies in the laboratory both workers and young stages are necessary; but a queen is unnecessary and may even be harmful, since she appears to compete with the larvæ for the attention of the workers and tends to be 'ritually' fed at the expense of the larvæ. After a few hours, however, the queen is deserted and the larvæ receive more attention. Such feeding of the queen by workers appears to be a truly instinctive act, with a releasing mechanism, and to have a variable threshold. The lowest ratio of workers to pre-adults with which a colony has been founded successfully was forty workers to fifty-three pre-adults, of which twenty-one were pre-pupæ.

Trapping has indicated the probability that established colonies of this ant have a habit of wandering as a whole, or of dividing and then rejoining, and perhaps it is not legitimate to think of the population of an infested building as consisting of a number of discrete colonies.

It seems clear that the spread of infestation of *M. pharaonis* is not a simple matter. For example, although it is no doubt possible for this species to be disseminated in a cake, it would be necessary for quite a large number of worker ants and pre-adult stages to be present if the establishment of a colony in a new situation is to result.

Dr. D. M. Vowles (University of Oxford) considered the social structure of the ant colony in terms of the behaviour patterns of the individual ant. He described how workers of *Lasius niger* will carry their brood from a light into a dark area and said that, if one ant is made to retrieve too many larvæ, this activity ceases, although other activities do not. This can therefore be interpreted as exhaustion of the drive for brood retrieving. The method of handling the brood when retrieving it varies in different species—the inherited innate component differs. Furthermore, the method of handling individual larvæ and pupæ depends upon their size, shape and similar characteristics, the taxis component of instinctive behaviour allowing adequate adjustment. The releasing stimulus seems to depend on a combination of size, odour, solidity and the hunched shape of the anterior end of the larva.

In *Myrmica ruginodis* the foraging activity, both of the individual and of her colony, can be intensified by increasing the proportion of larvæ to workers in the colony. Increasing the number of pupæ does not result in any increase of foraging activity. There are two types of foraging activity, one for sugar, which takes place continuously and represents the individual ant's feeding activity, and the other for protein, which is stimulated by the presence of larvæ, but not pupæ, and is parental activity.

Food exchange between workers is an important factor in the integration of the colony. The results of Dr. Vowles's work with *Camponotus pennsylvanicus* suggest that, when adult ants appear to be begging for food, they are really seeking it anywhere that they can find it and will take it from the first available source. They have learned early in life that they can obtain it from other workers, and he said that, as a rule, food exchange is a question of a would-be donor finding a willing acceptor. The signal for regurgitation appears to be a touch on the mouthparts, and the antennæ of both donor and acceptor appear to be used during food exchange for finding and orientating the other ant's head. It is the donating, rather than the receiving, behavioural mechanism which has evolved in ants.

Dr. Vowles concluded by suggesting that ant behaviour is essentially parental and that nearly all the duties performed by workers could readily have been carried out by their solitary ancestors. During the evolution of social life, worker ants have had to lose certain behaviour patterns, such as those involved with courtship, mating and egg laying, which if present would tend to disrupt the social life of the colony. One must distinguish between sexual and parental behaviour; only the former has become suppressed in worker ants.

Mr. S. J. Holt (Nature Conservancy, Edinburgh) gave some details of his work in a Scottish forest on the quantitative assessment of the foraging activities of colonies of the wood ant, *Formica rufa*. From a nest a number of well-defined, branching tracks radiate, each of which terminates in a large pine tree up which the foragers climb in search of honeydew. Each individual ant usually, but not invariably, uses one particular track on her way to and from the nest, and the speed at which she walks and, therefore, the rate of foraging and the rate of flow of foragers from the nest vary with the temperature. If one sets up check points along a track, one finds that the number of foragers passing along the track decreases the farther one gets from the nest, and, although most of the ants (about 80 per cent) keep to the track, a certain number leave it at intervals and spread out to hunt in the areas between the radiating tracks.

By marking individual ants belonging to a particular isolated colony, Mr. Holt has been able to study the economy of their colony. Each forager carried at one time about 0·0019 gm. of honeydew or, if she was collecting insect food, a load weighing on an average 0·008 gm. Each forager on a good day brought home food equivalent to about half her own body-weight. *Formica rufa* is very fond of midges, and on those days when midges settle in numbers on the rowan trees, the foragers tend to desert the pines and go to the rowans instead.

Prof. J. E. Webb (University College, Ibadan) considered the swarming behaviour of termites as an adaptation to the particular type of social life adopted by this order of insects in comparison with that found in the higher social Hymenoptera. He pointed out that the termites differ from most social insects in that each colony has both a king and a queen. The 'swarming' in termites of winged males and females is a prelude to colony formation, during which the male requires not only to contact the female but also to remain in association with her throughout the hazardous period before the first chamber of the new nest is formed. The chances of survival of the termite pair are much less than those, for example, of single fertilized queen ants, and the fact that they survive at all would appear to be due largely to the complex pattern of behaviour that winged termites exhibit during the process of 'swarming'.

The male and female termites emerge from the nests in which they have been born in large and approximately equal numbers around dusk on the day following the first rains; thus there is a reasonable chance of mating occurring between individuals from different colonies, and, further, at this time the soil will be soft, thus permitting easy excavation, and will remain so long enough for the colony to become sufficiently large to regulate its own humidity conditions.

On first emerging, the male and female termites are positively phototactic and are attracted by, and fly towards, the brightest light. The females settle on the ground some distance from their parent nests and shed their wings. The males search for females, making short flights interspersed with periods of running in all directions on the ground, and do not generally shed their wings until they have found females. When a male finds a female, he caresses the hind part of her abdomen with his mouthparts and antennæ, and this stimulates her to run forward with the male following 'in tandem'. As soon as such contact has been established, the female becomes negatively phototactic and runs away from the light in search of a suitable site, where both she and her mate begin to excavate the first chamber of the new nest. Should the pair become separated, the female promptly stands still with her abdomen raised and flattened while the male runs in circles seeking her. When contact is re-established the male resumes his caresses, which once more stimulate the female to run forward.

Prof. Webb pointed out that with respect to their swarming behaviour the termites appear to be unique among social insects. He said that the behaviour pattern he had described for *Macrotermes nigeriensis* is essentially similar, except for minor details, to that of all other termites, and suggests that this behaviour during swarming is one of the basic characteristics of the Isoptera and may well be one of the important factors which has initiated development of the social habit within the group.

During the short discussion which followed these four papers, Dr. S. H. Skaife (South Africa) suggested that it would be more correct to speak of the 'mating flight' of termites rather than 'swarming', as this phenomenon is in no way comparable with the 'swarming' behaviour of honeybees. Prof. Webb replied that, while agreeing that these two phenomena are not comparable, he thought that the term 'swarming' is well understood when used for describing the mating behaviour of termites and ants.

Dr. Sudd asked whether antennal stimulation by one ant is important in inducing another ant to give food to it. Dr. Vowles replied that he is convinced that it is not and, on the contrary, that it rather appears that an ant which wishes to give up food stimulates another ant to receive this food by offering it to her. Dr. C. G. Butler remarked that this also appears to be true in the case of worker honeybees. Most of the rest of the discussion, in which various members took part, was concerned with an attempt to find an all-embracing definition of social life, but no definition that was acceptable to all was suggested.

Prof. Peacock closed the discussion with a few remarks, in the course of which he said that he was very interested to find that there is so much in common in the behaviour shown by the different species of social insects that had been discussed.

Honeybees

The opening paper in the afternoon session was given by Mr. C. R. Ribbands (Rothamsted Experimental Station) on new evidence concerning the language of honeybees, in which he discussed some of the recent work which he and his collaborators, Dr. H. Kalmus and Mr. H. L. Nixon, have completed. Since this work has been recently discussed in *Nature* (September 13, p. 438), it is not reported in detail in this article. Suffice it to say that their experiments have demonstrated that food transmission among the honeybees of each colony is the foundation of the division of labour, and also, since they have shown this to be the basis of individual colony odour, enables the bees of a colony to distinguish their comrades from strangers and thus to protect their hive.

Dr. C. G. Butler (Rothamsted) briefly described some of the observations of Mr. J. B. Free and himself on the guarding of their hives by worker honeybees. He said that honeybees do not guard the entrances of their hives unless their colonies have been disturbed in some way, such as by the presence of numbers of strange bees, and that they are much more inclined to become and remain alert at those times when little or no fresh food is being brought into their hives and, similarly, to give up guard duties on the advent of a honey-flow. Almost any bee will assume guard duties when necessary, and, should numbers of strange bees attempt to enter the hive of a really alert colony, mass fighting sometimes takes place and many bees are killed. In such cases both the owners of the hive and the intruders apparently regard the hive as their own and attempt to defend it. However, such mass fighting between guard bees seldom occurs unless beekeepers are careless, and the fate of bees which attempt to enter hives which they have mistaken for their own is largely dependent on their own behaviour.

Guard bees recognize members of their own colony, as well as intruders from other colonies, by the scent of their bodies; but there is evidence that robber bees are recognized as such by their characteristic hesitant flight in front of the hive entrance before the guards can approach them closely enough to identify them by their scent. Guards always attempt to kill robber bees, but seldom attempt to kill bees which have strayed to the guard bees' hive by mistake.

A paper on chemo-reception in the honeybee was then read by Mr. G. D. Glynne Jones (Seale-Hayne Agricultural College). He pointed out that laboratory experiments with honeybees are often valueless since the bees do not behave normally; on the other hand, it is impossible to control all the variables in the field. He therefore carried out his experiments in a glass-house where many of these disadvantages could be eliminated. While attempting to measure the effectiveness of certain substances such as phenol, acetic acid and dimethylphthalate as bee-repellents, he obtained results which showed that the bees' response follows definite patterns, some of which appear to be of interest in throwing light on the mechanism of chemo-reception in the honeybee. The responses of honeybees to sucrose solutions containing concentrations of phenol ranging from 0·1 to 0·000001 per cent were measured using different techniques. In one series of experiments the bees were offered an alternative to the test solution in space; in another series an alternative was offered in time rather than space. When the alternative was offered in time, a distinct sigmoid response curve was obtained involving a very narrow range of concentrations, a solution of 0·01 per cent being completely acceptable whereas a 0·05 per cent solution was completely unacceptable. But, when the alternative was offered in space, a double response curve was obtained, the concentrations involved ranging from 0·05 to 0·000001 per cent.

Mr. Glynne Jones said that, when the alternative of unadulterated sugar syrup is offered in space, it may be assumed that concentrations of phenol above 0·000001 per cent are detected by the olfactory sense organs of at least some of the bees, and a proportion chooses the pure sugar syrup. As the concentration of repellent is increased above this level, the proportion of bees choosing pure sugar syrup also increases until a maximum is reached, after which further progressive increases in concentration result in reduction in the repellent effect. This reduction may be due to the fact that the olfactory sense organs become very quickly fatigued when exposed to these concentrations of phenol, or because these sense organs in the bee are specially adapted for appreciating very low concentrations of stimulants. This fall-off in response soon ceases if the concentration of the repellent is further increased above a certain level, and this may be due to irritation of the common chemical sense of the bee. This argument is strongly supported by the results obtained when the test solutions are alternated with pure sugar syrup in time instead of space. Under these conditions there is a direct conflict between the stimulus inherent in the bee to collect food and the power of the chemical to act as an irritant and elicit an avoidance reaction. A much narrower range of concentrations is involved which still has the same concentration of 0·05 per cent as its upper limit. Although the same pattern of behaviour was always obtained, it was found that the concentration of phenol which was capable of repelling all the bees fluctuated with different colonies at different times of year between 0·04 and 0·2 per cent. It was also reported by Mr. Glynne Jones that he has observed bees which were flying over test solutions touching the surface of the liquid with the tarsi of their hind-legs, and suggested that perhaps these bear olfactory organs. At the close of his paper he showed a short film of some of his experiments.

The discussion which followed the afternoon papers was very brief and consisted of a few questions addressed to the speakers rather than a discussion on the behaviour of social insects.

CHEMICAL ENGINEERING

THE growing appreciation of the importance of chemical engineering was evident at the recent meeting in Belfast of the British Association, when Section G (Engineering) devoted a session to the subject of education and training in chemical engineering, at which, under the chairmanship of Sir Ben Lockspeiser (president of the Section), papers were presented by Prof. D. M. Newitt (Courtauld professor of chemical engineering, Imperial College of Science and Technology, London) on "The Training of Chemical Engineers", and by Dr. E. H. T. Hoblyn (director, British Chemical Plant Manufacturers' Association, London) on "The Chemical Engineer in Industry". The discussion was opened by Sir Harold Hartley (past president of the British Association and of the Institution of Chemical Engineers). The contents of the two papers, together with points from the discussion, are summarized in this article.

The rise of chemical engineering as a primary technology is one of the direct consequences of industrial and economic developments which are still taking place. It may be said to owe its origin to the big expansion in the heavy chemical industry and to the simultaneous growth of new industries, resulting from intensive scientific research during the latter half of the nineteenth century. There was at that time a growing conviction that empirical methods of plant design, based mainly upon trial and error, could no longer meet the needs for better process control and for higher operating efficiencies and would have to give place to more scientific procedures. George E. Davis, one of the pioneers of chemical engineering, first began to lecture on the subject in 1887, and his well-known "Handbook of Chemical Engineering" was published in 1901. The introductory chapters of this book should be studied by anyone in doubt as to the true functions of a chemical engineer.

The new branch of engineering, however, made slow progress in Great Britain and, as has so often happened, it was left to Germany and the United States to build up those renowned schools of chemical technology and chemical engineering which, during the inter-war years, gave them such an outstanding lead in the international race for higher industrial productivity. In Britain we now have to face the task of recapturing some of the lost ground and, by increasing our facilities for higher technological education and vocational (technical) training, of making available to industry the skilled men required, at all levels, for the purpose.

But, in the interval, the problem has increased in scope and complexity. Technological, economic and social factors are now so closely interwoven in the structure of the modern State that higher technological education must aim at providing not only for the vocational requirements of the technical specialist but also that wider culture essential to those destined for leadership in industry and commerce. It is in this broader context that the training of chemical engineers should be considered.

There is a great deal of evidence to suggest that our industries have, over the course of years, lost the initiative in the development of new processes and products; and numerous examples might be quoted in which inventions and discoveries made by British scientific workers have been left for exploitation abroad. The growing practice of paying royalties to foreign competitors on this count is, in every respect, undesirable; not only is purchased 'know-how' always out of date, but also the practice denies to our technologists those opportunities for widening their experience and displaying their skill and initiative which are so necessary if we are to compete on level terms in the world's markets.

It was pointed out in the Dunsheath report on "Universities and Industry" (published by the Anglo-American Council of Productivity) that many Americans believe that their large numbers of chemical engineers have been an important factor in the rapid progress of industry in the United States. During 1949–50 the number of first degrees in chemical engineering in the United States was 4,529, to which must be added 712 master's and 178 doctor's degrees. It is doubtful if in Great Britain the output of chemical engineers from graduate and postgraduate courses will exceed 250 in 1953. Dr. Dunsheath's team was impressed by the importance attached to chemical engineering in the United States, and reported that this is a field to which American industry looks for a large and increasing number of its graduates. It is not too soon, therefore, that so much attention is being focused on the training of chemical engineers in Britain.

The objective of a chemical engineering training is, in the words of Prof. W. K. Lewis, "the development of the capacity of the student when faced with a new and unfamiliar situation, to handle it with a competence, involving skill, initiative and leadership". Industry must ensure that, when such men are available, opportunities are offered for the exercise of their talents.

The main types of work in which chemical engineers find employment in the chemical and allied industries, including the gas and oil industries, are research, development and design of plant; construction and installation of plant; process control and plant operation; plant maintenance. The nature of the work, the type of man employed and the level of qualification required all vary from job to job and from section to section of the industry.

Chemical plant manufacturers use chemical engineers for research and for designing and installing plant and handing it over to the customer in a satisfactory operating condition. Such work is fundamentally the same whether the plant is to be used in the chemical, gas or oil industries, and requires to be carried out by fully qualified men of high technical ability and preferably having had some plant-operating experience. The plant manufacturer also employs chemical engineers on his sales staff.

The chemical and allied industries employ chemical engineers in two very different spheres which require different levels of qualification. In the first place, the chemical industry uses them for research and development and the subsequent design and installation of plant for its own particular processes. This often involves the linking-up of specialist equipment supplied by a number of plant manufacturers. Such work may also include the costing of the plant and process and its comparison on technical and commercial grounds with an alternative process. A fully qualified chemical engineer is required for such duties, and he must be competent to work closely from the outset of the project, on one hand with the chemist who has evolved the process in the laboratory, and on the other with the civil, mechanical and electrical engineers who will be concerned with the erection and servicing of the plant and the structures which support it or the building which houses it. The chemical industry also employs chemical engineers for plant operation and process control. While large numbers are employed in this way, the number could, with advantage to productive efficiency, be greatly increased, if men with the right type of training were available in sufficient quantity; a lower level of training can normally be accepted for such work, for which chemical engineers with the Higher National Certificate (to whom reference is made later on in this article) should be admirably suited.

The oil industry and the gas industry, like the chemical industry, use chemical engineers for design and development work and for process control and technical supervision.

It is clear, then, that in the chemical and allied process industries and in the engineering industries which serve them there is tremendous scope for chemical engineers of varying levels of competence and inclination.

It has been pointed out that chemical engineering constitutes a distinctive discipline which embraces the whole of that body of applied science utilized in transferring a process from the laboratory stage to large-scale production; it is, in addition, concerned directly or indirectly with the economics of production and with the social implications of new scientific discoveries. The range of subjects to be covered is therefore extensive, and any endeavour to insist upon a high degree of proficiency in all the sciences included in the definition would be impracticable. A thorough grounding in the fundamental principles of the physical sciences is essential, but attention should thereafter be directed towards those special applications which constitute what are now generally known as the unit operations and unit processes of chemical engineering. In addition to this later study, as much of the groundwork training as possible should be carried out in the chemical engineering departments.

Any endeavour, therefore, to base a first-degree course in chemical engineering upon any synthesis of existing courses in chemistry, physics and mechanical engineering is unlikely to be successful. The only feasible compromise is that by which chemical engineering may be taken as a postgraduate subject following upon a first degree in chemistry or mechanical engineering; this method, however, involves an additional one or two years of study and carries with it no very tangible compensating advantages.

The most significant advance which has been made recently in the scope of chemical engineering training in Britain is the establishment of Higher National Certificates in the subject; the courses to this level will be taken by students holding a National Certificate in chemistry or engineering.

Industry should welcome these new courses, which will produce what have already been described as the 'non-commissioned officers' of the chemical and chemical-plant industries, which must ensure that sufficient raw material is forthcoming from their ranks to warrant the establishment of Higher National Certificate courses in various centres. Industry must also ensure that it uses these 'non-commissioned officers' properly. First, they should be employed at a level of work suited to their training —in some cases this should enable better qualified men to be released for more responsible duties, while in others it should enable more chemical engineers to be used on duties for which at present they are sadly lacking, such as plant and process control, as mentioned earlier. Secondly, industry must provide the 'non-commissioned officer' with the incentive of promotion, where competent, to 'commissioned' rank.

From the educational point of view, one of the important problems common to all categories of technology is the emphasis which should be given to works experience as an integral part of a university training. The purpose of introducing a student to industrial life during his university career is to impress upon him at an early stage that this work has to form part of a complex structure, other component parts of which are labour and management and the economics of production; but nothing can replace the first-hand experience gained by direct contact with men and things.

Two alternative methods have been adopted to this end in Great Britain, one based upon vacation work and the other upon sandwich courses: in the former, the student is expected to devote some eight weeks of at least two long vacations to employment in a works; in the latter, more extended periods of employment are sandwiched between attendance at the university. There is not much to choose between the two, and both depend for their success upon the student being able to identify himself with the routine and life of the works and being given definite duties and responsibilities. In all circumstances, he will pick up something of value from such industrial contacts and, when the courses are carefully planned, the benefit he obtains is important and far-reaching.

In general, first-degree courses in chemical engineering extend over three post-intermediate years, the first two of which are devoted to the physical sciences and to certain branches of mechanical engineering and mathematics, and the final year to unit operations and processes. It cannot be held that such a short period is sufficient to enable any comprehensive syllabus to be covered in its entirety, and it is particularly important to guard against the dangers of introducing so much detail that the student fails to obtain a broad perspective of his subject. For this reason, an extension of the course to a fourth year, with all the formal apparatus of lectures, tutorials and examinations, is not altogether desirable. The atmosphere of impending examinations is not conducive to independent thought and inquiry; and, if we wish to foster and develop initiative and enterprise, there must be a period during which the student can, under direction, begin to apply his knowledge. In some respects, this end is attained by one or two postgraduate years devoted to original work. In the case of selected students the time so spent is undoubtedly of great value. The planning of a systematic piece of research, the devising of new experimental methods and techniques, the critical appraisal and discussion of results bring out qualities in a student which no system of examinations can hope to reveal. But it must be recognized that all students are not temperamentally or intellectually fitted for research work, and no useful purpose is served by forcing them to spend one or two years in a distasteful occupation.

If we remember, however, that the technologies aim at the application of fundamental principles to practical problems and at the introduction of new methods and techniques into industrial practice, it becomes possible to devise a postgraduate course which will entail investigations of a more practical character than those generally included under the heading of fundamental research.

There is no reason why such investigations should not, in suitable circumstances, be undertaken by teams of students rather than by individuals, and in co-operation with industry rather than in the isolation of a university laboratory. This matter has been referred to indirectly in the Cremer report on chemical engineering research (published by H.M. Stationery Office for the Department of Scientific and Industrial Research), which emphasizes the importance of the functional analytical approach to chemical engineering research.

As the result of such a system of training, the graduate should enter industry with a background of fundamental science, with some knowledge of industrial organization and with a sound understanding of the basic operations of chemical engineering. He will not be familiar with the practice of any one industry nor with those technical details of plant operation which can only be acquired by works experience; and it must be recognized that some time will elapse before he can be expected to make his full contribution as a technical specialist. He should, however, be competent, at the outset, to undertake design and development work and to bring to it those qualities of initiative, originality and adaptability which are so urgently needed in industry to-day.

It is appreciated by industry, however, that it must be prepared to train the graduate further after he leaves the university, and some firms in the chemical plant field and elsewhere have developed two-year trainee courses for chemical engineering graduates.

Finally, it will be evident that chemical engineering differs essentially from those technologies which are confined to the principles and practices of particular industries or of groups of related industries, and that the strong suit of chemical engineers is that they can, by the generality of their training, be regarded as a mobile force of technologists able to move from industry to industry as economic conditions dictate.

Engineers must therefore give their support to this fourth primary technology; it is complementary to the older technologies—not competitive with them—and must have a place in their team, for on such team-work so much of the future industrial prosperity of Britain depends.

THIRTEENTH INTERNATIONAL HORTICULTURAL CONGRESS

THE thirteenth International Horticultural Congress was held in London during September 8–15. It was opened on the morning of September 8 by Sir Thomas Dugdale, the Minister of Agriculture and Fisheries. Lord Aberconway, president of the Congress, and Dr. H. V. Taylor, vice-president and chairman of the National Organizing Committee, also spoke. Lord Aberconway particularly stressed the importance for horticulturists as well as for botanists of the stability of names of the more widely grown plants, and meetings of the International Committee on Horticultural Nomenclature and Registration were held every day throughout the Congress.

This was the first International Horticultural Congress since the one in Berlin in 1938 and, as befitted the times, the main theme of the Congress was the discussion of methods by which new developments in horticulture, plant breeding and the control of pests and diseases have raised and can raise further the world production of food and other economic crops. Each morning there were general lectures which were considered as being of wide importance to horticulturists, while in the afternoon the Congress divided into seven sections dealing with fruit growing, vegetable growing, ornamental plant growing, plant breeding, environmental control, seeds and tropical and sub-tropical horticulture, respectively. As far as possible, summaries of the general lectures and full copies of the papers prepared for sectional meetings were made available in advance to Congress members

Throughout the Congress the reliance of modern horticulture on scientific research was stressed, particularly in the fields of genetics and cytology and plant physiology.

The role of climate and its influence on plant growth was discussed by Dr. F. W. Went, of the United States. In particular he described the modifications in various factors, such as temperature and humidity, which can be obtained by artificial means such as cultivation in greenhouses or against walls, and their effect on the plants cultivated, and was able to bring under a scientific scrutiny many traditional horticultural methods. Other aspects of this problem were discussed by Prof. Pierre Chouard, of France, and Dr. J. W. M. Roodenburg, of the Netherlands. Prof. G. E. Blackman, of Oxford, showed his methods for making an analysis of the effects of seasonal light intensity and temperature on the growth of plants in the vegetative phase with special reference to the English bluebell, *Scilla non-scripta* (*Endymion non-scriptus*), and the effects of shading on growth and development. He was able to show that for each plant it is possible to estimate the light intensity at which growth will be optimal. The control of photoperiodicity by practical methods and the effect of artificial lamps on growth were discussed by several speakers. Dr. J. W. M. Roodenburg showed that the low-tension neon lamp giving a red-orange light and the ordinary incandescent lamp were effective in increasing growth in periods of low light intensity such as the shorter days of winter. Radiation from the red end of the spectrum appears to be effective in promoting the flowering of many long-day plants such as sugar-beet, but retards flowering in the case of short-day plants. Prof. F. G. Gregory also gave a most interesting paper as a general background to recent physiological research in the control of growth and reproduction in plants by environmental factors.

Prof. K. Mather, of Birmingham, in a general lecture on the relation of genetics to plant breeding, gave some pointers for the production of new horticultural crop plants through polyploidy and other factors, such as the variation induced by the use of ionizing radiations like X-rays and by certain chemicals. He confessed, however, that we still have no clue as to how to produce direct mutations, or even as to whether this is possible. The importance of heterosis or hybrid-vigour was stressed by several other speakers, particularly by Dr. Gordon Haskell, and the effects were well shown by the hybrid strains of onion produced by Dr. H. A. Jones, of Beltsville, United States. In this section Dr. S. L. Emsweller, also of Beltsville, read a fascinating paper on developments in plant breeding due to the use of colchicine, a substance which, by inducing polyploidy, has opened the door to many interesting new combinations of genes. The effects of polyploidy on sterility were mentioned by several speakers, and this is obviously a subject which requires further study.

The section on fruit growing was a strong one, and Prof. T. Wallace, of Long Ashton, Bristol, gave an introductory general lecture entitled "Some Aspects of the Mineral Nutrition of Horticultural Plants". Prof. Wallace has made a special study of the effects of deficiencies of mineral trace elements in the cultivation of fruit, and this paper gave a valuable summary of a field of obvious interest and importance to the practical grower and one in which, once the correct diagnosis has been made, the cure can be effected with reasonable certainty. The work of the East Malling Research Station in Kent in standardizing root stocks for apples and pears is now well known and part of the common horticultural practice of the fruit grower, but Dr. Beryl Beakbane described some of the scientific reasons behind the effects of particular rootstocks in a paper on the anatomical structure in relation to rootstock behaviour, while Mr. A. P. Preston, also of East Malling, discussed some new apple rootstocks. The proportion of bark, that is tissues outside the cambium, to wood in the lateral roots of clonal rootstocks has been found to be related to the effect of the rootstock on the size of tree at maturity, rootstocks with a large amount of bark being the most dwarfing. Mr. Preston described a new series of apple rootstocks resistant to woolly aphid. These were bred jointly at East Malling and the John Innes Horticultural Institution, and more than twenty new rootstocks have been bred and selected out of 3,758 seedlings. Damage from spring frosts has proved one of the most difficult problems with which the grower of fruit in Britain has to contend. Dr. W. S. Rogers, also of East Malling, described the new technique of continuous water sprinkling for protection from frost, the main heating effect coming from the release of the latent heat of freezing, 80 calories per gram, as the water turns to ice. A precipitation rate of 6 mm. per hour was found to be the most effective and would protect most fruits from a temperature of 21·5° F. In this section one of the most interesting papers was given by Prof. H. B. Tukey, of the United States, in which he described the uptake of nutrients of the leaves and bark of fruit trees and the use of radioactive isotopes for following the nutrients through the tree. This treatment was shown to be effective also in winter when the tree appeared dormant.

In a combined session on plant diseases and purity of stocks, Mr. W. C. Moore stressed very strongly the importance of ensuring really healthy plant material before it is moved from country to country. The introduction of major pests with plant material is unfortunately only too well known and common an experience. Virus diseases are one of the most difficult problems that horticulturists now have to face, and in his paper on the serological diagnosis of plant diseases caused by virus, which he supported with a film, Prof. E. van Slogteren, of the Netherlands, showed how many virus diseases can at any rate be diagnosed by serological methods, a diagnosis which is independent of the symptoms of the plant.

A paper of great interest on the use of 'Krilium' as a soil conditioner, by Dr. A. J. Lloyd and Dr. C. E. Morgan, of Monsanto Chemicals, Ltd., was presented in this session, and a film was shown demonstrating the power of 'Krilium' to retain a crumbly soil structure and for the treated soil to retain drops of water without disintegrating. 'Krilium' was described by the authors as "a new synthetic polymeric electrolyte of a resin type, which by reason of its high anion potential, possesses large numbers of reactive groups in the molecule". It is understood that tests are proceeding in Great Britain, and it is to be hoped that soon this material, which is already on the market in the United States, will also be available in Britain.

In a Congress to which more than a hundred different papers were presented by speakers from twenty-seven different countries, it is obviously impossible to do more than touch on a few of the aspects of the very varied mass of material which was available. The report of the Congress will be published through the Royal Horticultural Society, Vincent Square, London, S.W.1, in due course.

In the field of the nomenclature of horticultural plants, a revised International Code was worked out during the Congress and will shortly be published as an interim code prior to submission to the next Horticultural Congress, which it is anticipated will be held in Holland in 1955 or 1956. The Congress also laid great stress on the importance of the registration of the names of cultivated varieties, and in a resolution recommended that an International Registration Authority should be set up as soon as practicable for each genus or group of genera in which cultivated varieties are numerous. The Congress also passed unanimously two resolutions on nomenclature for transmission to the next International Botanical Congress. It put on record that it was "strongly of the opinion that the interest of increased stability in the nomenclature of cultivated plants would be served by incorporation into the International Code of Botanical Nomenclature of the proposals for *Nomina Specifica Rejicienda* set out in Taxon I, No. 5 (1952) and urged their adoption at the next International Botanical Congress". It also recommended in a resolution that any provision of this nature should "allow for the rejection of certain earlier homonyms as well as earlier synonyms, and while appreciating the technical difficulties involved, urged the appropriate botanical authorities to make every effort to overcome them". Mr. J. S. L. Gilmour, director of the Cambridge Botanic Garden, was appointed chairman of the International Committee for the Nomenclature of Cultivated Plants.

Other resolutions of the Congress were passed (1) in favour of the establishment of a horticultural bureau in the Food and Agriculture Organization; (2) in support of the recommendations of the International Plant Protection Convention and for increased facilities for the exchange of experimental material between country and country; (3) in support of the encouragement of research into the fundamental problems of plant physiology; and (4) for the setting up of a small working party for considering an international method for recording light values on the lines of the Dutch Committee.

PATRICK M. SYNGE

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

OPEN DAYS

FOR the sixth year in succession the Chemical Research Laboratory, Teddington, of the Department of Scientific and Industrial Research, held a series of open days to which the director invited representatives of industry, universities and government departments. This year the open days were during September 23–26, and the attendance at all sessions indicated that there is no slackening of interest in this annual event.

A special feature this year was the new radiochemical building which has been specially designed and constructed, under the supervision of the Ministry of Works, for work with radioactive materials. It incorporates many modern features which make it one of the finest of its kind in Great Britain both for work with radioactive materials and for general chemical research. This building, with its associated pump house and tank farm, occupies an area of some twelve thousand square feet sited about a hundred yards from the main Laboratory block and is constructed of red brick with stone facing to conform to other buildings in the area. It comprises administrative offices, laboratories, plant room and service void, and pump house and tank farm. The administrative offices form a single-story section near the main entrance to the building and comprise an entrance hall, offices, conference room (also used as staff room), and cloakrooms which are provided with special facilities for changing and washing.

The main part of the building consists of two large laboratories and a number of smaller rooms divided, in part, by a central passage. Immediately beyond the cloakrooms and on one side of the passage are two laboratories concerned with research on the application of ion-exchange resins to the separation of metals. In these rooms an exhibit showed the development of a method for separating gold from other metals, such as iron, copper, silver, nickel, cobalt and zinc, in cyanide solution by an anion-exchanger. In this process, gold is removed from the resin by eluting with a mixture of acetone and hydrochloric acid. The other metals are eluted with aqueous solutions of salts such as sodium cyanide and potassium thiocyanate.

On the opposite side of the passage from the foregoing laboratories is a suite of rooms dealing with the measurement of radioactivity and allied topics. These laboratories comprise a counting room completely screened from electrical interference, a main laboratory for the measurement of carbon-14 (including apparatus for low-activity measurements and a microscope for scrutinizing tracks on photographic plates), and a dark-room showing apparatus for the determination of radioactivity by measurement of scintillation in a liquid medium using solutions of *p*-terphenyl as the scintillator for radioactive material. A number of other items used in measurements of activity were shown in an adjoining laboratory.

Beyond the rooms already mentioned is a group of small laboratories and rooms. These laboratories, which can also be used as offices, are designed for one worker or for special purposes. Exhibits shown in two of these rooms included an automatic resin-life tester for determining how long an ion-exchange resin will stand up to continual re-use, and an apparatus for the continuous determination of metals by a polarographic method. Two further rooms contain balances and physical apparatus used in analytical work. Of special note is a nephelometer for turbidimetric determination. Beyond these small rooms is a large analytical laboratory containing eight double-benches, ancillary fume-chambers, dry benches for furnaces, washing-up sinks and built-in desks down each side of the laboratory. This laboratory deals with analyses of minerals and ores and with research on analytical methods. An exhibit of chromatographic methods using paper strips and columns was shown here, and particularly noteworthy was the method developed for determination of niobium and tantalum in minerals, ores and other substances. A small adjoining laboratory is devoted exclusively to fluorimetric methods, while a larger room is concerned with the separation of metals on paper strips using radioactive tracers, which are detected and determined on a special scanner built in the Radiochemical Group for this purpose.

The rest of the laboratory space is used for research work on the extraction and recovery of valuable metals from minerals and ores. A large room is available for operating with larger quantities of material than is possible in an ordinary laboratory. This large laboratory contained exhibits dealing with ion-exchange methods, precipitation under *p*H control and other techniques. Associated with this work are three smaller laboratories for research and control work, and a grinding room. The grinding room includes an ore storage annexe and contains a ball mill, hammer mill, mechanically operated screens, and an electromagnetic separator for preliminary ore treatment. This room is provided with a separate ventilation system to guard against hazard due to dust.

The plant room contains the machinery for ventilation and other items. Incoming air is filtered, washed and warmed before passing to the laboratories. Air is extracted through the fume chambers in the laboratories and passes through an electrostatic precipitator before ejection to the atmosphere through a 60-ft. chimney. This ventilation system is designed to provide at least 80 linear feet of air a minute through the fume chambers. A service void forms a second story to most of the building, and houses all the ducting and services. It provides a very colourful but orderly sight, and repairs can be carried out with minimum disturbance to the laboratories underneath.

The disposal of liquid effluent has also been carefully considered. All liquid waste from the laboratories passes through polythene piping to one of three stainless-steel delay tanks (500 gal.), where it is monitored for radioactivity. The liquid is then either left to allow time for activity to decay while the other two tanks are used, or pumped to one of two larger tanks (5,000 gal.) for dilution, or pumped directly to the drain, depending on the activity present. Provision is also made for chemical treatment in the smaller tanks and disposal by tank truck if necessary.

In the Corrosion Group of the Chemical Research Laboratory, work on the high-temperature corrosion of steel has been supplemented by a new research on oxidation by flue gases ; this is intended to assist in the development of a ferritic steel suitable for boiler superheater tubes operating at temperatures above the present normal maximum. The apparatus used consists of a tubular furnace in which the weight increase of several specimens can be measured *in situ*.

An interesting exhibit was an automatically controlled apparatus of the weatherometer type for accelerated corrosion testing. Constructed of 'Perspex', this permits continuous or intermittent exposure of specimens to spray (simulating either industrial or marine atmospheres) and infra-red and ultra-violet radiation as desired. A recently recognized ('filiform') type of corrosion which appears as worm-like tracks on plain or lacquered steel plates is being investigated ; examples produced in the laboratory were exhibited. The mechanism of corrosion inhibition by sodium benzoate and potassium chromate is being studied by radioactive tracer methods and by electrode potential decay curves. The practical application of inhibitors has been extended by the formulation of corrosion-inhibitive greases and thixotropic pastes. In electrochemical studies of paint films on immersed steel, special attention has been given to the estimation of the amount of water absorbed by the paint.

The Pure Metals Committee of the Chemistry Research Board continually collects and examines information on the availability of metals of high purity and, in addition, carries out analyses of such materials. In certain cases samples of the purest obtainable metals are kept in stock, and these can be made available to workers in other laboratories for their researches. At present twenty-three metals are kept, twenty-two of which were shown in the exhibit of the Inorganic Group. Also on view were samples of highly pure germanium and germanium dioxide in which the arsenic content had been reduced to one part in 10^8–10^9. These were purified by a process developed in the Laboratory and for which a patent application has been made. The process of purification has been studied by the use of radioactive arsenic.

Results of investigations on the production of fertilizers have been published and communicated to the industry. Further work in this field is confined to some more-specialized aspects, notably a study of the production of dicalcium phosphate. A wide range of equipment was shown in the microanalytical and spectrographic laboratories, including apparatus for the determination of active hydrogen by means of lithium aluminium hydride and a spectrum projection comparator.

One of the direct services of the Organic Group of the Laboratory to industrial and other laboratories is the supply of extremely pure organic compounds as standards for the calibration of mass spectrometers and for ultimate reference in other physical methods of analysis. Samples of thirty-six such standards were shown which are all available on request. Recent advances in chemotherapy have emphasized the potential importance of certain of the homologues of pyridine, and special attention has been given to the devising of methods for their recovery from crude-tar bases, and to the establishment of suitable analytical techniques. Jointly with the Physics Division of the National Physical Laboratory, a study of the thermochemical properties of pyridine homologues has been started.

Preparative work of the Organic Group has included the synthesis of a supply of a cinnolylguanidine derivative (at the request of the Medical Research Council) for large-scale trial as a trypanocide, applications of the Kolbe–Schmidt reaction, and new syntheses of organic compounds containing isotopic carbon. Use of naphthalene labelled with isotopic carbon has been made in a method of estimating the naphthalene content of tar oils. The method would be suitable for use in studies of the effectiveness of naphthalene extraction in large-scale processes.

In the High Polymers Group, work on semipermeable membranes and ion-exchange resins was shown. The behaviour in non-aqueous systems of membranes prepared from polyvinyl alcohol is of outstanding interest. Using membranes of this type, polymer molecular weights from one million to two thousand have been determined by osmometry; in no case was there evidence of solute diffusion through the film (*J. Chem. Soc.*, 3190; 1952). Statistical analysis of the results has shown that the relationship between osmotic pressure and concentration is best satisfied by the equation, $\pi = aC + bC^2$, where a and b are constants. Simple osmometers (capacity about 3 ml.) based on the Zimm–Meyerson design have been constructed for use with polyvinyl alcohol membranes. A novel form of reversed-phase partition chromatography was exhibited. Cross-linked polystyrene beads are allowed to swell in a carbon tetrachloride solution of the water-insoluble complexing agent, for example, dithizone. The swollen beads behave as selective absorbents and may be used for the recovery and separation of metals from aqueous acid solution.

Another service of the Chemical Research Laboratory is the supply of bacterial cultures of industrial and research interest. The National Collection of Industrial Bacteria, within the Microbiology Group, now maintains some six hundred strains, most of which are preserved in the freeze-dried state. Methods of classification and maintenance were demonstrated. Responsibility for the maintenance of 'official' cultures of antibiotic-producing organisms has recently been assigned to the National Collection by the United Nations World Health Organization.

Fundamental research on the sulphate-reducing bacteria has included a study of their oxidation of lactic, malic, pyruvic and other acids with sulphate as oxidizing agent, and the discovery of a 'sulphate-free' fermentation leading to ethanol and acetic acid. Work on their utilization of hydrogen has shown that this can result in the reduction of fumaric to succinic acid. Evidence for a co-hydrogenase, replaceable by methylene blue, has been obtained. Investigations on the microbiological production of sulphur and sulphide from sulphate are in progress at the Laboratory and at the Microbiological Research Department (Ministry of Supply) at Porton. At the latter station, a continuous method of bacterial sulphate-reduction is being used; photographs and a diagrammatic flow-sheet of the apparatus used were exhibited.

OBITUARIES

Prof. C. H. Lees, F.R.S.

PROF. C. H. LEES passed away on September 25, at the age of eighty-eight. He was a man of great charm and endeared himself to friends and students. Lees possessed great patience, and he was not to be deviated from the course he had set himself by difficulties when carrying out a piece of research.

Born in Glodwick, Oldham, in 1864, he was a student at the Owens College, Manchester, becoming Berkeley Fellow in 1888. He then studied at the University of Strassburg.

In 1891 Lees was appointed senior assistant lecturer and demonstrator in physics in Owens College and became lecturer and assistant director of the Physical Laboratories of the University of Manchester in 1900. He left Manchester in 1906 to become professor in Queen Mary College, where he remained until 1930, retiring with the title of emeritus professor of physics in the University of London.

Although Lees's first claim to fame lies in the field of thermal conductivity measurements, he was a man of wide interests. In the years between the two World Wars, he had students carrying out research on problems of acoustics, elasticity, light, electricity, as well as heat. He contributed papers on A.C. bridges and on fluid flow through pipes. The technique he used in thermal conductivity measurements now finds a place in the text-books. His *Phil. Trans.* paper on the thermal conductivity of metals to low temperatures was the subject for 1908 of the Bakerian Lecture of the Royal Society.

Lees was an excellent committee man and for more than twenty years served on the Engineering Committee of the Food Investigation Board of the Department of Scientific and Industrial Research. He also served on the Safety in Mines Board.

Education was a topic of great interest to him and for a long period he served on the Kent Education Committee and the delegacy for managing Goldsmiths' College, London. For a time he was vice-principal of Queen Mary College. He served as president of the Physical Society and vice-president of the Institute of Physics.

His hobby was handicrafts, and up to within a few days of his death he occupied his time with carpentry.

In the passing of C. H. Lees we mourn the loss of one of the 'old guard' of physics of the past generation and one of the greatest of friends.

EZER GRIFFITHS

Prof. Millais Culpin

IT is with regret that we record the death on September 14 of Prof. Millais Culpin at the age of seventy-eight. He was one of the brilliant group of psychiatrists revealed by the First World War.

He studied at the London Hospital and qualified M.R.C.S., L.R.C.P. in 1902, passing the F.R.C.S. three years later. It seemed that he was prepared for a surgical career and, indeed, he practised this for a time at Shanghai. However, when the War broke out, he joined the R.A.M.C. and became interested in war neurosis. Then he served in France during 1916 and 1917 as a surgeon, but still retained his psychiatric interest. At the end of this time he was asked by Aldren Turner to work in the Army neurological hospitals and there found ample material for research. His M.D. thesis in 1919 was devoted to his findings, and the following year he published his "Psychoneuroses in War and Peace".

Culpin was then appointed lecturer in psychiatry to the London Hospital Medical School and neurological specialist to the Ministry of Pensions. In 1923 he joined in research on neurosis organized by the Industrial Health Research Board and in 1930 was made lecturer in psychology to the London School of Hygiene and Tropical Medicine. The year after, he was appointed to the chair of medical and industrial psychology, which he occupied until he resigned in 1939.

He had a remarkably lucid mind and often was able to see things from an unusual angle. His spare dry wit occasionally illuminated his points. His writing, also, showed his clear, logical thought. He published a number of books, including "Spiritualism and the New Psychology", "The Nervous Patient", "Medicine and the Man", "Mental Abnormality Facts and Theories", and, in collaboration with Dr. May Smith, "The Nervous Temperament". His best known work was "Recent Advances in the Study of the Psychoneuroses", which summarized all the work up to its publication in 1931.

Prof. Culpin was never a spectacular figure; but he leaves behind a solid basis of research and exposition which has earned him a place among the pioneers of dynamic psychology in Great Britain.

CLIFFORD ALLEN

NEWS and VIEWS

Institution of Mining and Metallurgy: New President

PROF. J. A. S. RITSON, professor of mining in the Royal School of Mines, London, has been elected president of the Institution of Mining and Metallurgy for the session 1953–54 and will take office at the general meeting to be held on May 28, 1953. Prof. Ritson was educated at Uppingham School and in 1910 took his B.Sc. in mining at the University of Durham. He acted for a time as manager of a colliery in Northumberland and then became an inspector of mines. In 1923 he was appointed to the chair of mining in the University of Leeds, where he remained until he went to the Royal School of Mines in 1935, in which year he was awarded the O.B.E. Prof. Ritson served throughout the First World War, eventually commanding a battalion of the Royal Scots, and gained the M.C. and D.S.O. and bar. During the Second World War he was director of supplies at the Ministry of Fuel and Power until the middle of 1942. Prof. Ritson is a past president of the Institution of Mining Engineers.

Illuminating Engineering Society: New President and Awards

AT the opening sessional meeting of the Illuminating Engineering Society held on October 14 at the Society's headquarters at 32 Victoria Street, London, S.W.1, Dr. W. J. Wellwood Ferguson took office as president of the Society for the session 1952–53. Dr. Ferguson, who is senior ophthalmic surgeon at the Royal Infirmary, Sheffield, and lecturer in ophthalmology in the University of Sheffield, is one of the relatively few ophthalmologists who take an interest in lighting and is the second of his profession to become president, the first being Sir John Parsons, who held the office during 1921–23. One of Dr. Ferguson's particular interests in lighting matters is the illumination of mines and miners' nystagmus, and he has published numerous papers on these subjects He is the only ophthalmologist who takes an active part in the meetings of the International Commission on Illumination, and he serves on a number of subcommittees of the National Illumination Committee and on the Light and Vision Committee of the Medical Research Council. Recently, he visited the United States to study the work being done there in the use of cortisone in connexion with certain diseases of the eye.

The Leon Gaster Memorial Premium of the Society for 1952 has been awarded to Mr. J. S. McCulloch for his paper on "The Lighting of Shipyards"; Mr. McCulloch is with R. W. Gregory and Partners (consulting engineers) of Newcastle upon Tyne. Honorary membership of the Society has been awarded to Prof. J. T. MacGregor-Morris, professor emeritus of electrical engineering in the University of London, in recognition of his many services to the Society and in acknowledgment of his pioneering work in illuminating engineering and photometry, particularly his research on the carbon arc as a standard of light; Prof. MacGregor-Morris is one of the original members of the Society and was president in 1940.

The Biological Council

THE Biological Council, which is composed of representatives of some fifteen specialist biological societies, has recently resolved to become an advisory body to the Institute of Biology. It is expected that the closer relations between the Council and the Institute—formed on the initiative of the Biological Council—will be mutually beneficial. At a meeting of the Biological Council held on September 29, the following officers were elected. *Chairman*, Dr. W. P. K. Findlay (Forest Products Research Laboratory, Princes Risborough, Bucks); *Hon. Treasurer*, Prof. F. L. Warren (London Hospital Medical College); *Hon. Secretary*, Dr. J. L. Cloudsley-Thompson (Department of Zoology, King's College, University of London). All communications should be addressed to Dr. J. L. Cloudsley-Thompson, c/o The Institute of Biology, Tavistock House South, Tavistock Square, London, W.C.2.

Technological Education in Manchester

AT a ceremony on October 11 at the College of Technology, Manchester, which formed part of the jubilee celebrations of the College, the associateship of the College was conferred on the Minister of Education, Miss Florence Horsbrugh, and on Lord Cherwell and Alderman Wright Robinson. Although more than one speech emphasized the dependence of the economic future of Great Britain upon technicians and technologists, Miss Horsbrugh made no reference to the Government's plans for the expansion of higher technological education. She assured her audience that the claims of the Manchester College of Technology had been very fully presented to her, and that she would do her best to meet the needs of both university and non-university work there. She could not say how quickly the Government could carry out developments which would lead to a major change in the character of the College. Lord Cherwell referred to the increasing need for well-trained technologists, but also gave no indication of the Government's plans. Mr. David Cardwell, the acting principal, referred to the way in which uncertain financial backing had led to students having to abandon advanced courses before completion and urged the necessity of an extension of grants for postgraduate research. Mr. Cardwell also referred to the high quality of the part-time students and the potentialities of such students for increasing the supply of university graduates in science and technology. The City Council, he said, is pressing forward with a building programme for the College which would cost some £1,600,000.

International Nutrition Congress

THE second International Congress of Nutrition, held under the auspices of the International Union of Nutritional Sciences, has just concluded at Basle. At a meeting of the Executive Committee of the Union, attended by representatives from sixteen nations, it was unanimously decided to accept the invitation of the Netherlands members to hold the third International Congress in Amsterdam in the summer of 1954. Prof. E. J. Bigwood (Brussels) was re-elected chairman of the Committee and Dr. Leslie J. Harris (Cambridge) honorary secretary. The following national, or organizational, representatives served on the Committee: Prof. E. J. Bigwood (Belgium), Dr. Morley Whillans (Canada), Prof. H. Dam (Denmark), Prof. A. I. Virtanen (Finland), Prof. E. Terroine (France), Prof. H. Kraut (Germany), Dr. M. Demarchi (Iraq), Dr. F. Mancini (Italy), Dr. A. Seliskar (Jugoslavia), Dr. M. van Eekelen and Prof. B. C. P. Jansen (Netherlands), Mrs. B. Q. Werenskiold (Norway), Prof. E. Abramson (Sweden), Prof. K. Bernhard and Prof. F. Verzár (Switzerland), Mr. A. L. Bacharach and Dr. L. J. Harris (United Kingdom), Dr. S. G. Greenberg (U.S.A.), Dr. W. R. Aykroyd (Food and Agriculture Organization), Dr. T. Norris (World Health Organization), Dr. D. P. Cuthbertson (Scottish Group, Nutrition Society), Miss D. F. Hollingsworth (International Dietetic Congress).

Regeneration and Re-afforestation

IN *Forestry Abstracts*, Vol. 12, No. 4 (Commonwealth Forestry Bureau, Oxford, June 1951), under "Sylviculture", F. C. Hummel describes "The Sylviculture of Mixtures in some Forests in S.W. Germany". The general policy, as contrasted with the almost universal habit in Germany during the past century and before of pure coniferous crops, is now to grow conifers and broad-leaved species in mixture. This involves what is almost a revolution in sylvicultural and management methods, and the possibilities of applying them under British conditions are described. In discussing the degree in which artificial assistance is given to this new regeneration, it is mentioned that beech and other broad-leaved species are often transplanted when 4–6 ft. high; but it is necessary to prune both the roots and crowns of such large plants and to stake them. The method is not new. In the old days, when the Forest of Dean was resown with acorns, the practice was to put in at every 20 ft. or so an oak transplant of 4–5 ft. in height. The method is employed by the French in the tropical rain-forest of the Ivory Coast in West Africa. In re-afforesting work, transplants 1½–2 m. in height are used. P. Dineur discusses the ecology of *Quercus sessiliflora* (*Q. petraea*); measurements of light under various degrees of canopy closure were undertaken for seedling regeneration, using a photometer of photoelectric cell type. Sylviculturists have for years advocated the possibility of being able to ascertain the more-or-less exact light requirements of seedlings under overhead canopy. It looks as if data on this problem may be obtainable. Lessons long since learnt in India are discussed by T. S. Serevo on "Silvicultural Observations in Cut-over Areas in Ajusan, Philippines". Logging was undertaken in an over-mature Dipterocarp forest with sparse advance growth. It is impossible to remove the main stand in such a type of forest without destroying all the undergrowth, since with the removal of the canopy the forest floor dries up. The dangers of logging in tropical forests are pointed out. The lesson was learnt in Madras in the years following the First World War, when attempts were made to introduce Canadian and American methods of logging into the evergreen forests. The result was a failure and a considerable pecuniary loss. But the lesson was learnt once and for all for India. The breaking of the overhead canopy exposes the moist soil below, never before exposed, to heat, heavy rain and wind, and it is quickly dissipated; the area is then useless for agriculture and difficult to re-afforest.

National Foundation for Scientific Research, Brussels: Annual Report for 1950–51

THE twenty-fourth annual report of the National Foundation for Scientific Research, Brussels (pp. 193; 1951), covering the year 1950–51, refers to the establishment on July 26, 1951, of the Inter-University Institute of Nuclear Sciences and to the increase of its financial resources from 20 million to 25 million francs. The Atomic Energy Commission has also since established, on April 9 this year, a Centre of Studies for the Application of Nuclear Energy, which, mainly under academic direction, will be responsible for the utilization of the products of the Belgian nuclear reactor. A list of publications of the nuclear physics centres at Brussels and Louvain during 1947–51 is included; work at the Ghent centre has included technological research on the preparation of graphite and metallic uranium and on photographic emulsions, and at the Liège centre on absorbent media for gamma-rays and neutrons, the application of photographic emulsions, nuclear chemistry and the construction of a high-tension generator of the Panthenier type. During 1951–52 the Foundation has distributed sixty subsidies, totalling 3·2 million francs and including contributions towards the cost of construction of an electronic calculating machine, an oceanographic research station at La Rochelle-Pallice, an insectarium at Mentone, an epigraphic and archæological survey of the two provinces of Nejran and Hasa in Saudi-Arabia, the construction of a heliostat for the scientific station of the Jungfraujoch, for excavations at Alba Fucens, for studies on the performance of gas turbines, and for studies of the radiation of the night sky at Arosa Observatory in co-operation with the High-Altitude Research Centre at Pasadena. Details of the distribution of radioisotopes in Belgium are included in the report, to which are appended lists of recipients of grants for 1951–52 and of papers by recipients of grants published during 1950–51.

Human Relations in Industry

THE report of the conference on human relations in industry, arranged by the Ministry of Labour and National Service during March 18–20 (see *Nature*, 169, 872; 1952), has now been published (pp. 128;

London: H.M.S.O., 1952; 3s. 6d. net). It includes the text of the Minister's opening address, Sir George Schuster's address on the work of the Panel on Human Factors in Industry; Sir Cuthbert Clegg and Mr. T. Williamson's comments on the work of the Anglo-American Council on Productivity; and reports of the discussions, together with the final text of the four group reports on, respectively, the opportunity to work, the capacity of workers, wastage of man-power and the will to work. Appended to the report are the papers on these subjects issued for discussion at the conference, and the paper summarizing the findings of the industrial productivity teams of the Anglo-American Council on Productivity relating to subjects on the agenda of the Conference; also included is Sir George Schuster's memorandum on conclusions drawn from the projects sponsored by the Schuster Panel on Human Factors in Industry.

Durban Museum and Art Gallery: Annual Report for 1950–51

The report of the Durban Museum and Art Gallery for 1950–51 is the last issued under the directorship of Mr. E. C. Chubb, who has so ably controlled the remarkable progress of this institution for forty-one years. Occasion is thus taken in the report to review this long period, which is shown to be one of continuous growth accompanied by increased popularity and educational value, limited only during the past few years by restricted accommodation. Unfortunately, although a new building embodying more adequate accommodation has been advocated during the past fourteen years, circumstances resulting from the Second World War have prevented its realization.

University College of North Staffordshire: Appointments

The following appointments in the University College of North Staffordshire have recently been made: *Senior Lecturer*, Dr. A. M. Macbeath (mathematics); *Lecturers*, Dr. Monica M. Cole (geography), Miss Ruth M. Badcock and R. L. Plack (biology), Dr. D. J. O'Connor (philosophy), Mrs. P. Elizabeth Perrott (education), Dr. A. Frohlich and B. Noble (mathematics), Dr. G. F. Smith (chemistry), and A. H. Oliffe (psychology); *Assistant Lecturers*, A. Hunter (economics), W. M. Williams (geography), Dr. S. C. Nyburg (chemistry), Miss Helga M. T. Frankland (biology), and P. H. Shelford and A. F. Trendall (geology).

University of Birmingham: Appointments

The following appointments in the University of Birmingham have recently been announced: *Lecturers*, R. D. Mackey (civil engineering), K. M. Brown and W. G. Thomas (mining); *Research Fellows*, Dr. L. A. Radicati and Dr. J. G. Valatin (mathematical physics), J. J. Pick (Lucas Research Fellow in industrial metallurgy), and B. E. L. Deckker (James Watt Research Fellow in mechanical engineering).

British Society of Rheology: Members of Committee

At the recent annual general meeting in Southampton of the British Society of Rheology, members of committee were elected as follows: *President*, A. G. Ward; *Secretary*, A. P. Feltham (British Iron and Steel Research Association, 140 Battersea Park Road, London, S.W.11); *Treasurer*, Dr. J. G. Oldroyd; *Editor*, A. A. Milne; *Northern Representative*, L. Grunberg; *Midland Representative*, A. W. Richardson; *Ordinary Members*, D. W. Jopling, Dr. J. W. S. Mardles and N. Wookey.

Announcements

The autumn provincial meeting of the Physical Society will be held in the Physical Laboratories of the University of Manchester during December 18–19. The meeting will be on "Ionization Loss by Relativistic Particles" and will include speakers from the Atomic Energy Research Establishment, Harwell, and from the Universities of Bristol, Brussels, Glasgow, Leeds and Manchester. Non-members are welcome to attend. Details of the programme and application forms can be obtained from the Offices of the Society at 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

To mark the opening earlier in the year of the Textile Institute's new headquarters at 10 Blackfriars Street, Manchester 3, a series of inaugural lectures is to be given there, the speakers and their subjects being as follows: October 24, Sir Ben Lockspeiser (secretary of the Department of Scientific and Industrial Research), on "Science in Industry"; November 21, Sir Wallace Akers (a director of Imperial Chemical Industries, Ltd.), on "The Chemical Industry and Textiles"; and January 30, Mr. A. H. Wilson (research director of Courtaulds, Ltd.), on "Whither Man-Made Fibres?". Each lecture will commence at 3 p.m. Admission is by ticket, applications for which should be made to the Registrar of the Institute at the above address.

The twelfth series of postgraduate lectures organized by the Oil and Colour Chemists' Association will be given by Prof. C. E. H. Bawn, professor of inorganic and physical chemistry in the University of Liverpool, who will speak on "Autoxidative Reactions: their Chemistry, Mechanisms and Catalysis by Metal Salts". The lectures will be given at 6.30 p.m. on November 17, 24 and December 12 in the Lecture Theatre of the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1. The fee for attendance is 15s. for members of the Association and £1 for others (inclusive of a copy of the lectures). Further information can be obtained from the Association at Memorial Hall, Farringdon Street, London, E.C.4.

The Medical Research Council invites applications for the Kathleen Schlesinger Fellowship, tenable initially for one year at the National Hospital for Diseases of the Nervous System, Queen Square, London, and worth £700–1,000 a year. This Fellowship is provided from a fund established by the late Mr. and Mrs. E. M. Schlesinger in memory of their daughter; it is for the investigation of the origin and nature of cysts of the brain, and preference will be given to candidates who elect to work on the mechanisms underlying degenerative processes affecting the brain. Applications must reach the Secretary of the Medical Research Council, 38 Old Queen Street, London, S.W.1, not later than November 15.

The University of Chicago, with the financial support of the Rockefeller Foundation, is offering three postdoctoral fellowships in statistics for 1953–54. These fellowships, which are worth 4,000 dollars each, are open to holders of a doctorate or its equivalent in research accomplishment, and their purpose is to enable research workers in the biological, physical and social sciences to acquire training for the application of statistical methods to their normal work. Details of application (to be completed by February 3, 1953) and further information can be obtained from the Committee on Statistics, University of Chicago, Chicago 37.

HUMAN BIOCHEMICAL GENETICS

A JOINT SESSION arranged by Sections D (Zoology), I (Physiology), J (Psychology) and K (Botany) of the British Association was held during the recent Belfast meeting to discuss "Human Biochemical Genetics".

In his introductory remarks, Prof. L. S. Penrose (Galton Laboratory, University College, London) pointed out that the foundations of the exact study of human genetics were laid down almost simultaneously by Landsteiner in his work on the *ABO* blood groups and by Garrod in his work on alkaptonuria. These investigations, carried out between 1900 and 1902, described human characters which were found to follow simple rules of inheritance, and the tests for their presence or absence were precise. The branch of the subject initiated by Landsteiner utilized serological techniques depending ultimately, but not yet demonstrably, upon inborn biochemical peculiarities. The other branch of biochemical studies in human genetics is derived from Garrod's work, and it deals with characters identified by ordinary chemical tests or their equivalents, like colour reactions.

It is convenient to classify the known types of inborn biochemical specifications by the substances involved in the test reactions. Anomalies of protein metabolism include alkaptonuria, the amino-acidurias, such as phenylketonuria, tyrosinosis, cystinuria and beta-amino*iso*butyricaciduria (the 'T-pattern' described by Crumpler, Dent, Harris and Westall), the melanin peculiarities exemplified by albinism and the globulin specificities found in the blood in sickle-cell trait and thalassæmia. Abnormal lipoid metabolism is represented by such diseases as xanthomatosis and cerebromacular degeneration; at present this group has proved intractable for experimental investigation. Anomalies associated with carbohydrate metabolism include pentosuria, fructosuria and renal glycosuria; diabetes mellitus is only included in a very indirect manner. There is also a large miscellaneous group of conditions, not easy to classify, some associated with disease and others quite harmless; for example, gout, porphyria, congenital methæmoglobinæmia, red hair and taste deficiency.

A primary aim in human genetics is to reduce all characters so far as possible to chemical differences. In this way, the study of human constitution will gradually become an exact science freed from ambiguities and superstitions which surround the cult of physical types. Moreover, with harmful traits, knowledge of the causal mechanisms can help in planning their alleviation or cure.

Three aspects of the subject were emphasized by Dr. H. Harris (University College, London): the precise characterization of human variations in biochemical terms, the genetical analysis of traits so defined, and the study of the processes by which individual genes produce their particular effects. These points were illustrated by reference to amino-acidurias in general and especially to cystinuria, a condition first recognized by Wollaston in 1810 on the discovery of a renal stone of unusual composition. Since the introduction of paper chromatography, it has been possible to separate a classical type of cystinuria, in which cystine excretion is accompanied by excessive excretion of lysine and arginine, from other types, in which it occurs as part of a generalized amino-aciduria (for example, Fanconi syndrome, Wilson's disease). Quantitative studies using the technique of polarography were carried out in families containing cases of classical cystinuria. Those with stone formation were found to excrete on the average about 750 mgm. of cystine daily, whereas normal people averaged about 60 mgm. In one group of families studied, cystinuria segregates sharply and behaves as a single Mendelian recessive trait. In the remainder of families, three distinct types of individuals were found: the data here were consistent with the hypothesis that heterozygotes (carriers of the gene causing cystinuria in homozygotes) excreted about 150 mgm. daily and were thus distinguishable from normal homozygotes. The frequency of carriers of this incompletely recessive gene is about 3 per 1,000 in the general population.

Garrod's view on the causation of biochemical anomalies was that there was congenital absence of an enzyme concerned in performing a particular step in metabolism. This theory is easy to apply to alkaptonuria and phenylketonuria; but in renal glycosuria or cystinuria the process is not so clearly demonstrable. A block in intermediate metabolism would tend (as it does in phenylketonuria) to cause an increase of unusable metabolites in the blood-stream or tissue-fluids. This does not occur in classical cystinuria, and it is thought that there is failure of reabsorption in the kidney tubules due to a defect in one of the chemical reactions concerned in this complex process.

A detailed account of the effects of the recessive gene for phenylketonuria in its homozygous form was given by Dr. V. Cowie (Maudsley Hospital, London). In this disease, first described by Folling in 1934, about 1 gm. of phenylpyruvic acid is excreted daily in the urine. Dr. Cowie pointed out that mental impairment, usually of a severe degree, is always present, and there are many associated physical features including dilution of hair colour and postural peculiarities. The fundamental defect is a reduced capacity to metabolize phenylalanine through the normal channel by way of tyrosine. Experiments have shown that although this pathway is not completely blocked, phenylalanine accumulates in the blood and cerebrospinal fluid and is eventually excreted after deamination as phenylpyruvic acid. The way in which the mental and physical abnormalities are produced by the biochemical defect, she said, is not yet clear. However, the condition is present at birth, and attempts at alleviation by dietetic methods have so far been unsuccessful, though the possibilities of very early treatment have not been fully explored.

Besides demonstrating hereditary biochemical specificities within the human species, Garrod directed attention to the biochemical differences between species. An account of a comparative survey of urinary amino-acid patterns in a number of different animal species was given by Dr. S. P. Datta (University College, London). Most of the animals tested were in the London Zoo. Sufficient urine was placed on two-dimensional chromatograms to give up to six main spots. Glycine was almost always present, and alanine and glutamine or glutamic acid occurred very frequently. In the mouse and the binturong, however, only taurine was found. One substance of special interest, a sulphur-containing amino-acid, purified from cats' urine by Westall, was named 'cat-spot'. In most of the Felidæ it appears to be an alternative to taurine for the excretion of organic sulphur. The Kenya blotched genet has a peculiarity unique among the animals studied in that it excretes very large quantities of cystine. The question as to how so much cystine can be kept in solution in these urines might have some relevance to the study of the prevention of cystine-stone formation in man.

Dr. Datta showed that methyl histidine, which occurs variably in human urine, is always present in laboratory cats which are fed mainly on meat. It is not excreted by animals such as rats, mice, rabbits and guinea pigs, the diets of which are mostly of vegetable origin. By experiments on man, it has been possible to demonstrate that methyl histidine in the urine is probably derived from ingested anserine, a known constituent of muscle. Anserine is hydrolysed in the body to produce beta-alanine, which is further metabolized, and methyl histidine, which is excreted. Thus a peculiarity which superficially resembles an inborn trait turns out on chemical analysis to be mainly a question of diet.

Prof. D. C. Harrison (Queen's University, Belfast) dealt with the rare hereditary disease familial methæmoglobinæmia. He reviewed work done in collaboration with Prof. H. Barcroft, Dr. Q. H. Gibson and others. In methæmoglobinæmia, an abnormally large proportion of the blood pigment hæmoglobin (Hb) is changed to the corresponding ferric compound methæmoglobin ($Met\text{-}Hb$), which is useless for oxygen transport. In normal blood, the equilibrium $Hb \rightleftharpoons Met\text{-}Hb$ lies far to the left owing to the action of enzyme oxidation-reduction systems in the red blood corpuscles. These systems reduce the methæmoglobin which is constantly being formed from hæmoglobin and prevent the methæmoglobin from accumulating in more than traces. In the type of methæmoglobinæmia caused by certain drugs or (in infants) by nitrates in drinking water, the oxidation of hæmoglobin to methæmoglobin becomes so fast that the restoring enzyme systems are temporarily unable to maintain the normal level of hæmoglobin; but conditions return to normal when the offending agent is removed. In familial methæmoglobinæmia, on the other hand, the rate of production of methæmoglobin is normal but its rate of reduction is abnormally slow, so that it may accumulate to form as much as 40 per cent or more of the total blood pigment. Denny observed that large doses of ascorbic acid (acting as a reducing agent) shift the equilibrium back towards normal.

The work of Gibson has shown that the disease is due to an enzyme defect in the red blood cells; there is a shortage of diaphorase I (a flavoprotein enzyme). This shortage was demonstrated by direct assay in the blood of all seven patients who were tested. The values were in every case lower than those of any of the sixteen normal bloods used for comparison. Addition of excess diaphorase I restored full activity. The oxygen dissociation curve of the blood of the patients was found to be shifted to the left, that is, the blood parted with its oxygen less readily than normal. This, coupled with the large amount of pigment present in the abnormal, non-functional state, makes it surprising that the patients as a whole were able to lead active, energetic lives. The compensating polycythæmia which was present in the more severe cases may help to explain this.

The disease is apparently due to a mutation of the gene responsible for synthesis of the flavoprotein diaphorase I. In all three families studied, the disease appeared to be inherited as a recessive Mendelian trait. Prof. Harrison stated that quantitative studies on the blood of relatives of the patients had given no evidence for the presence of detectable genetic carriers. Treatment of the patients (which was successful in all cases) consisted of large daily doses of ascorbic acid continued indefinitely, preferably supplemented by a single dose of methylene blue after the first few days.

GROWING-POINTS IN CYTOLOGY

On the opening day of the recent British Association meeting in Belfast, a session was devoted by Section D (Zoology) to the discussion of some recent advances in cytology. The first paper, by Mr. I. C. Smith (Dundee), on the curious cytology of Pharaoh's ant, *Monomorium pharaonis* L., followed naturally on Prof. Peacock's presidential address (see *Nature*, September 6, p. 395), which earlier in the day had been concerned with some aspects of hymenopteran reproduction. Pharaoh's ant shares with many other hymenopterans the peculiarity that the males arise from unfertilized eggs by haploid parthenogenesis, or arrhenotoky, with the result that the male germ cells and much of the soma remain haploid. The females, on the other hand, develop from fertilized eggs, so that the female germ cells and much of the soma are diploid. Clearly, the eggs of virgin females can develop only into males.

Since the male germ-line is already haploid, it is obvious that no further reduction can take place in the chromosome number during the maturation of spermatozoa. In the hornet, Meves showed as early as 1904 that, during spermatogenesis, the first meiotic division, which is normally a reduction division, is abortive, while oogenesis is normal. Considerable attention has therefore been paid to the details of the first meiotic division in the spermatogenesis of Pharaoh's ant. Mr. Smith described the untidy nature of this division and the curious fact that about this time a small fragment of cytoplasm separates as a bud. Some have considered this bud to represent a vestigial cell, the remnant of a typical meiotic division; but there are now good reasons for abandoning this view. The division is, in fact, a normal mitosis, and the two daughter cells develop without any further division into spermatids and spermatozoa, which are, of course, haploid. There is therefore no stage in spermatogenesis which corresponds to a normal first meiotic division.

The meeting then passed on to consider an interesting paper by Dr. R. J. Goldacre (Chester Beatty Institute, London) on the tail region of *Amœba*. Dr. Goldacre began by tilting at the insistence of so many zoologists that the *Amœba* is an animal without form, a point of view that is perpetuated by such names as *Amœba chaos* and *Chaos chaos*. A text-book *Amœba* is said to throw out pseudopodia at random from any part of its surface, whereas the real *Amœba* has an obvious antero-posterior polarity with a well-marked permanent tail, or rear contracting end. This rear end can easily be distinguished as a group of wrinkles caused by a contraction of the cortical gel, which in the tail is liquefying to be squeezed forward up the central channel of the *Amœba*.

That the tail region of an *Amœba* is relatively permanent is shown by the fact that the animal has never been seen to reverse, even when watched for as long as a week. This fact can also be demonstrated by staining a living *Amœba* with neutral red. The stain becomes concentrated in the tail, which can then be seen to keep its identity for long periods of time. Dr. Goldacre also described how the fate of the tail region can be followed during cell division, and how the tail seems to determine the plane of the division furrow. This furrow is first evident anteriorly, and the tail region is the last part to divide and separate. He therefore suggested that the tail of an *Amœba* may play some important part in the organization of the cell, surviving possibly throughout its whole life by passing from parent to daughter.

The third contribution to the symposium was a paper by Prof. H. G. Callan (St. Andrews); but since he was unable to be present it was read in his absence by Dr. Ann R. Sanderson. A description was given of recent research on amphibian oocyte nuclei, with particular reference to their chromosomes. These nuclei have the attraction that when they have been extracted from the yolky cytoplasm they are large enough to be visible to the naked eye. Investigations have shown that there are at least two, and probably three, materials forming the nuclear sap: a fluid phase extending through a jelly phase, and probably an even more rigid centrally placed jelly in which the chromosomes are embedded. The whole is surrounded by a membrane pierced by close-packed hexagonal pores.

The chromosomes themselves have been the subject of considerable observation, the necessary preliminary being the development of a technique for their extraction. In *Triturus* newts the growing oocytes contain chromosomes in the diplotene of meiosis. These chromosomes are almost 800 μ long and are arranged in pairs joined at one or more points of contact. They are of the type known as 'lampbrush', and it is their peculiarity that loops of material sprout out from the chromosome axis and return to their points of origin. There are many structures along the lengths of lampbrush chromosomes which enable one to map them. In a given position there may be a loop which is short and thin, or long and fuzzy, and there are also well-defined regions concerned with the production of nucleoli. When fully formed, these nucleoli detach themselves and migrate to the nuclear membrane. With all these structures available for matching chromosomes, it is possible to show that the contact points between pairs of chromosomes occur in homologous regions, although they differ in different nuclei. Indeed, they show the same type of variation in position as is shown by chiasmata. The paper ended with the suggestion that the great value of this oocyte material may prove to lie in what it can teach of gene activity, for in examining these lampbrush chromosomes one may really be seeing genes in action.

The session ended with a paper by Prof. W. S. Bullough (Birkbeck College, London) on hormones and cell replacement in the epidermis. The research involved was not strictly cytological, but was rather an example of what can be achieved in biological and biochemical work by the use of cytological methods. It had earlier been shown that the most critical single factor determining the rate of epidermal cell replacement is the rate of energy-production inside the cells. Since it is known that a number of hormones affect the rate of production of energy, a study has now been made of their effect on cell division. Epidermal cells are normally half-starved for glucose, apparently because of their poor powers of absorption of this sugar from the surrounding medium. Insulin is well known to assist the uptake of glucose from the blood by stimulating the hexokinase reaction, and it was found that it also has this effect on epidermis *in vitro* as evidenced by an induced doubling of the rate of mitosis. It is also known that the pituitary growth-hormone inhibits the hexokinase reaction, and experiments have shown that *in vitro* it powerfully inhibits cell-division. This result suggests that a re-examination of the actions of this hormone is now due, and that the substance may prove to have been misnamed. Possibly its ability to promote growth may be through the induced secretion of other hormones such as insulin.

Attention was then turned to the action of the œstrogenic hormones, which also stimulate epidermal cell-division both *in vivo* and *in vitro*, and evidence was briefly reviewed which indicates that they too act by facilitating the hexokinase reaction. However, *in vivo* the stimulus they exert is only short-lived, and a reaction quickly sets in. This appears to be due, at least in part, to some stimulus to the adrenal cortex, which then actively secretes hormones similar to cortisone. Both *in vivo* and *in vitro* cortisone depresses the rate of production of energy and of epidermal mitosis. Androgens do not induce over-activity of the adrenal cortex with growth inhibition, and this fact suggests a reason for the larger body-size of so many male mammals.

The session ended with a lively discussion, ranging in subject from protozoans to cancer.

APPLICATION OF RADIOACTIVITY TO MINERAL DRESSING

THE third Sir Julius Wernher Memorial Lecture of the Institution of Mining and Metallurgy was given on September 22 at the Royal Institution before a gathering of mineral-dressing engineers who had come to London from many parts of the world to attend the first symposium on this subject to be held in Great Britain. The lecturer, Prof. A. M. Gaudin, Richards professor of mineral engineering in the Massachusetts Institute of Technology, chose for his subject "The Application of Radioactivity to Mineral Dressing".

Radioactivity can be used in three ways—as a research tool, for the control of plant processes, and in the direct separation of radioactive from inert minerals. Beta- and gamma-radiation is employed, the limitations of the alpha-rays making them unsuitable. Such properties as self-diffusion, adsorption across the liquid/solid interphase of minerals suspended in fluids, rates and site packings, as well as the mode of movement are of critical research importance in the exploration of surface phenomena used in the process of froth flotation. Prof. Gaudin's lecture not only showed some of the work which is being done but also gave fascinating glimpses of possible new methods of mineral-dressing research. In the complex field of attrition, the use of labelled particles of a closely defined size-range as part of the total mixture of wide-ranging sizes fed into an attrition mill is throwing light on the selective grinding which goes on among these sizes under controlled conditions. Natural radioactivity is in use in north-west Canada to actuate sorting mechanisms which segregate the uranium-bearing ore from inert material, and the same process is being studied for possible use with artificially induced, short-lived radioactivity (gamma-radiation) for a selected mineral such as one containing beryllium.

Another incipient aid to fundamental work promises to be the differentiation between slightly varying crystals of what are loosely grouped as the same mineral. For example, galena (lead sulphide) could be thought of as being just galena ; but minute traces of impurity and minute variations in its lattice structure and discontinuity make profound differences in its behaviour, both in study and in its practical concentration from its ores. These differences can be greatly magnified by the use of suitable radioactivating techniques.

The Lecture provided an admirable introduction to the symposium held at the Imperial College of Science and Technology, London, by the Institution of Mining and Metallurgy during the following three days, when about forty papers were presented and at which a wide variety of research and practical aspects of this important and growing technology was examined. In recognition of his distinguished services, honorary membership of the Institution of Mining and Metallurgy was conferred on Prof. Gaudin before he gave the Lecture.

RESEARCH COUNCIL OF ALBERTA

REPORT FOR 1951

THE thirty-second annual report of the Research Council of Alberta*, describing the work of the Council in 1951, again stresses the work on the bituminous oil sands ; and preparation for the Athabasca Oil Sands Conference, which was sponsored by the board of trustees of the Oil Sands Project, made heavy demands on the Research Council's staff. The terms 'bituminous sand' and 'tar sand' have now been dropped, because of their false implication, in favour of 'oil sands'. Laboratory investigations have confirmed the presence of vanadium in the oil sand, both as a mineral and as a component of the oil, especially in the resin and asphaltene fractions. Some work was done on the characteristics of the flow of sand suspensions, including a study of the friction factor in pipes, as well as on the electrical resistance of oil sand and its breakdown under a high potential difference.

A balanced programme of studies on coal included a study of the absorption spectra of oxidation degradation products of Alberta sub-bituminous coals in aqueous solution, of the cleaning of coal with cyclone washer equipment, analytical and physical testing, and of the physical properties of magnetite, Burmis iron ore, loess, limestone and tailings from a zinc refinery with reference to their suitability for the preparation of the media used in dense-media processes of cleaning coal.

A reconnaissance pleistocene survey was made of the Lake St. Ann map area, and the Gasoline and Oil Testing Laboratory again surveyed gasolines sold in the area and initiated a study of viscosity data at low temperatures on aviation lubricating oils diluted with aviation fuel, and one on the effect of storage time on preformed gum, and on 5-hr. and 16-hr. potential gum tests on aviation fuel. The pyrolysis of natural gas, the partial oxidation of butane, and the National Research Council's Pidgeon process for carbon black received attention, while irrigation soil-survey work on the Bow River project was started and the William Pearce project was continued. A re-survey of the Edmonton map sheet was commenced, and work on the Sturgeon Lake sheet resumed. The investigation of biological cycles continued, particularly with reference to the fluctuations of wild life in northern latitudes, and measurement of ultra-violet solar radiation continued with the thorium photo-cell and with a zirconium photo-cell in spite of adverse conditions. A list of publications of the Council is appended.

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* Thirty-second Annual Report of the Research Council of Alberta, 1951. Pp 32 (Edmonton : Queen's Printer, 1952.)

A WAVE-RECORDER FOR USE IN SHIPS

By M. J. TUCKER
National Institute of Oceanography

ALTHOUGH sea-waves have been recorded for a number of years using shore-connected pressure-measuring instruments or inverted echo-sounders laid on the sea-bed, collection of exact information about waves, studies of the growth of waves relative to the wind, and studies of ship motion and of coastal changes relative to the waves have always been retarded by the absence of a reliable method of continuously recording waves from a ship in deep water.

Some measurements have been made by a method in which an observer stations himself at such a height that the top of a wave comes just level with the horizon when the ship is on a fairly even keel in the trough. Much more accurate measurements have been made by stereo-photogrammetric methods using cameras with a long base-length mounted high on the ship.

Neither of these methods is satisfactory for obtaining a continuous picture of changing wave conditions, and for this purpose the best method until recently has been that employed before the Second World War by the Deutsche Versuchanstalt fur Luftfahrt for the study of seaplane landings in a variety of wave conditions. In this method a pressure recorder was suspended on a steel wire 100–200 ft. below a flat lens-shaped float : because of the rapid attenuation of wave-pressure with depth, the recorded pressure fluctuations were mainly due to the recorder following the vertical movements of the float on the surface. A correction could be made for the residual wave motion at the depth of the recorder when the presence of long waves made this necessary. The pressure fluctuations were recorded by a diaphragm connected to a diamond which scratched a spiral record on a polished steel cylinder rotated and moved along its axis by clockwork. The scratch recorder has been replaced in Great Britain by an electrical pressure recorder the output of which is transmitted to the attendant ship by wireless or by a buoyant cable, but the basic idea is the same. Measurements have also been made by an apparatus attributed to Froude and which consists of a buoyant graduated pole held vertical by a weight on its lower end and kept steady in the water by a drogue of relatively large area suspended on 200 ft. of wire from the bottom of the pole. The movements of the water up and down the pole are usually observed visually or photographed, but on a recent voyage of the R.R.S.

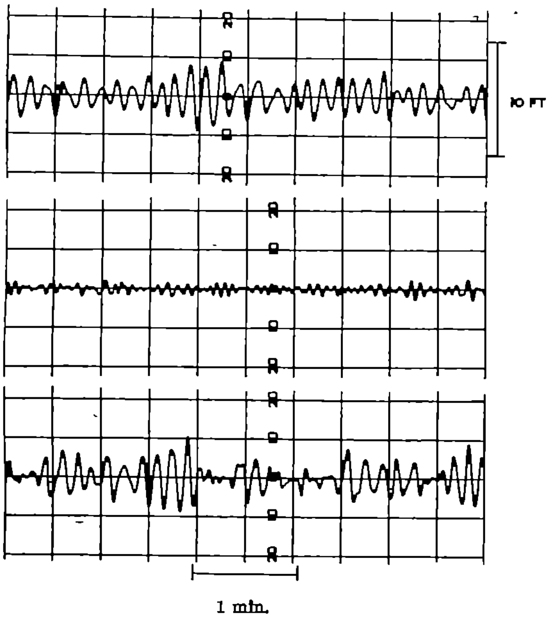

Fig. 1

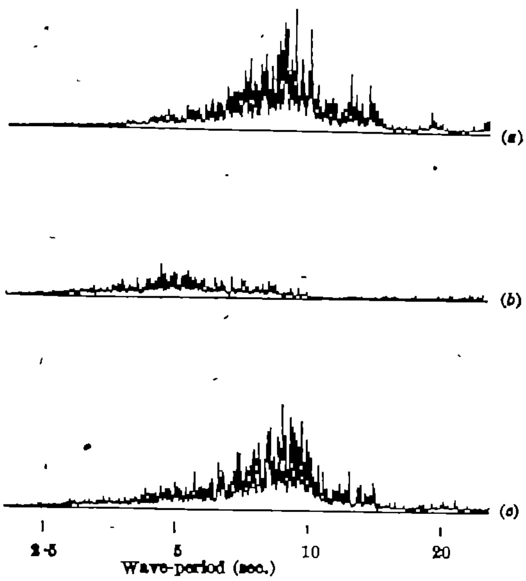

Fig. 2

Portions of records taken with the wave-recorder (Fig. 1) and the corresponding frequency spectra (Fig. 2): (a) accelerometers only connected; (b) pressure measurements only; (c) combined output giving true wave record. The records were taken in sequence, so that the wave record is not the sum of the other two records in detail. It can be seen, however, that the spectrum of the wave record is the approximate sum of the other two

Discovery II satisfactory measurements were obtained by attaching a limp air-filled rubber bag to a point below the mean water-level on the pole and communicating the changes in pressure to the ship through hose-pipe.

All these methods involve laying out apparatus from the ship and recovering it, and, if the apparatus is connected to the ship by a cable or hose-pipe, it is also necessary to hold the ship stationary to prevent the apparatus being towed through the water. These operations can be difficult, particularly in bad weather, when the results may be of greatest interest, and suitable stowage of the comparatively delicate and bulky equipment may not be easy. The advantages of a recorder contained entirely inboard are apparent.

The officers of the German research vessel *Gazelle* (1874–76) used a very sensitive aneroid barometer to measure the fluctuations in air pressure caused by the waves and the movements of the ship, but the uncertainties of this method are too great to enable it to be relied upon.

The new instrument developed by the National Institute of Oceanography is contained completely within the hull of the ship and is well suited for routine measurements. In principle it measures the height of the water surface above some point on the ship's hull and the height of this point above an imaginary reference plane. The sum of the two measurements gives the height of the water surface above the reference plane, and hence is independent of the movement of the ship. The height of the water surface above the point on the ship's hull is measured by the pressure transmitted through a small hole in the ship's side, and the displacement of the point is measured by means of a vertical accelerometer the output of which is integrated twice electronically with respect to time. To allow for the effects of reflexion of short waves from the sides of the ship, a pressure-recorder – accelerometer unit is fitted in each side of the ship, and the mean of their outputs is taken. The response of this arrangement to waves which are only partially reflected has not been rigorously calculated; but it is apparent from physical reasoning that large errors will not be introduced.

The units have to be mounted some distance below the water-line because the point of pressure-measurement must always remain below the water surface, and they will therefore not measure very short waves. If the units are 10 ft. below the water-line, the response will drop to approximately half for waves of 4 seconds period.

To measure true vertical accelerations the accelerometers should be mounted on gyroscopes or long-period compound pendulums; but, to simplify design and to reduce both the space and maintenance required, they are in practice mounted on short-period pendulums which set themselves into the apparent vertical. This results in an apparent increase in gravity (that is, an increase in the mean output of the accelerometers) when the ship moves into a wave train, because the water particle motion, and hence the ship motion in the longer waves, is in circular orbits. If this increase were truly integrated the output would drift off scale; but, by a correct choice of the time constants of the integrating circuits and by including a resistance-capacitance coupling in the circuit, the effect can be minimized and does not appear to be serious in the present instrument.

To avoid trouble from instrumental drift, the accelerometers must be very linear and give large voltage outputs. The accelerometers in this instrument have a sensitivity of approximately 30 volts/g and are linear within about 1 per cent over the range $-0\cdot4$ to $+0\cdot4\,g$.

The first of these wave-recorders, fitted in the R.R.S. *Discovery II*, the research ship of the National Institute of Oceanography, has been tested during a recent cruise in the North Atlantic Ocean. During this cruise, which lasted 2½ weeks, a gale of force 9 was encountered and waves with a maximum height of approximately 30 ft. were measured. The instrument behaved satisfactorily during this period and developed no faults. Records from the instrument were compared with those obtained from pressure and echo-sounding wave-recorders in shallow water, and with records from the electric and pole and drogue recorders as already outlined. Preliminary analyses of these results show satisfactory agreement. The overall accuracy of the instrument in its present form is estimated at ± 10 per cent.

Portions of three records are shown in Fig. 1 with the corresponding analyses in Fig. 2. (*a*) is the output of the instrument with only the accelerometers connected, (*b*) the output with only the pressure units connected, and (*c*) the combined output. The records are not simultaneous, but were taken in sequence. They demonstrate that the pressure units measure the short waves to which the ship does not respond, whereas the accelerometers measure the waves which are long enough to cause the ship to heave.

In conclusion, I would like to acknowledge the help of Mr. F. E. Pierce, who was mainly responsible for the mechanical design of the instrument.

NEW AMINO-ACIDS IN YOUNG APPLE FRUITS

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A PRELIMINARY examination of the amino-acids present in young (10 gm.) fruits of Bramley's Seedling apples by means of filter-paper chromatography[1] suggested the presence of at least one 'unknown' amino-acid. A more extended examination of young (15 gm.) Worcester Pearmain apples indicated the presence, on two-dimensional chromatograms, of at least four spots reacting to ninhydrin in positions not attributable to any recorded amino-acid[2]. The position of these four substances (*A*, *B*, *C* and *D*) will be seen from Fig. 1, which represents a two-dimensional chromatogram of the amino-acid fraction absorbed from extracts of these young apples on 'Zeokarb 215' and displaced by 0 15 *N* ammonia, and from which a considerable portion of the asparagine (which comprises about 80 per cent of the total soluble nitrogen of the fruit) had been removed by crystallization.

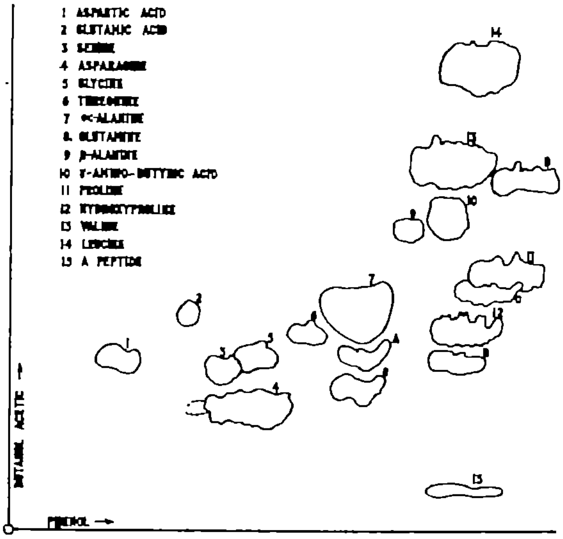

Fig. 1. Chromatogram prepared from an extract of young Worcester Pearmain apples

In more recent work substance *A* has not appeared, and substance *C* has been found to be a peptide. To isolate, for identification, substances *B* and *D*, which were clearly present in the fruits in very small quantities, extracts were made of 70 kgm. of pulp tissue from Worcester Pearmain apples (15 gm.) and the extracts suitably treated for the separation of the amino-acid fraction. By fractionation of the mixed amino-acids on a range of ion-exchange resins, a simple mixture was finally obtained which comprised practically all substance *D*, some γ-amino butyric acid, β-alanine, and a little proline and substance *B*. At this stage a peculiarity of substance *D* became very obvious. In early two-dimensional chromatograms the spot attributed to *D* sometimes gave a yellow colour with ninhydrin, sometimes a purple colour and sometimes a mixture of the two. When the purple colour was present, the ninhydrin-treated spot fluoresced a bright magenta colour in ultra-violet light. Since the two colours were never separated on conventional two-dimensional chromatograms and on single-dimensional chromatograms in butanol – acetic acid – water, it was at first thought that the 'two-colour' appearance was either analogous to the 'two-colour' spot often given by a compound such as methyl histidine or due to a peculiar structure of the compound. On careful fractionation of the simple mixture already mentioned on a lightly cross-linked polystyrene resin[3], fractions were obtained which on chromatograms gave a sequence of spots as shown in Fig. 2. Early fractions, associated with proline, gave a yellow colour with ninhydrin, middle fractions a mixed colour spot, and later fractions a purple spot (and no other ninhydrin-reacting substance) which fluoresced a bright magenta colour in ultra-violet light. In the final fractions γ-amino butyric acid, β-alanine, etc., also appeared. Thus it became virtually certain that 'substance' *D* was in fact two substances: *D*1, the acid reacting yellow with ninhydrin, and *D*2, the acid giving a purple colour with ninhydrin and fluorescing a magenta colour in ultra-violet light. By a further fractionation on a small column of the sulphonated polystyrene resin, a few milligrams each of two sets of crystals

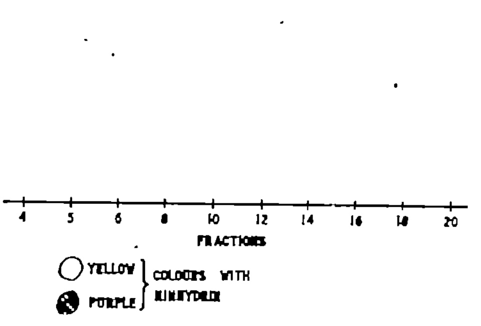

Fig. 2. Chromatogram of fractions containing amino-acids *D*1 and *D*2

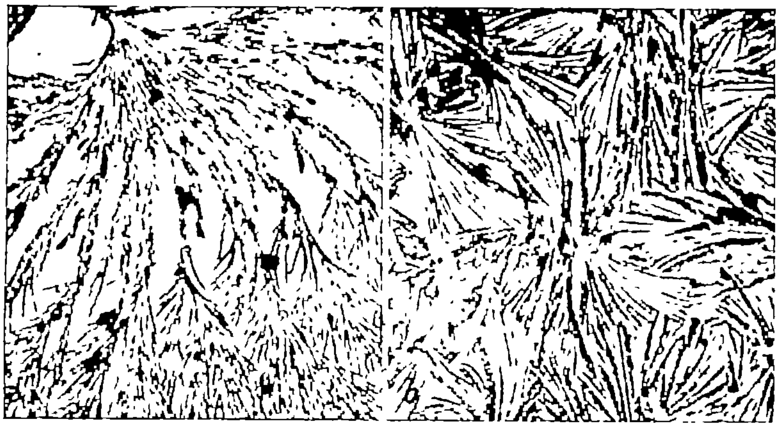

Fig. 3. Photomicrographs of amino-acids (× 35) (*a*) preparation *D*1 and proline ; (*b*) preparation *D*2

were obtained, one of which proved, on chromatographic examination, to be *D*1 contaminated with a little proline and the other pure *D*2 (about 60 mgm.). The known properties of these acids are as follow.

*Properties of D*1. (1) The acid gives a lemon-yellow colour with ninhydrin. (2) On filter paper it gives a pure blue colour on spraying with 0·1 per cent isatin in ethanol – butanol (1 : 1 v/v) and heating the paper to 110° C. for 1–2 minutes. This isatin test was first applied in filter-paper chromatography by Acher, Fromageot and Jutisz[4]. Of many known amino-acids tried, the blue colour is given only by the pyrrolidine derivatives proline and hydroxyproline, and it is surprising that this extremely useful test has not been more widely used. As described by Acher *et al.*, proline gives a blue very rapidly and hydroxyproline a somewhat fainter colour which develops rather more slowly during heating. We have found that tryptophane gives a bright rose-red colour. Other amino-acids tried (citrulline, asparagine, tyrosine, dihydroxyphenylalanine, leucine, α- and β-alanine, N-hydroxyl ethyl β-alanine, histidine hydrochloride, γ-amino butyric acid, taurine, and sarcosine hydrochloride arginine) give pink to purple colours after more prolonged heating of the isatin-sprayed paper, but the intensities of the colours are much less than those given by the pyrrolidines and tryptophane. Pyrrole does not give the blue colour. The blue isatin colour given by compound *D*1 appeared on heating almost as quickly as that given by proline and more quickly than with hydroxyproline. (3) Hydrolysis in a sealed tube at 103° C. with 6 *N* hydrochloric acid for twenty hours produced no change in the colour reactions of the compound or its position on paper chromatograms. (4) Heating with hydrogen peroxide and molybdate[5] produced no shift in its position on paper chromatograms, so that *D*1 cannot be a sulphone. (5) After dusting the paper with powdered basic copper carbonate along the line of future travel of *D*1 before running chromatograms, no spot was revealed on subsequent ninhydrin treatment[6]. The acid cannot therefore contain an amino group other than in the α-position. (6) The rate of travel of the acid in phenol is not slowed down by the presence of acetic acid instead of ammonia in the bottom of the chromatographic tank ; *D*1 is not likely, therefore, to be a basic amino-acid[6]. (7) The substance appeared to give a strongly positive test with nitroprusside in the presence of acetaldehyde—a test for a secondary amine[7]—but since it has so far been impossible to obtain the compound completely free of proline, this test is not conclusive.

*Properties of D*2. (1) It gives a blue colour with ninhydrin when run on paper, the colour changing to purple as the paper cools. The ninhydrin-treated spot fluoresces a strong magenta colour in ultra-violet light. (2) With isatin the substance gives a bright greenish-blue colour which develops immediately on heating the isatin-sprayed chromatogram. (3) The acid is unaffected by heating with 6 *N* hydrochloric acid in a sealed tube for twenty-four hours. (4) It disappears from chromatograms treated with basic copper carbonate and cannot therefore contain an amino group in other than the α-position. (5) It gives a positive test for a secondary amine[7].

As can be seen from the photomicrographs in Fig. 3, acid *D*2 crystallizes in the form of long, flat, rather feathery needles. Acid *D*1 has a somewhat similar form, but the crystals shown are from a sample contaminated with proline.

The R_F values of both *D*1 and *D*2 are shown in the table. From its reactions, including the close company it keeps with proline on ion-exchange resins and the fact that it has a higher R_F value in butanol – acetic acid – water than proline, it appears that *D*1 might well be an alkyl proline, probably methyl proline.

R_F VALUES (at 20° C.) OF VARIOUS AMINO-ACIDS IN VARIOUS SOLVENTS

Solvent*	R_F value OH-proline	Proline	*D*1	*D*2
Butanol–acetic acid–water (4 . 1 · 5 v/v)	0·19	0 30	0·44	0·42
*iso*Butyric acid–water (40 : 60 v/v)	0·41	0·60	0·71	0·67
Phenol–ammonia	0·65	0·92	0·88	0·92

* Paper equilibrated for 24 hr. with solvent-poor phase before solvent run commenced.

The elementary analysis of *D*2 was found to be: C, 55·4 per cent ; H, 8·75 per cent ; and N, 10·8 per cent. This corresponds with the formula $C_6H_{11}O_2N$. Methyl proline and the piperidine carboxylic acids have this molecular formula. Synthetic piperidine 2-carboxylic acid was prepared[8] and found to have all the properties of *D*2. Mixed melting points and a comparison of the chromatographic behaviour of the two compounds has established that *D*2 is, in fact, piperidine 2-carboxylic acid. (It has just been noted that this acid has now been isolated from beans[9].)

Apart from the interest aroused by the presence of this acid in fruits, it is surprising to find an imino-acid giving a bright purple colour with ninhydrin.

The work here described was carried out as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

[July 10.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Extension of the *K*-Region Hypothesis of Carcinogenic Chemical Compounds

Working on suggestions put forward by Schmidt and by Swartholm, a number of French and English workers, notably A. Pullman, B. Pullman, P. Daudel, R. Daudel and C. A. Coulson, have developed a hypothesis relating the carcinogenic power of polycyclic aromatics to the structures of these compounds on the basis of quantum mechanics. Evidence has been accumulating in recent years which does indicate a fair correlation to exist between the reactivity calculated for the most reactive double bond in these molecules and their carcinogenicity. The reactive region thus supposed to be mainly responsible for neoplastic activity is usually termed the *K*-region.

Whereas the various theoretical methods used in assessing the above double-bond reactivity appeared to give fairly consistent results, some rather striking deviations were found as regards biological activity[1].

Several attempts have been made to determine double-bond reactivity by experimental means. However, both the perbenzoic acid addition method employed by Eckhardt[2] and by Boyland[3], and the osmium tetroxide addition method developed by Badger[4]—although in fair agreement with the available quantum mechanical results—again revealed several discrepancies with regard to carcinogenicity.

Being engaged in investigating the interaction of trichloromethyl radicals with various types of hydrocarbons[5], we worked out a method for the determination of the relative reactivities of these radicals towards unsubstituted polycyclic aromatics at 90° C. As recently reported[6], the rates of addition (K_R) were found to parallel the highest free valence numbers calculated for these compounds by means of the molecular orbital method. Therefore, the order of reactivities will probably be quite similar when radicals other than CCl_3 are involved, or when slightly lower temperatures are used.

Relative Reactivities of Polycyclic Aromatics towards Osmium Tetroxide (K_{OsO_4}) and towards CCl_3 (K_R)*

Compound	K_{OsO_4}	K_R	Remarks (cf. graph)
3,4-Benzopyrene	0·94	2·85	
20-Methylcholanthrene	1·1	1·95	
Cholanthrene	1·0	1·8	
Benzanthracene	0·48	1·25	
1,2-Dimethylchrysene	0·84	0·5	
2′,7-Dimethylbenzanthracene	0·62	0·21	
9,10-Dimethylbenzanthracene	2·7	0·21	
1,2,5,6-Dibenzanthracene	0·64	0·16	
Naphthacene	—†	4·4	Represented by points parallel to the K_R axis
9-Cyanoanthracene	—†	1·3	
Anthracene	—†	0·9	
Pyrene	—†	0·04	
Phenanthrene	(0·05)†	0·01	
9-Methylbenzanthracene	0·96	—‡	Represented by points parallel to the K_{OsO_4} axis
10-Methylbenzanthracene	0·91	—‡	
5,6-Dimethylbenzanthracene	0·64	—	
9,10-Diethylbenzanthracene	2·1	—§	
9-Methyl-10-cyanobenzanthracene	0·40	—	
5,6,9,10-Tetramethylbenzanthracene	2·9	—	
Acenaphthanthracene	1·1	—	

* K_{OsO_4} was determined at 37° C., K_R at 90° C.

† Not determined; judging from the low bond orders found for the most reactive 'double bonds' in these compounds, these values will be very low. Phenanthrene was found by Badger and Reed (*Nature*, 161, 238; 1948) to be about ten times less reactive towards osmium tetroxide than benzanthracene.

‡ Probably greater than 1·2 as the presence of the mesomethyl group may increase the free valence number of the opposite meso-position.

§ Probably below 0·25 (cf. 9,10-dimethylbenzanthracene).

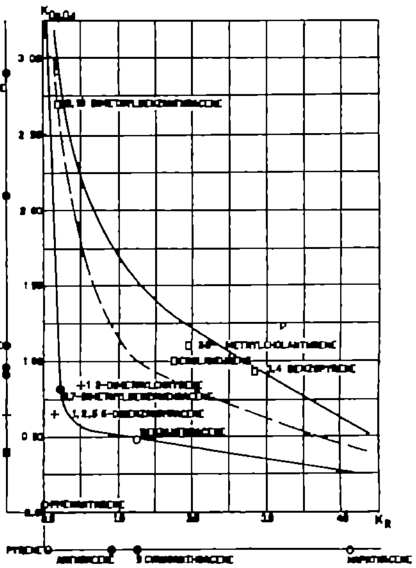

Fig. 1. □—□—, Highly active carcinogen; ●—●—, active carcinogen; +—+—, moderate activity; ○—○—, little or zero activity. (Gradings according to ref. 3)

In the course of the latter investigation, we also determined the K_R values of a number of substituted aromatics at our disposal. The results are given in the accompanying table, together with the osmium tetroxide addition-rates reported by Badger[4].

In view of the fact that several biological processes are now believed to involve homolytic rather than heterolytic reactions[7], we thought it of interest to plot K_{OsO_4} against K_R (Fig. 1).

The admittedly limited number of data would seem to suggest that carcinogenic potency depends on a quantitative relation between the two different reactivities, rather than on the *K*-region—as measured by K_{OsO_4}—alone. This supposed relationship has been illustrated in the graph by hyperbolic curves. Thus, the compounds within the region between the lower curve and the co-ordinate axes have zero or low activities, whereas the two upper curves should include a region of comparably high activity. The present data give no indications as to whether decreasing neoplastic activity will occur in the region beyond the upper curve. (However, styrene, which is inactive and which has—by definition—a K_R of 0·50[6], will probably react extremely rapidly with osmium tetroxide.)

Unfortunately, compounds which are very striking exceptions to the relation between carcinogenic power and *K*-region activity, such as acenaphthanthracene and 9-methyl-10-cyanobenzanthracene (cf. footnotes in the table), were not available to us. On the other hand, the very low activity of 2′,7-dimethylbenzanthracene and the high potency of the cholanthrenes and of 3,4-benzpyrene, which is comparable to that of 9,10-dimethylbenzanthracene, cannot be well correlated on the basis of the *K*-region activity alone. In accordance with the conclusions of Magat and Bonême based on the inhibition of thermal polymerizations of styrene by carcinogens[8], there appears to be no direct relation between neoplastic activity and reactivity towards radicals.

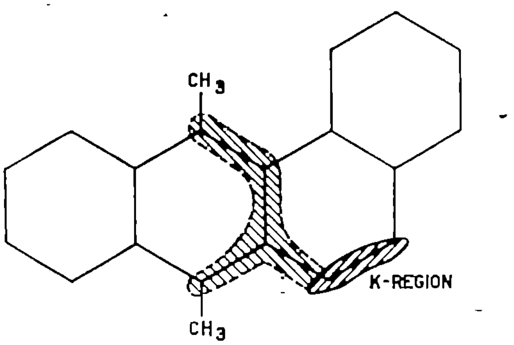

Fig. 2 Supposed reactive region in 9,10-dimethylbenzanthracene, including the reactive meso-positions and the *K*-region

From a theoretical point of view, the above extension of the *K*-region hypothesis implies a relationship between carcinogenic potency, on one hand, and the highest free valence number and bond order (or excess of charge[1]), on the other. As the positions of highest free valence number scarcely ever coincide with one of the atoms of the most reactive double bond[1], this suggests that a larger part of the molecule is involved in the carcinogenic mechanism than the *K*-region alone (Fig. 2). (According to the molecular orbital method, the free valence number of a given atom is obtained by subtracting the sum of the bond orders of the bonds terminating at that atom from a constant which is characteristic for that atomic species and its binding type[9].)

It may be remarked that such a possibility was recently mentioned by Boyland[1]; his interesting hypothesis, however, deals with structural properties of carcinogens rather than with different types of reactivity.

The requirement of two different types of reactivity within a single molecule suggests possibilities for interpretation or experimental attack as regards combination or inhibition effects; for example, by studying the biological effect of a potent carcinogen admixed with a non-carcinogenic compound having a high K_{OsO_4}. Strong evidence for the existence of these effects has been given by Lacassagne *et al.*[10].

In conclusion, it is emphasized that the above speculation ensued as a sideline from fundamental work on hydrocarbons in progress in this laboratory. Thus we have not attempted any detailed verification; our main intention is to direct attention to a number of data which may suggest that free radical reactions play a part in a field of such widespread interest as carcinogenesis.

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Carbohydrate Residue of a Urine Mucoprotein inhibiting Influenza Virus Hæmagglutination

The first step in the propagation of influenza virus is the adsorption of the infective particle on to the receptor substance at the surface of the host cell. Human, guinea pig and fowl erythrocytes, though not susceptible to infection, possess analogous receptors which, by allowing virus particles to form 'bridges' between cells, give rise to the hæmagglutination characteristic of influenza viruses[1]. A variety of soluble mucoids, by competing with the cellular receptors for the virus, inhibit hæmagglutination[2]. There is much indirect evidence to suggest that the receptors and the soluble mucoids have some basic structure in common, that this common structural feature is predominantly of carbohydrate nature and that the carbohydrate is instrumental in the attachment of the virus to the cell receptors and their mucoid analogues[1]. In fact, the inactivation by living virus of the capacity of a mucoprotein to inhibit hæmagglutination by indicator virus is accompanied by the release of a sugar derivative characterized as an N-substituted fructosamine[3].

The availability of a pure mucoprotein from urine[4] inhibiting the virus hæmagglutinin to a high titre rendered possible an investigation of its carbohydrate residue. With this mucoprotein prepared by a modified technique[5], three series of experiments were performed:

(1) *Acid hydrolysis*: (*a*) *Simple sugars*. The hydrolysate from acid treatment (1 *N* sulphuric acid, 100°, 4½ hr.), after removal of the acid as barium salt, was dialysed at 4° against 10 volumes of water. The concentrated dialysate was analysed qualitatively and semi-quantitatively[6] by paper-partition chromatography (descending), using butanol/acetic acid/water (40 : 10 : 50) and *s*-collidine as solvents and aniline hydrogen phthalate as spraying agent. The results were as follows: 5·4 per cent galactose, 2·7 per cent mannose, 1·0 per cent fucose. The fucose content of the untreated mucoprotein, estimated spectroscopically by courtesy of Prof. Z. Dische, of New York, was found to be 1·1 per cent. Xylose present in traces (about 0·04 per cent) may be regarded as an artefact. (*b*) *Amino sugars*. The hydrolysate (2 *N* hydrochloric acid, 100°, 14 hr.) contained 7·6 per cent hexosamine (base), as determined colorimetrically[7]. From chromatographic evidence it would appear that the hexosamine is a mixture of glucosamine and galactosamine (run in *s*-collidine at 4°, sprayed with Ehrlich reagents). This identification is based on: (i) the identity in R_F value and colour of the two assay spots with the spots given by the glucosamine and galactosamine standard respectively; (ii) the positive ninhydrin reaction of the two assay spots; and (iii) the observation that addition of a glucosamine–galactosamine mixture to the hydrolysate resulted in an intensification of the pre-existing spots but not in the appearance of further ones.

(2) *Periodate oxidation*. When the mucoprotein was treated with an excess periodate (0·01 *M* potassium periodate, *p*H 5·0, 20°, 24 hr.), followed by acid hydrolysis, neutralization and dialysis as under (1), half the galactose and mannose, a fraction only of hexosamine and none of the fucose were recovered.

(3) *Alkaline treatment*. By treatment of the mucoprotein with 10 per cent barium hydroxide at 100° for 12 hr., the carbohydrate complex may be separated

from the bulk of the protein. After removal of the insoluble residue and concentration of the supernatant, the polysaccharide was precipitated by 66 per cent ethanol; on acid hydrolysis it yielded galactose, mannose, fucose and hexosamine. This hydrolysis was accompanied by the formation of considerable amounts of soluble and insoluble humin matter, suggesting the presence in the polysaccharide of the component released from the mucoprotein by viral enzyme action[3]. The polysaccharide is dialysable through 'Cellophane' casing.

From these observations, it may be concluded that the smallest carbohydrate unit in the mucoprotein consists of approximately six hexosamine, four galactose, two mannose, one fucose residue(s) and probably of another minor component corresponding to the molecular weight of about 2,500 (assuming N-acetylation of the hexosamine residues) or a multiple *n* thereof, if the smallest unit contains more than one fucose residue. However, the dialysability of the polysaccharide obtained from the mucoprotein by alkali treatment or, in preliminary experiments, by tryptic digestion, would suggest that *n* is not more than 3 or 4; crystalline lysozyme (mol. weight 16,000) in a buffer solution of *p*H 6·0 passes through the membrane to a minute degree only. Therefore the smallest unit $(2,500)_n$ may be regarded as a complete prosthetic group rather than the repeating unit of a giant polysaccharide. The mucoprotein, then, is visualized as a conjugated protein containing as prosthetic group a relatively small polysaccharide; about two hundred of such groups may be linked to each protein molecule (on the basis of 7×10^6 mol. weight[4]). This concept is consistent with the biological[8] and biochemical[9] data. It seems of considerable interest that the carbohydrate moiety of the receptor substance present at the surface of human erythrocytes consists of glucosamine, galactosamine, galactose and fucose[6], though only further work with periodic acid will reveal any common structural features of the identical components of the cellular receptors and their soluble analogues.

Prof. G. Blix, University of Uppsala, kindly informed me that his laboratory is also engaged in an analysis of the carbohydrate residue of the urine inhibitor, and we agreed to submit to *Nature* simultaneously but independently a summary of our results.

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IN a study carried out in this Institute on the polysaccharides of normal human urine, particular attention was paid to the urinary mucoprotein reported to inhibit influenza virus hæmagglutination[1].

The inhibitory substances to be reported here were prepared in three different ways. (1) A preparation was made by the method of Tamm and Horsfall[1], by precipitating urine with ethanol. The precipitate was dissolved in water and shaken with chloroform–amyl alcohol. The interfacial precipitate was redissolved in water, dialysed, and dried by lyophilization. (2) Diluted urine was precipitated by addition of sodium chloride to a concentration of 0·58 *M*, according to the method of Tamm and Horsfall[2]. By this means, these authors obtained an electrophoretically homogeneous, very strongly inhibiting product. No details about its carbohydrate components were given. (3) Urine was centrifuged for 15 min. at 45,000 r./min. in a Sharples supercentrifuge. The precipitate was dissolved in distilled water, washed with 0·58 *M* sodium chloride, and dialysed. The solution was then centrifuged for one hour at 22,000 r./min. and the supernatant lyophilized. All three preparations are strong inhibitors of hæmagglutination and show about the same activity.

Some of the analytical results are given in the accompanying table.

Component	Amount in preparation (per cent)		
	1	2	3
Hexosamine	6·4	9·4	7·0
'Sialic acid'	8·2* 7·3†	0·2* 9·1†	0·4* 9·1†
Hexose	6·8	8·4	9·0
Fucose	0·7	1·1	1·1
Nitrogen	11·2	10·9	10·7
Phosphorus	—	0·09	0·16
Sulphate sulphur	—	0·4	0·8

* 'Direct' Ehrlich reaction (ref. 3). † Bial's reaction (ref. 3).

In addition to the quantitative determinations given in the table, the following analysis was carried out. Preparation 2 was hydrolysed and studied by paper-partition chromatography. Spraying with aniline phthalate indicated the presence of galactose, mannose, and a small amount of fucose. With ammoniacal silver nitrate as spraying reagent, the presence of hexosamine was also indicated.

The analytical results indicate that the inhibitory mucoprotein contains, in addition to 'sialic acid', carbohydrate of the glucosamine–mannose–galactose type commonly occurring in proteins, and a small amount of carbohydrate of the type occurring in blood-group substances.

The name 'sialic acid' has recently[4] been given to a monobasic reducing acid with the probable composition $C_{14}H_{24}NO_{11}$, which was first isolated in crystalline form from submaxillary mucin in 1936[5]. Its structure is still unknown. It is characterized by strong humin formation and liberation of carbon dioxide on heating with mineral acid. It gives a purple colour even without previous treatment with alkali on heating with Ehrlich's *p*-dimethylaminobenzaldehyde reagent, and a violet colour when treated with Bial's orcinol reagent. Judging from these reactions, sialic acid or closely related substances are widely distributed in the animal organism[7]. Sialic acid seems to be regularly accompanied by chondrosamine[4].

From observations made in a study of the dialysable product split off by the action of influenza virus on the inhibitory urinary mucoprotein, Gottschalk[8] concluded that the carbohydrate component involved in this reaction has the structure of *iso*glucosamine. He defined the split product as N-1-deoxy-1-ketose amino-acid (lysine ?) or peptide. It is not yet clear what relation Gottschalk's product bears to sialic acid. (Preliminary experiments, however, indicate that a substance obtained by Gottschalk's procedure gives the colour reactions characteristic of sialic acid.)

Inhibitory products obtained by us from egg-white, ovomucin[7], allantoic fluid[8], ovarian cysts[8], follicular fluid from cows[8], and cancer fluid[8], were all found to contain sialic acid. Both the cancer fluid and the contents of one of the cysts showed very strong inhibitory activity, and no other carbohydrate (except hexosamine) was found to be present in appreciable amounts. This might suggest that sialic acid is of fundamental importance for the inhibitory reaction and may bear some relation to the receptor substance of erythrocytes. This suggestion is supported by the fact that a great many materials reported in the literature as containing hæmagglutination inhibitors have also been found to contain sialic acid; for example, blood serum, some plasma glycoproteins[4], human tears[9], cow's milk[4], epithelial mucins of various origins[9], human saliva[9], and meconium[9]. No quantitative relation, however, has been found between the content of sialic acid and the inhibitory activity of the different products examined. Thus a preparation of submaxillary mucin from cattle has a high content of sialic acid but a very low inhibitory activity, whereas allantoic fluid has a low sialic acid content and a high activity. Pure sialic acid has no activity at all.

It is then evident that if substances giving the characteristic reactions of sialic acid are concerned in the inhibition of virus hæmagglutination, either finer structural differences in the carbohydrate group or the properties of the accompanying protein component must be the determining factors for the inhibitory activity.

It was agreed with Dr. A. Gottschalk, of the Walter and Eliza Hall Institute of Medical Research, Melbourne, who is also investigating the carbohydrate components of the hæmagglutination-inhibiting mucoprotein from urine, to submit to *Nature* independently but simultaneously a summary of our results.

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Indicator Spray for Amino-Acids

IN quantitative one-dimensional paper chromatography of amino-acids, the position of the various bands is generally determined either by running reference strips on the edges of the paper or by spraying lightly with weak ninhydrin solution. Neither method is entirely satisfactory. Reference strips are not always a reliable guide to cutting, particularly if the bands are close together, since the fronts may not be straight; the use of ninhydrin must give rise to some loss, which will fall most heavily on the acids present in least amount.

In this laboratory, we determine the individual acids manometrically following oxidation, and have developed an indicator spray which shows the position of the bands and does not interfere with the subsequent analysis. The spray consists of an alkaline alcoholic solution of bromothymol blue incorporating formaldehyde, so that, on the principle of the formol titration, the amino-acids appear as acid (yellow) bands against an alkaline (blue) background. The paper gradually fades to a uniform yellow colour; but the bands can, if necessary, be marked with a ball-point pen for subsequent cutting.

The spray has been used successfully for some time now, generally following a neutral solvent such as propanol–water, so that there is no trouble from residual acidity or alkalinity on the paper which, for quantitative work, is air-dried without application of heat. The spray solution is prepared by adding 3 ml. formalin and 0·1 ml. 60 per cent aqueous potassium hydroxide to 20 ml. 0·15 per cent (w/v) solution of bromothymol blue in 95 per cent alcohol.

The indicator appears to be almost as sensitive as ninhydrin, particularly for the shorter-chain amino-acids; but the bands tend to be somewhat narrower, and, when cutting for quantitative work, a little of the paper on either side of the band should be included.

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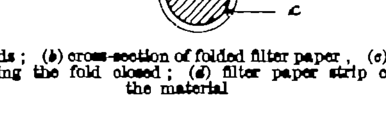
Application of Material in Filter Paper Chromatography

IN order to obtain a good separation in filter paper chromatography, the size of the spot of liquid applied to the paper must be small, which often necessitates repeated, time-consuming applications of material. Methods have been evolved with the purpose of having spots or a band laid down automatically by a burette[1,2]. There still seems to be a need, however, for a technique by which a larger volume of fluid can be deposited quickly and simply, yet permitting small-sized bands or spots for good separation.

We have used the following procedure. The fluid material is deposited on a strip of filter paper 2–5 mm. in width according to the degree of separation wanted. The filter paper strip, after drying, is placed in a z-shaped fold of the filter paper sheet. The size of the fold is slightly larger than the strip (see diagram). In this way the strip carrying the substance to be chromatographed is covered by the filter paper sheet on both sides. The fold is kept closed by the application, on each side of the sheet, of glass rods ground plane on one side or by glass plates of some 5 mm. width and 1·5 mm. thickness. The glass rods or plates are held together on each side of the paper with rubber bands exerting a slight pressure. The filter paper strip should not reach the margin of the sheet but leave 0·5–1 cm. on each side.



(*a*) Glass rods; (*b*) cross-section of folded filter paper, (*c*) rubber band keeping the fold closed; (*d*) filter paper strip carrying the material

The filter paper strip can, according to its size, absorb an amount of fluid of 5–10 c.mm. per cm. at each application. After drying, additional amounts of fluid can be applied.

In order to facilitate application of a total of 0·5–1 ml. fluid on a filter paper strip, the strip is placed on the flat floor of a small 'Lucite' trough holding 1–2 ml. and with sloping walls. The solution is easily dried up on the paper in the desiccator. It is preferable to treat the trough and glass plates with some anti-wetting compound. In this way a given extract concentrated to a suitable volume can be absorbed quantitatively by the strip, dried and subjected to chromatography in a short time.

The separation is satisfactory if a filter paper strip (2·5 mm. × 40 mm.) which has absorbed in one stage 0·02 ml. of a solution containing 1 mgm. adrenaline and 1 mgm. noradrenaline per ml. (ascending run, 15 hr. in phenol/0·1 *N* hydrochloric acid) is used.

The method has proved adequate with Grycksbo *OB* paper, but is not suitable for the harder papers such as Whatman No. 1 or 4.

We have found no difference in result if the paper strip is placed in one or the other of the two folds.

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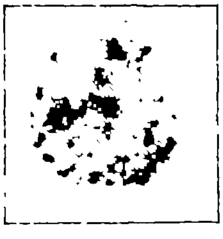
Demonstration by Radioactive Tracers of the Adsorption of Cations by Metals

The electromotive force of a primary electric cell is still explained by Nernst's theory, which only considers the case of a metal and its own cations. We have developed a more general theory[1], based on the hypothesis that the electrode potentials are due to the adsorption of cations. To emphasize the difference between the two theories, it is only necessary to say that, according to our view, all the individual potentials ought to be negative.

Experiments carried out in our laboratory, which will be published in due course, show that every metal has a selective adsorption power in the sense that if the electrolyte contains several kinds of cations, though all of them contribute to the potential of the electrode, only the active ones are adsorbed. It seems, moreover, that in some cases ions from the metal go into the solution and are replaced by an equivalent number of active cations.



Autoradiograph of an aluminium foil after 12 days immersion in a 0·27-*M* solution of activated zinc sulphate. It shows that only isolated domains are active. Similar results have been obtained with copper, lead, iron and nickel

The direct proof for the exchange of cations has been obtained with radioactive tracers. A sample from the Atomic Energy Research Establishment, Harwell, containing 5 gm. of irradiated zinc converted into zinc sulphate, with an activity of 7 mC. due to zinc-65, was diluted so as to obtain a solution of 0·27 molarity. Metals in the form of wires, of about 25 mm. length and 0·55 mm. diameter, were immersed in separated portions of such a solution and, after thorough washing, were tested with a Geiger–Müller counter, with the aid of a sample changer which makes it possible to reproduce the geometrical conditions very accurately. Table 1 shows the results, corrected for the background counting rate, after 7 days immersion.

Table 1

Metal	Pt	Pd	Au	Ag	Cu	Fe
Counting-rate per min	15	128	241	330	159	889

The effect, which is rather small with platinum, becomes very striking with all other metals. We consider this result as a proof that in the first case there is pure adsorption, whereas in the second, adsorption is followed by exchange of cations.

With foils instead of wires, it has been possible to compute the total number of atoms of zinc, radioactive and not radioactive, taken by each square centimetre. The results obtained with lead are given in Table 2. Copper and nickel have shown similar behaviour.

Table 2

Concentration	Time of Immersion	Atoms per sq. cm.
0·27 *M*	1 hr.	4·1 × 10^{14}
"	22 hr.	11·3 "
"	22 days	8,800 "
0·0027 *M*	22 hr.	7·5 "
"	22 days	200 "

Autoradiographs obtained with foils activated by immersion in the solution of radioactive zinc show that the exchange of cations takes place in small and separated portions of the surface; thus, the so-called local effect has been made visible.

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Ion-Exchange Elution Series

A comparison of the efficiency of various eluants in ion-exchange separations of the lanthanons[1] has led to the hypothesis that the relative values of eluants (and the optimum conditions of their employment) may be simply related to the overall stability constants of the complexes formed between the lanthanon ions and the eluting agent.

Comparison of eluants apart, however, the argument entails that the sequence of stability values ($\log \overline{K}$) of lanthanum eluant complexes should coincide with the elution sequence. This has been confirmed not only for tervalent lanthanon ions but also for bivalent metal ions. However, in systems of mixed bi- and ter-valent ions, although the elution sequence for ions of the same charge remains the same, the elution series of the mixed ions is out of conformity with the stability series for the mixed ions. Thus, the stability series for ethylenediamine tetra acetic acid complexes is[1,2]:

Ion	log $\overline{K}$	Ion	log $\overline{K}$	Ion	log $\overline{K}$
Yb^{3+}	18·70	Sm^{3+}	17·20	Co^{2+}	16·10
Ni^{2+}	18·45	Nd^{3+}	16·75	Ce^{3+}	16·05
Cu^{2+}	18·38	Pr^{3+}	16·55	La^{3+}	15·30
Pb^{2+}	18·20	Cd^{2+}	16·48	Fe^{2+}	14·22
Er^{3+}	18·15	Zn^{2+}	16·15	Mn^{2+}	13·47
Y^{3+}	18·00				

The elution sequence, however, is:

Ni, Cu, Yb, Y, Dy, Cd, Eu, Zn, Sm, Co, Fe, Nd, Mn, Pr, La[1].

Similarly, with nitrilotriacetic acid complexes, some log $\overline{K}$ values are:

Cd, 9·54; La, 10·37; Pr, 11·7; Sm, 12·4.

Fitch and Russell[3] find that cadmium is interpolated between neodymium and samarium. These interpolations, of manganese between praseodymium and neodymium, and of cadmium between neodymium and samarium, while of great use in lanthanon separations[1,2], introduce two possible amendments to the case for a simple relationship of stability constants and eluant efficiencies: (*a*) that the stability series determined through potentiometric titrations of the complex system do not hold in ion-exchange systems, because of the formation of different complex species; or (*b*) that the stability series varies because of a factor influenced by the valency of the ions.

Since log $\overline{K}$ values are overall constants and take account of a multitude of complex species, alternative (*a*) is scarcely tenable. An examination of the second factor has, however, confirmed that a preponderance of tervalent ions induces an apparent increase in the stabilities of bivalent ion complexes and vice versa. Thus, with ethylenediamine tetra acetic acid solutions as the eluant, the experimentally determined series are as follow:

With preponderance of bivalent ions:
Yb, Er, Ni, Cu, Sm, Nd, Pr, Ce, La, Cd, Co, Fe, Mn.

With preponderance of tervalent ions:
Ni, Yb, Y, Cd, Eu, Zn, Sm, Fe, Nd, Mn, Pr, La.

With equivalence of bi- and ter-valent ions:
Yb, Ni, Pb, Er, Sm, Nd, Pr, Cd, Co, La, Fe, Mn.

This phenomenon does not appear to have been recorded hitherto and is being further studied.

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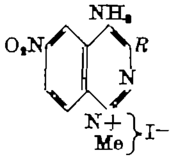
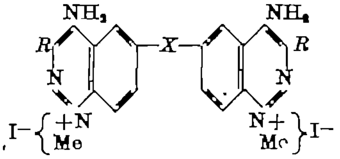
Reduction of Nitrophenanthridinium Salts: Influence of Molecular Size on Trypanocidal Activity

In 1948 Kenneford, Lourie, Morley, Simpson, Williamson and Wright[1] reported that the crude reduction products of the cinnolinium salts (I; *R* = H or Me) showed considerable activity in infections of *Trypanosoma congolense* in mice, whereas the pure diamino-salts were inactive. They attributed this phenomenon to the probable presence in the crude products of azo-compounds (II; *X* = —N=N—) of high trypanocidal activity. It has recently[2] been further demonstrated that structures of the general formula (II), where *X* may have values other than —N=N—, have trypanocidal properties, the most effective being '528' (II; *R* = H, *X* = $-\mathrm{NH.}\underset{\underset{\mathrm{NH}}{\|}}{\mathrm{C}}\mathrm{.NH}-$).

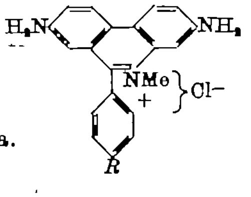


(I)

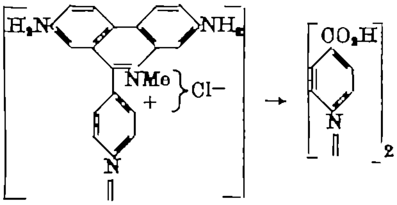


(II)

One of us (L. P. W.) has long used iron powder for the reduction of nitrophenanthridinium salts in aqueous solution to amino-salts, and has observed[3] that sparingly soluble by-products are frequently formed, although usually in very small amount. In the reduction of 2-amino-10-methyl-9-*p*-nitrophenylphenanthridinium chloride, however, a crystalline by-product was isolated[4], and the reduction of 2 : 7-diamino-10-methyl-9-*p*-nitrophenylphenanthridinium chloride (III; *R* = NO_2) by iron – water is so unsatisfactory that this reagent was replaced by ferrous hydroxide – water[5], which is a much better reagent for the reduction of nitro-quaternary salts. In 1949, a quantity of the powerful trypanocide (III; *R* = NH_2) was required for field trials, and we decided to re-examine the iron – water reduction of (III; *R* = NO_2).



(III)



(IV) (V)

When a hot aqueous solution of 70 gm. of (III; *R* = NO_2) was stirred with iron powder (70 gm.; "reduced with hydrogen"), 49 gm. of a sparingly soluble substance was isolated. It separated from its purple solution in hot water as a gel, which slowly changed to a mass of microscopic black plates, but crystallized from methanol in black prisms, which are purple by transmitted light, unmolten at 350°. A small quantity of (III; *R* = NH_2) was isolated with difficulty. The new substance is undoubtedly the azo-salt (IV) (found for dried salt: C, 69·4; H, 4·85; N, 16·0; Cl, 10·4. $C_{40}H_{34}N_8Cl_2$ requires C, 68·9; H, 4·9; N, 16·1; Cl, 10·2 per cent). Its light absorption resembles that of (III; *R* = NO_2) rather than that of (III; *R* = NH_2), supporting the presence of the chromophore —N=. It was oxidized readily in aqueous solution by permanganate, affording a good yield of 4 : 4′-azobenzenedicarboxylic acid (V), which was identified as its ethyl ester with an authentic specimen. Under similar conditions (III; *R* = NO_2) gave 4-nitrobenzoic acid. The azo-salt is converted by dilute hydrochloric acid into a crystalline rust-coloured hydrochloride, which is rapidly hydrolysed by water or alcohol to the original salt.

There appears to be no adequate analogy to the facile reduction of a nitro- to azo-compound, which occurs in this and presumably the cinnoline series, and the explanation is probably to be found in the fact that both reactant and product are present in aqueous solution. The azo-compound is unlikely to be an intermediate in the reduction to amine, for it is highly resistant to further reduction. More probably the nitroso-compound is intermediate and, if it is not itself rapidly reduced further to amine, condenses with amine already present. The proportion of amine (III; $R = NH_2$) formed appears to increase at the expense of (IV) as the efficiency of stirring improves, and this suggests that for reduction of (III; $R = NO_2$) to (III; $R = NH_2$) an adequate concentration of ferrous ions is required throughout the reaction solution. With a colloidal suspension of ferrous hydroxide this condition is more likely to be fulfilled, and (IV) is therefore not produced. This explanation is, of course, incomplete in that it does not account for the great variation of yield of azo-salt from different nitro-quaternary salts.

In view of the results of Lourie and his collaborators and the known efficacy of 'double' molecules as trypanocides[1], our biological results with (IV) are of considerable interest. Against *T. congolense* in mice it is only one-hundredth as active as either (III; $R = NO_2$) or (III; $R = NH_2$), these results being in striking contrast to those obtained by 'doubling' the aminoquinoline or aminocinnoline molecules. On the other hand, it exerts a more prolonged prophylactic action in mice than any other phenanthridinium salt we have examined, and its toxicity by the subcutaneous route is low, mice surviving a subcutaneous dose of 1 gm. per kgm. body-weight for ten days. These results suggest slow absorption, perhaps due to depot formation; but other properties of (IV) do not necessarily support such an explanation. Thus its solubility in water (6 gm. per litre at 20°) is practically the same as that of (III; $R = NO_2$), and its activity against *T. rhodesiense* in mice amounts to one-third of that of (III; $R = NH_2$), which is the most active member of the series yet known against this species. Thus against *T. rhodesiense* the activity of (IV) ranks high in the series[6]. That (IV) separates from aqueous solution as a gel suggests that the solution is colloidal, and it is significant that the notable prophylactic properties of suramin, which also is a large molecule, have been attributed *inter alia* to the colloidal nature of its solution. It is possible also that (II) and (III) represent optimum molecular patterns for *T. congolense* activity, and that the area of the molecules is critical.

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Relation between Intrinsic Viscosity and Degree of Polymerization

It is generally agreed that the relation between intrinsic viscosity and degree of polymerization (D.P.), for the majority of polymer systems, is of the form $[\eta] = K\,(\text{D.P.})^{\alpha}$; but there appears to be no slackening in the controversy as to the numerical values of K and α for a particular system. Most of the values have been obtained from measurements of the intrinsic viscosity and osmotically determined degree of polymerization on nearly homogeneous fractions. Apart from experimental error, there is a number of ways in which discrepancies can arise. High intrinsic viscosities may not be free from the influence of the non-Newtonian behaviour of the solutions from which they are derived; fractions may not be sufficiently homogeneous; and membranes may not be strictly semi-permeable[1].

There is, however, an additional source of error, more often than not neglected. It has been pointed out[2] that in osmometry the osmotic pressure in cm. of water is not simply the difference in height between the menisci of the solution and solvent, multiplied by the density of the solution; it is actually the difference in pressure between the column of solvent and the column of solution, when the column length is measured from the centre of pressure of the cell, in the case of a vertical membrane, or from the membrane, when it is horizontal, to the meniscus. For dilute solutions, the correction to be added requires an approximate measurement of the vertical distance between the solvent meniscus and the centre of the membrane, and a knowledge of the densities of the solvent and solution.

The correction is much larger for the Fuoss–Mead[3] than for the Schulz[4] osmometer. For a solution of given concentration in a particular osmometer, the correction to the osmotic pressure is of the same order whatever the degree of polymerization of the solute. The effect on the absolute value of the osmotic pressure is then greatest for solutes of high degree of polymerization, and hence the relation between intrinsic viscosity and degree of polymerization is altered.

The relation between the intrinsic viscosity (dl./gm.) in butyl acetate at 25° C., and the degree of polymerization, measured in an osmometer of the Fuoss–Mead type, has recently been determined in these laboratories for a series of fractions of cellulose nitrate, containing 14 per cent of nitrogen, derived from viscose rayons and covering the range of degrees of polymerization from 100 to 1,800. The uncorrected values for K and α were 0·0154 and 0·93 respectively, but on making the correction they became 0·0108 and 1·0. This startling change stresses the importance of the density of the solution in osmotic pressure measurements.

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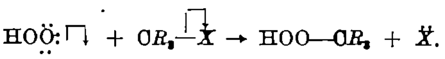
Preparation of Alkyl Hydroperoxides

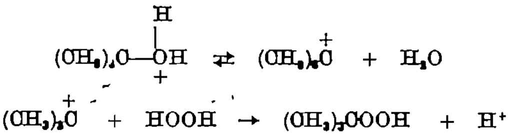
Alkyl hydroperoxides have been prepared by the action of hydrogen peroxide on: (1) alkyl sulphates, R_2SO_4, in the absence (for example, R = Bu^t)[1] or presence (for example, R = Et)[2] of alkali; (2) tertiary alcohols in the presence of a trace of concentrated sulphuric acid[3]; (3) triphenylmethyl halides[4,5]. All these reactions may be interpreted as involving nucleophilic attack of the HOOH molecule or HOO^- ion on a carbon atom according to the general equation:



$$HO\ddot{\underset{..}{O}}{:} + CR_3{-}X \rightarrow HOO{-}CR_3 + \bar{X}.$$

Both oxygen atoms in the resultant peroxide thus originate in the hydrogen peroxide molecule. This must necessarily be the case in reaction (3), but it is also thought to apply in reactions of types (1) and (2). The reaction may proceed by either of the two established mechanisms of nucleophilic substitution (the S_N1 and S_N2 mechanisms), and variation in constitutional and environmental factors will produce the usual effects[6]. Characteristic stereochemical consequences may be expected; for example, partial or complete racemization should accompany mechanism S_N1.

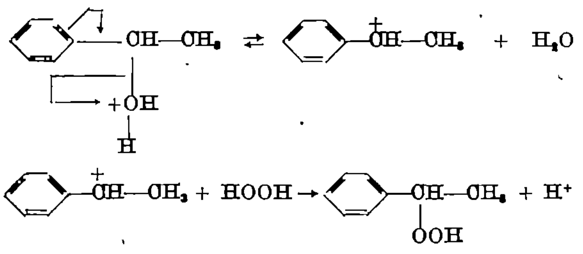
Criegee and Dietrich[3] state that primary and secondary alcohols do not react under the conditions of reaction (2). This reaction probably occurs readily with tertiary alcohols because inductive and hyperconjugative electron release by the alkyl groups, in conjunction with acid catalysis, facilitates the production of a carbonium ion which is then attacked by the hydrogen peroxide to give the alkyl hydroperoxide (the S_N1 mechanism).



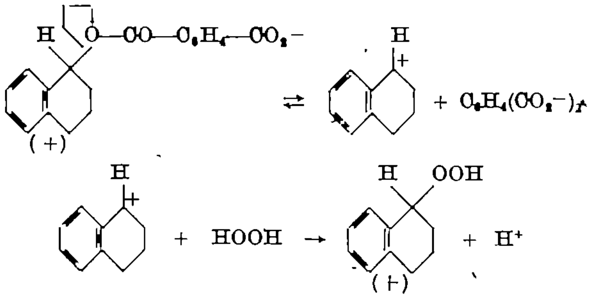
$$(CH_3)_3C{-}\overset{H}{\underset{+}{O}}H \rightleftharpoons (CH_3)_3\overset{+}{C} + H_2O$$

$$(CH_3)_3\overset{+}{C} + HOOH \rightarrow (CH_3)_3COOH + H^+$$

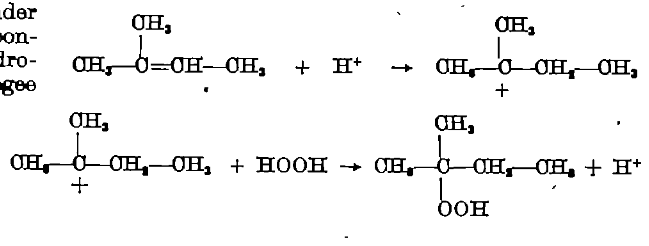
The reaction should, therefore, not be restricted to tertiary alcohols, but should apply to any alcohol which will yield carbonium ions under the conditions of reaction. This has been confirmed by the preparation of 1-phenylethyl hydroperoxide from 1-phenylethyl alcohol under Criegee and Dietrich's conditions. In this case, the S_N1 reaction is facilitated by electron release by the phenyl group; in *sec.*-butyl alcohol this factor is absent, and this alcohol is unreactive under the same conditions[7].



Hydroperoxides should also be produced by other types of compounds which are capable of the production of alkyl cations. Thus a carboxylic ester which readily undergoes alkyl–oxygen fission should be perhydrolysed to give an alkyl hydroperoxide and a carboxylic acid. This reaction has been established in the case of the hydrogen phthalate of 1 : 2 : 3 : 4-tetrahydro-1-naphthol. This ester has been shown to have a tendency to react by an alkyl–oxygen fission mechanism: for example, the optical activity of the alcohol obtained by hydrolysis of the ester decreases with decreasing nucleophilic power of the hydrolytic reagent, and the alcohol itself readily forms a sulphone with *p*-toluenesulphinic acid[8]. It has now been found that when 1 : 2 : 3 : 4-tetrahydro-1-naphthyl hydrogen phthalate is dissolved in 90 per cent hydrogen peroxide containing sodium bicarbonate, 1 : 2 : 3 : 4-tetrahydro-1-naphthyl hydroperoxide, identical with the product obtained by the autoxidation of 1 : 2 : 3 : 4-tetrahydronaphthalene, soon separates in good yield; if the optically active ester is used, the inactive hydroperoxide results. It has been shown that 1 : 2 : 3 : 4-tetrahydro-1-naphthol does not react under similar conditions and thus cannot be an intermediate in the reaction. The reaction would therefore appear to proceed by a unimolecular alkyl–oxygen fission mechanism, as follows:



The addition of a proton to an olefine will also produce an alkyl cation, which should react with hydrogen peroxide to lead to the formation of an alkyl hydroperoxide. This has been confirmed in the case of 2-methylbut-2-ene. This olefine, when stirred for 18 hr. with 90 per cent hydrogen peroxide in the presence of a trace of concentrated sulphuric acid, gives a good yield of *tert.*-amyl hydroperoxide. The mechanism of this reaction is hence thought to be as follows:



$$CH_3{-}\overset{CH_3}{C}{=}CH{-}CH_3 + H^+ \rightarrow CH_3{-}\overset{CH_3}{\underset{+}{C}}{-}CH_2{-}CH_3$$

$$CH_3{-}\overset{CH_3}{\underset{+}{C}}{-}CH_2{-}CH_3 + HOOH \rightarrow CH_3{-}\overset{CH_3}{\underset{OOH}{C}}{-}CH_2{-}CH_3 + H^+$$

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April 2.

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Nature of the 'Induction Period' in the Preparation of Lithium Aluminium Hydride

FOR the preparation of lithium aluminium hydride, Schlesinger *et al.*[1] claim that an addition of lithium aluminium hydride to the ether covering the powdered lithium hydride is essential. In absence of it a smooth reaction between lithium hydride and aluminium chloride was not always possible, and a period of induction ranging from a few minutes to several hours followed. Such induction periods were undesirable as they made the reaction uncertain and also difficult to control once it began again. To overcome this difficulty, Schlesinger *et al.* give two elaborate methods for making lithium aluminium hydride for subsequent catalytic use. These methods unfortunately involve complicated apparatus which is difficult to find, if at all, in most laboratories.

Thus when making lithium aluminium hydride, owing to the non-availability of lithium aluminium hydride for catalytic purposes, the reaction was tried without the addition of lithium aluminium hydride to ether covering powdered lithium hydride. It was noticed that the reaction always started immediately and continued smoothly to the end. In view of these observations it was difficult to understand the difficulty encountered by other authors until the following clue was obtained.

Once, while making lithium aluminium hydride by the usual method (that is, without the addition of lithium aluminium hydride), the reaction failed to start and an induction period lasting for twelve hours followed. When the reaction was conducted on a portion of lithium hydride from the same source, but with an addition of lithium aluminium hydride to ether covering it, the reaction went smoothly. This proved conclusively that there was something in ether that was responsible for the induction period and that it was removed or destroyed by lithium aluminium hydride. A portion of the ether was therefore distilled over lithium aluminium hydride and then used in the preparation of hydride. The reaction went smoothly. The same effect was produced when ether was carefully dried again over sodium. In view of these results, it was clear that the induction period was caused by inactivation of lithium hydride powder, probably by water that remains in ether when not thoroughly dry. This view fits in well with the fact that, whereas sodium wire takes a long time to remove the last traces of moisture owing to its surface reaction alone, lithium aluminium hydride, by virtue of its solubility in ether, can remove moisture spontaneously on mixing. The inactivation of lithium hydride may therefore lie in the formation of a protective film, probably of lithium hydroxide, on the surface of its particles, and the induction period may well be the time required to remove this film by chemical and mechanical means. Once this unreactive coating is removed, a vigorous reaction is conceivable in presence of a large amount of aluminium chloride in ether.

In view of these observations, it can be stated that it is desirable to add lithium aluminium hydride for catalytic purposes; but in absence of it, a smooth reaction can be ensured by using carefully dried ether.

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March 17.

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[1] Schlesinger *et al.*, *J. Amer. Chem. Soc.*, **69**, 1199 (1947).

Intensification of the Latent Photographic Image produced by Beta-Rays

IT is known that a latent image produced by a brief exposure to light can be intensified by a post-exposure to light of low intensity. This fact can be explained by assuming the production of a non-developable latent sub-image in addition to the normal latent image which can be developed. The latent sub-image can be converted to a developable latent image by a carefully controlled post-exposure to light of low intensity.

As the photographic action of charged particles on an emulsion is basically the same as that of light, it is to be expected that a latent sub-image is also produced by these particles. It is also to be expected that this latent sub-image would be produced in quantity when a fine-grain emulsion is exposed to fast particles of low charge, for example, if β-rays fall on plates which are not very sensitive to these rays.

We had available Kodak *NT* 2 *A* plates and a source of 0·01 μC. radium-D from the Atomic Energy Research Establishment, Harwell. This source was filtered by 10 mgm./cm.^{2} aluminium, so that only the β-rays from radium E were effective. The middle part of the plates was exposed to the β-rays for 1–2 days. After this exposure, half the plate was exposed to light from a 6·5-V. 0·2-amp. lamp at a distance of 2 m. for 20–28 sec. The plates were developed with *D* 19.

The density produced by the post-exposure alone varied from 0·007 to 0·11. For all post-exposures an increase of density of 50–100 per cent over that without post-exposure was obtained. Pre-exposure gave no appreciable effect. This agrees with the general rule that intensification can only be obtained if a long low-intensity exposure follows a short high-intensity exposure. The exposure of a grain hit by a β-ray is, of course, very intense and short in time.

Fuller details of this work will be published in due course in the *Revue de la Faculté des Sciences de l'Université d'Istanbul*.

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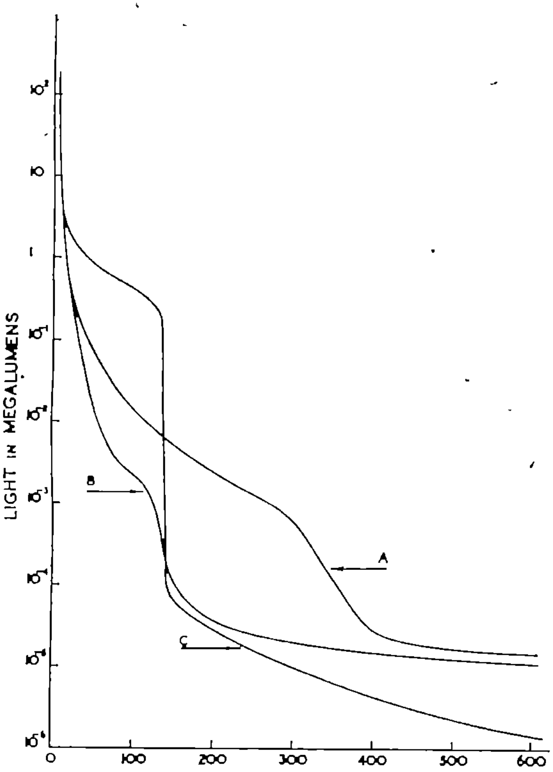
Decay of Light to Very Low Levels from Spark Discharges

RECENT publications on the after-effects from the electrical explosion of wires[1] and in Geiger counters[2], the cold emission of electrons in spark gaps[3] and the light output of sparks[4] suggest that the following experiments may be of interest, as we have not seen comparable results reported elsewhere.

We have observed the decay of light from pulsed high-current discharges in several gases and liquids down to extremely low levels and extending for several hundred microseconds. Single, approximately rectangular, current pulses obtained from a condenser network charged to 10 kV., of 1–9 μsec. duration and 100–10,000 amp. peak value, were used with electrode separation of a few millimetres. Triggering was effected by means of a trigger pulse applied to an auxiliary electrode. The light output was detected by means of an *RCA* 931*A* photomultiplier cell, amplifier and oscillograph. By altering the high



Decay of light from pulse discharges, 6,000 amp. peak and 6 μsec. duration: (*A*) in air, (*B*) in a rapid air stream, and (*C*) in water at 60 atm. pressure

tension of the cell and by the use of optical filters, the range of light output that could be measured was greater than 10^8 to 1, and the recovery time of the system from saturation due to the peak light was only about 20 μsec.

The types of decay curves obtained under various conditions are shown in the accompanying graph. Curve *A* is for a 6,000-amp. discharge between steel electrodes in air. The light decays very rapidly to about 10^{-4} of peak in the first 100 μsec. The rate of decay afterwards is much slower until a level of about 10^{-7} of peak is reached at 400 μsec., and this level is then maintained nearly constant to at least 600 μsec. This persistence of light at a low level is not due, apparently, to excited atoms remaining in the gap, as when the gap is swept by a powerful air blast only the initial rate of decay is changed, as shown in curve *B*. A similar curve is also obtained when possible direct radiation from the electrodes is screened off from the cell.

It was also found that the shape of the light decay curve is not significantly affected by the value of the peak current over the range investigated, but a slightly slower decay-rate is obtained when the pulse length is increased from 2 to 9 μsec. Slower initial decay-rates are obtained when the more volatile metals, such as aluminium, are used for the electrodes. Results similar to the air spark are obtained from discharges in photographic flash tubes, designed for a flash of a few microseconds duration, and in trigatrons.

Similar effects have also been observed with discharges in water; but in this case the initial rate of decay showed a marked increase when the water was subjected to considerable pressure, presumably due to the quicker collapse of the vapour bubble formed by the discharge. This effect is shown by curve *C* for a pressure of 60 atmospheres.

In all cases tried, light is still being emitted at a level of 10^{-7}–10^{-8} of peak some 600 μsec. after the current pulse, and this is not materially influenced by the conditions of the discharge. It is possible that ionization produced by continued electron emission from the cathode may account for this effect, and further study may yield new information on the processes involved. It is hoped to publish more detailed results in due course.

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R. H. Johnson
D. E. H. Jones

Radar Research and Development Establishment,
Malvern, Worcs. April 24.

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Rotational Analysis of the Columbium Oxide Bands

The bands of columbium oxide have been photographed on a 21-ft. concave grating with 30,000 lines per inch. The rotational analysis of three of these bands, λ 4,510 (1,0), λ 4,689 (0,0) and λ 4,915 (0,1) has been carried out. The rotational structure is found to resemble very closely that of vanadium oxide. Two *R* and two *P* branches have been identified in each band. The following constants have been determined for the ground and excited states:

$B_e' = 0{\cdot}5396$ cm.$^{-1}$ $B_e'' = 0{\cdot}6557$ cm.$^{-1}$
$B_0' = 0{\cdot}5325$ cm.$^{-1}$ $B_0'' = 0{\cdot}6553$ cm.$^{-1}$
$B_1' = 0{\cdot}5185$ cm.$^{-1}$ $B_1'' = 0{\cdot}6545$ cm.$^{-1}$
$\alpha' = 0{\cdot}0140$ cm.$^{-1}$ $\alpha'' = 0{\cdot}0008$ cm.$^{-1}$
$I_e' = 50{\cdot}32 \times 10^{-40}$ gm.cm.^{2} $I_e'' = 42{\cdot}18 \times 10^{-40}$ gm.cm.^{2}
$r_e' = 2{\cdot}237 \times 10^{-8}$ cm. $r_e'' = 1{\cdot}874 \times 10^{-8}$ cm.

The *D* values for the two states are of the order of 10^{-6} cm.$^{-1}$. Details of this work will be published elsewhere.

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Eye Rotations with Change of Accommodation

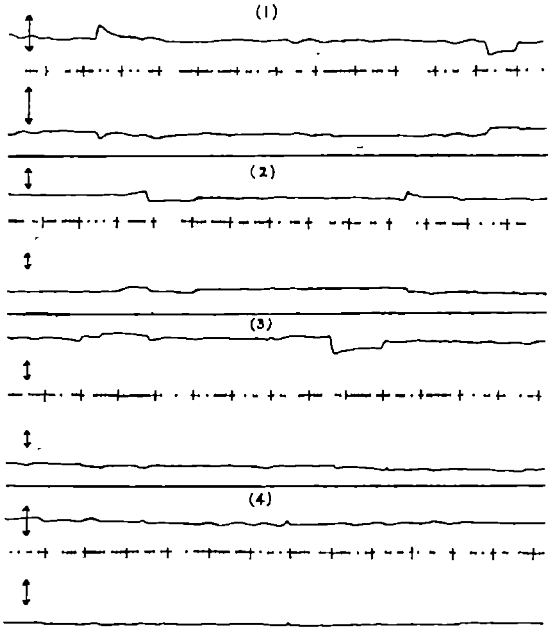
The apparatus, previously described[1], for studying eye movements of subjects in the sitting position, has been expanded so that side-to-side and up-and-down movements of the right eye can be recorded simultaneously. Rotations of this eye, occurring when accommodation is changed, have been studied with the apparatus. In these experiments, two fixation targets were used; both lay on the visual axis of the right eye when this eye was looking straight ahead. The farther target, which was viewed through a glass plate, was a bright pin-hole, angular diameter 1′, distant 5½ ft. from the subject. The nearer target was the mid-point between two virtual images, formed by reflexion at the front and rear surfaces of the glass plate, of another bright pin-hole. The virtual images were 2 ft. from the subject and the separation between them was 23′. Records were obtained for both horizontal and vertical separations of the virtual images. The subject fixated the far and near targets alternately; this cycle was repeated several times during a single recording, the frequency being at the subject's discretion. Records were obtained for both binocular and right-eye viewing of the targets.

As in the case of subjective change of convergence[3], change of accommodation was found to be associated with head movements similar to those occurring during steady fixation. Records for subjects R. S. L. and J. P. T. are independent of the direction of separation of the virtual images. It appears that change of accommodation is associated with a saccadic excursion of the eye, followed by return to its original fixation direction; saccadic movements are superimposed on the return drift in 50 per cent of the changes for J. P. T. and in 35 per cent for R. S. L. Characteristic records for R. S. L. for binocular viewing, and for J. P. T. for monocular viewing, are shown in Figs. 1 and 2 respectively. The average interval between changes is 1·7 sec. for R. S. L. and 1·6 sec. for J. P. T. For both subjects, the movements are oblique; for binocular viewing, the average magnitudes of the components for R. S. L. are 1·1° side to side, and 0·4° up and down; for J. P. T., they are 1·9° side to side, and 1° up and down. The monocular averages for R. S. L. are 0·8° side to side, and 0·3° up and down; for J. P. T., they are 1° side to side, and 0·7° up and down. For J. P. T., increase of accommodation is associated with a nasalward saccadic movement, and relaxation with a templeward saccadic movement. For R. S. L., the converse occurs for binocular viewing; for monocular viewing, nasalward saccadic movements are associated sometimes with increase, and sometimes with relaxation, of accommodation. The number of nasalward-upwards, nasalward-downwards, templeward-upwards and templeward-downwards saccadic rotations are approximately equal for J. P. T. For R. S. L., on the other hand, nasalward-upwards and templeward-downwards movements each comprise about 40 per cent of the saccadic rotations.

Injury to subject F. H. interrupted the investigation of his accommodation eye movements. However, the records obtained, which are for horizontal separations only of the virtual images, indicate qualitatively similar behaviour to that found for the other subjects. A characteristic record for F. H. is shown in Fig. 3.

Since the records are similar for the two directions of separation of the virtual images, it seems unlikely that there are any eye movements due to uncertainty of the subject about the position of the near fixation target. Moreover, steady fixation eye records[2] for such a target are similar to those for a single bright point.

For binocular viewing, Hering's[4] law predicts that, for the target configuration of this investigation, increase of accommodation would be accompanied by a nasalwards movement through about 2°, compounded with a templewards movement of equal magnitude. The behaviour of none of the subjects is in accord with this theory; in every case, the saccadic movements are oblique. Moreover, for subject R. S. L., the magnitude of the sideways component is smaller than that required by the theory. As for subjective change of convergence[3], the observed movements may be explained in terms of the energization, in activity, of the extra-ocular muscles.



(1) Right-eye record for binocular viewing for R. S. L.; separation of virtual images vertical.
(2) Right-eye record for right-eye viewing for J. P. T.; separation of virtual images horizontal.
(3) Right-eye record for binocular viewing for F. H., separation of virtual images horizontal.
(4) Right-eye record for right-eye viewing for A. L.; separation of virtual images vertical.
In Figs. 1–3, the movement at the extreme left of the record corresponds to increase of accommodation.
Side-to-side records are above the time-line; towards the time-line corresponds to nasalwards.
Up-and-down records are below the time-line; towards the time-line corresponds to upwards.
Time (increasing to right) | . . . | represents 0·2 sec.
Height of arrowed line represents a rotation of 3°, assuming the separation of the centre of curvature of the cornea and the centre of rotation of the eye is 5·3 mm.

Since most visual experience is binocular, an eye is accustomed to rotate when a change of its accommodation only is required. It is therefore not surprising that right-eye movements, on changing accommodation, should persist even when the left eye is screened; the movements are, however, somewhat smaller than those for binocular viewing, and, for R. S. L., are not always in the same direction.

To investigate whether eye rotations on changing accommodation arise entirely from binocular visual experience, records have been obtained for a subject whose visual experience is effectively monocular. The right eye of this subject, A. L., is emmetropic, acuity 6/4; with a correction of 1·5 D sph. combined with a $-$ 2·5 D cyl. (axis 15°), the left eye acuity is 6/18. A. L. has never worn glasses, and normally the left-eye vision is suppressed. His records are independent of the direction of separation of the virtual images, but otherwise differ considerably from those previously described; a characteristic record is shown in Fig. 4. The records for monocular and binocular viewing are similar and are little different from steady fixation records. It thus seems likely that binocular visual experience is entirely responsible for eye movements associated with change of accommodation, and that the precise nature of the movements depends on the energization, in activity, of the extra-ocular muscles.

I am grateful to Dr. R. S. Longhurst for acting as subject and for interesting discussions; and also to my students, Messrs. F. Hodgson, A. Langridge and

J. P. Tilt, who took part in the investigation. Mr. E. F. Fincham kindly helped in connexion with the refraction test. The continued financial support of the Medical Research Council is gratefully acknowledged.

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April 7.

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Education of the Deaf

MAY I be allowed to make a material correction to the otherwise admirable account in *Nature* of September 27, p. 525, of the discussion on the "Education of the Deaf" at the recent meeting of the British Association ? My own paper was specifically limited to the problem of educating the young, totally deaf—whether born deaf, or those who become totally deaf before learning to speak.

It is common ground that such children constitute a very difficult problem. Mr. Greenaway reported that of twenty deaf pupils leaving his school this year, 60 per cent could be considered as successes, but the remaining 40 per cent were unsuccessful. For these he suggested that something more than pure oral teaching should be added.

Mr. Askew, of the Mary Hare Grammar School, pointed out that the born-deaf pupils entering his school at 13 + years were 2–3 years retarded in vocabulary. Prof. and Mrs. Ewing claim that with skilful home training from a very early age, deaf children of two had been trained to lip-read. But they have also admitted that all totally deaf children are not equally teachable.

My purpose was to plead for the experimental use of a systematic sign language, in which every sign should be the equivalent of a spoken word, and that suitable parents or nurses should be trained to use the new signs, and to talk to the young deaf children, *in signs*, just as a hearing mother talks to her young hearing children in words. In this experiment *no effort should be required on either side*. At first the deaf child would understand nothing : then gradually the meaning of the various signs would begin to dawn on them.

Mr. Greenaway had made the interesting suggestion that parents or nurses using the new sign language should speak as they signed. In this way the deaf children would get to realize that the mouth-gestures of speech and the pantomimic hand-gestures of the new sign language *meant* the same things. It seems not unlikely that at the age of four, totally deaf children might acquire a vocabulary of as many signs as a hearing child of equal intelligence would know words. A born deaf child of four with a vocabulary approaching 2,000 'words' would obviously be immensely more teachable than even the best of the pure oral successes. It is also obvious that signs which are completely visible should be much easier for the deaf child to imitate than spoken words are to the hearing child ; for the method of manufacture of speech-sounds is largely a secret process.

I have made no 'recommendations'—I plead for the carrying out of an experiment which seems to offer valuable knowledge and material help to the young born deaf. I plead in good company, for when Lady Paget and I met Dr. Helen Keller in Cape Town last year, she was greatly interested in the new signs, and, after copying some of them for herself, she gave me this message : "Let the experiment be tried".

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In vitro Cultures of a Fern Callus

IN recent years, several reports of the successful growth in sterile culture of callus tissues derived from various pteridophytes have appeared[1]. A callus culture possessing several unusual morphological, cytological and metabolic features has been obtained from gametophytes of *Pteridium aquilinum* (L.) Kuhn, var. *latiusculum* (Desv.) Underw.[2], which had been growing in sterile culture on an agar medium containing Knudson's solution of inorganic salts[3], Berthelot's trace element solution[4], 2 per cent glucose and 0·5 gm./l. yeast extract (autoclaved) at Harvard University, United States. Soon after these gametophyte cultures were brought to Manchester, England (in September 1950), a callus-like growth was observed in one of the tubes. When subcultured on to the same medium, with Knop's inorganic salt solution[4] substituted for Knudson's, the abnormal tissue continued to grow in a disorganized manner. It has now been through sixteen passages, each of four to six weeks duration, and in each passage there has been a six- to ten-fold increase in the size of the inoculum.

The cultures are deep green in colour and form coherent but friable masses. They are predominantly filamentous, with numerous branched filaments radiating from centres of growth. Continued divisions in various planes result in the formation of regions of highly vacuolated, large-celled parenchymatous tissue in some of the older parts of the cultures. Whitish or pale-green outgrowths project from the surfaces of many of the cultures. These are compact tissues composed of small, deeply staining parenchyma cells. Meristematic growth in the outgrowths is confined to certain localized superficial regions behind which is often a core of elongated cells. Some of these cells may be further differentiated as short scalariform or reticulate tracheids. A variety of treatments has as yet failed to promote further regenerative growth of these bud-like structures.

During the first two passages prothallial regeneration occurred on five occasions, but has not occurred since, either spontaneously or following experimental treatment. The strain of gametophytes from which the callus arose was haploid[2]; $n = 52$. When first examined in the fourth passage, cells of the callus had approximately 100 chromosomes ; but on subsequent examination of material in the twelfth and fourteenth passages chromosome numbers were found to vary irregularly between 150 and 200. The callus is now irregularly aneuploid.

Nutritional requirements of the callus are very simple. Slow but continued growth is possible on an agar medium containing inorganic salts only. Rapid growth occurs when inocula are totally submerged in a liquid medium containing only inorganic salts and 3 per cent glucose.

A detailed account of these cultures will be published elsewhere.

Our thanks are due to the late Mr. A. Swaffer and to Dr. C. M. Wilson and Mr. C. Partenan for assistance with the cytological studies.

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I. M. SUSSEX
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Sept. 10.

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A Difference in *In vitro* Pancreatic Digestion between Animal and Plant Protein Feeds

MELNICK *et al.*[1] and Evans[2] found that the rate of enzymatic liberation of amino-acids from soybean proteins preheated at different temperatures provides an explanation for their different growth-promoting properties for the growing chick. We have used this principle to investigate the differences between the biological value of various types of protein feeding-stuffs for animals. In the course of this work we observed a property in which plant and animal proteins differ: pancreatic digests of plant protein feeds, but not of animal protein feeds, yielded considerable precipitates on addition of trichloracetic acid.

The experiments were carried out with feeding-stuffs defatted with ether and dried at room temperature. 6-gm. samples of each feed were placed in 250-ml. Erlenmeyer flasks, 300 mgm. of 'Pancreatin' (Byla, Paris), 150 ml. of phosphate buffer (*p*H = 8·2; Sørensen) and a few drops of toluene were added. The flasks and contents were incubated at 37–38° C. for 48 hr. with frequent shaking. In one set of experiments the non-digested materials were filtered, washed several times with phosphate buffer (*p*H = 8·2) and the nitrogen content of the precipitates was determined by Kjeldahl digestion. In a second set the whole digests (together with the substrates) were acidified with hydrochloric acid (methyl red) and 25 ml. of 5 per cent trichloracetic acid added. The precipitates were filtered and washed with hot water containing 0·5 per cent trichloracetic acid.

The precipitates obtained by addition of trichloracetic acid to plant protein digests contained much larger amounts of nitrogen than the non-digested residues by themselves, amounting to 20–25 per cent of the nitrogen contained in the original feeding-stuff. In the case of the pancreatic digests of animal-protein feeds, addition of trichloracetic acid did not cause precipitation of any additional quantity of nitrogen.

Feed	Total N-content of the fat-free feed (per cent)	Insoluble N after 48 hr. digestion with 'Pancreatin'	Insoluble and precipitated N after addition of $CCl_3.COOH$ to pancreatic digests
		In per cent of the N-content of the fat-free feed	
1. Fish meal (Norwegian)	11·6	40·1	40·1
2. Meat-meal (Argentinian)	11·4	25·0	25·8
3. Soy bean oil meal	7·7	10·3	30·0
4. Sesame oil meal	7·9	16·6	42·5

It may be noted that in similar digestion experiments carried out with pepsin (*p*H 1·5), no additional nitrogen was precipitated by trichloracetic acid, either in digests of plant proteins or in those of animal proteins.

Experiments to elucidate the chemical nature of these soluble nitrogen compounds precipitated by trichloracetic acid are under way.

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Rehovot.
March 21.

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Production of Gliotoxin in Unsterilized Soil

IT has long been recognized that microbial antagonisms exist in the soil, and the possibility that this might be due to production of antibiotics has been suggested although never actually proved.

It has been shown that soil can be used as a medium for growth of many micro-organisms and also for antibiotic production, but in general sterilizing and supplementing with organic matter have been found to be necessary. Grossbard[1] has demonstrated the production of an antibiotic in autoclaved and also in partially sterilized soil, and Hessayon[2] has shown that activity can be produced in sterile unsupplemented soil. Gregory, Allen, Riker and Peterson[3,4], moreover, have demonstrated activity in unsterile soil which was, however, supplemented with highly nutrient organic matter. In these cases it was assumed, but not conclusively demonstrated, that the antibiotic formed in the soil was identical with that produced by the fungus in synthetic media.

The results presented here show the production of gliotoxin by *Trichoderma viride* in Wareham Heath soil, a highly acid podsol, in which all the microflora was present.

Unsterile soil was supplemented with dried clover, inoculated with a spore suspension of a gliotoxin-producing strain of *T. viride* and incubated at 25° C. for four days. The soil was extracted with ether and the extract used to demonstrate and identify the antibiotic.

Identification was demonstrated by a bio-assay based on paper chromatography. Chromatograms were run on the soil extracts, and solutions of pure gliotoxin on filter paper strips, and these were placed on agar seeded with *B. subtilis* as the test organism. After incubation of plates the distance moved by the active substance was demonstrated by the position of a clear zone of inhibition and the R_F values were calculated. The amount of gliotoxin present could be estimated roughly from the size of the inhibition zone.

	R_F values
Pure gliotoxin	0·60
Inoculated soil + 5 per cent clover	0·59
Inoculated soil + 2 per cent clover	0·59

Activity was produced only in inoculated unsterile soil to which dried clover had been added, and as the R_F values of these extracts and pure gliotoxin were very similar, it was assumed that the activity was due to production of gliotoxin by the fungus. It was estimated, very approximately, that 0·6 μgm. of gliotoxin/gm. of soil was produced when 5 per cent dried clover was added. Activity was produced in soil to which only 1 per cent dried clover had been added.

A neutral garden loam was treated in the same way and inoculated with *T. viride*; but activity could only be demonstrated in soil which had been acidified. It has been shown by Jefferys[5] that inactivation of gliotoxin is more rapid in garden soil than in Wareham soil, and he related this to difference in *p*H, as gliotoxin is more stable at lower *p*H values.

JOYCE M. WRIGHT

Imperial Chemical Industries, Ltd.,
Butterwick Research Laboratories,
Welwyn, Herts. July 30.

[1] Grossbard, E., *J. Gen. Microbiol.*, 6, 295 (1952).

[2] Hessayon, D. G., *Nature*, 168, 998 (1951).

[3] Gregory, K. F., Allen, O. N., Riker, A. J., and Peterson, W. H., *Bact. Proc. Soc. Amer. Bact., Chicago, Ill.*, 18 (1951).

[4] Gregory, K. F., Allen, O. N., Riker, A. J., and Peterson, W. H., *Amer. J. Bot.*, 39, 405 (1952).

[5] Jefferys, E. G., *J. Gen. Microbiol.* (in the press).

Relationship of the Blood Sub-Groups A_1, A_2 and A_1B, A_2B to Hæmagglutinins Present in the Seeds of *Dolichos biflorus*

To identify the blood sub-groups of A and AB, an anti-A_1 serum is used. This is prepared by completely absorbing a human anti-A serum with A_2 cells[1]. The absorbed serum agglutinates A_1 and A_1B cells, but not A_2 or A_2B cells. A-specific hæmagglutinins have been demonstrated in saline extracts of the seeds of *Dolichos biflorus* by Bird[2], and it has been suggested[3] that because extracts of *Dolichos biflorus* seemed predominantly A_1-specific, they may be used to differentiate the sub-groups A_1 and A_2, A_1B and A_2B. The seed extracts have the advantage of being cheaper and more easy to prepare than human sera.

Two hundred samples of A and seventy-five of AB cells were therefore tested both with a human anti-A_1 serum and a saline extract of *Dolichos biflorus* seeds. All the samples were of Indians of no definite ethnological status and were obtained from the local blood-donor centre; 2 per cent suspensions of washed cells in isotonic saline were used. All the samples were less than 24 hr. old. The seeds used were those of *Dolichos biflorus*—Belgaum 1-1-8. They were extracted with isotonic saline by the simple method used by Boyd and Reguera[4] for small quantities of seeds. To differentiate A_1 from A_2 the seed extract was titrated against all the A samples. There was a clear-cut differentiation of the sub-groups of A, A_1 cells being agglutinated in titres ranging from 8,192 to 32,768; and A_2 cells in titres ranging from 4 to 16. In the case of AB cells, no titration was required as the undiluted extract agglutinates A_1B cells strongly and almost immediately, while it agglutinates A_2B cells weakly after about 15 min.

There was complete correspondence between the results obtained with the seed extract and those obtained with the absorbed human serum. There was no sample of A or AB which could not definitely be assigned to its proper sub-group; that is, there was no evidence of the occurrence of any 'A intermediates'. For routine work, a 1 in 64 dilution of the fresh extract in isotonic saline could be conveniently used to differentiate A_1 from A_2. This dilution can also be used to distinguish A_1B from A_2B, because A_1B cells are acted upon[3] up to a titre of 512.

Of the A samples, 177 (88·5 per cent) belonged to the sub-group A_1 and 23 (11·5 per cent) to A_2; while of the AB's, 60 (80 per cent) were A_1B and 15 (20 per cent) A_2B. As the numbers tested are small, and as the group examined was ethnologically indefinite, the anthropological aspect of these figures is not discussed.

G. W. G. BIRD

Blood Transfusion Department,
Armed Forces Medical College,
Poona. May 28.

[1] Wiener, A. S., "Blood Groups and Transfusion" (Springfield, 1943).

[2] Bird, G. W. G., *Curr. Sci.*, 20, 298 (1951).

[3] Bird, G. W. G., *Ind. J. Med. Res.*, 40, 289 (1952).

[4] Boyd, W. C., and Reguera, R. M., *J. Immunol.*, 62, 333 (1949).

Copepods New to British Waters

DURING a recent investigation on ascidicolous copepods, at least five species hitherto unrecorded from British waters have been found in Strangford Lough, Co. Down. All are members of the sub-order Notodelphyoida, and are listed below, together with their host ascidians.

Doropygus uncinatus Kerschner. in *Polyclinum aurantium* Milne Edwards and *Sidnyum turbinatum* (Savigny).
Enterocola pterophora Chatton and Brément: in an unidentified didemnid.
Haplostomides scotti Chatton and Harant: in *Polyclinum aurantium*.
Haplostoma brevicauda (Canu). in *Polyclinum aurantium*, *Sidnyum turbinatum* and *S. elegans* (Giard).
Haplostoma banyulensis (Brément). in *Trididemnum tenerum* (Verrill).

Five other notodelphyoids so far known only from isolated localities around the British Isles and recorded, for the most part, many years ago, have also been discovered in Strangford Lough, and are given in the subjoined list.

Gunenotophorus globularis Costa in *Pyura squamulosa* (Alder) and *Polycarpa* sp.
Botryllophilus ruber Hesse: in *Botryllus schlosseri* (Pallas) and *Botrylloides leachi* (Savigny).
Enterocola fulgens P. J. van Beneden: in *Polyclinum aurantium*.
Haplostomides hibernicus (T. and A. Scott) in *Polyclinum aurantium*.
Mycophilus roseus Hesse: in *Botryllus schlosseri* and *Botrylloides leachi*.

I have hesitated for some time to assign specific identity to the *Mycophilus* collected, due to the presence of two forms in the lough. One of these is undoubtedly similar to that described by Chatton and Brément[1] as *Mycophilus curvatus*, while the other is apparently identical with *M. vararensis*, originally described by T. Scott[2] as *Enteropsis vararensis* but later annexed to the genus *Mycophilus* by Chatton and Brément. There seems to be little doubt that a third form described by Gray[3] as *M. roseovula* is synonymous with Scott's species. Lang[4], however, regards all members of this genus as referable to the single species *M. roseus*. My own work supports Lang's conclusion; it is hoped to discuss this question more fully in a separate paper.

R. V. GOTTO

Department of Zoology,
Queen's University,
Belfast.
April 16.

[1] Chatton and Brément, *Bull. Soc. Zool. France*, 34, 234 (1909).

[2] Scott, T., Nineteenth Ann. Rep. Fish. Board Scotland, Pt. 3, 241 (1901).

[3] Gray, P., *J. Mar. Biol. Assoc.*, N.S., 18, 523 (1933).

[4] Lang, K., *Ark. f. Zool.*, 40A, No. 14, 1 (1948).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 20

Society of Dairy Technology (in the North Hall, Victoria Halls, Bloomsbury Square, London, W.C.1), at 2.30 p.m.—Dr. John Hammond, F.R.S.: "The Contributions of Artificial Insemination and Milk Recording to the Dairy Industry".

British Society for the History of Science (in the Lecture Room, Science Museum, Exhibition Road, London, S.W.7), at 5.30 p.m.—Dr. Derek J. Price: "Chaucer's 'Equatorie of the Planetis'".

Institution of Electrical Engineers (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Institution and Current Affairs" (to be opened by the President).

Society of Chemical Industry, Crop Protection Panel of the Agriculture Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. J. M. Barnes: "Crop Protection as a Health Hazard".

Society of Chemical Industry, Corrosion Group (joint meeting with the Institute of Metal Finishing, at the Northampton Polytechnic, St. John Street, London, E.C.1), at 6 p.m.—Mr. H. M. Angles, Mr. S. C. Britton and Mr. D. G. Michael: "Tin-Nickel Alloy Coatings".

Tuesday, October 21

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. J. B. S. Haldane, F.R.S.: "Indian Culture, Past and Present".*

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mrs. Margaret Pyke and Mr. H. A. Davidson: "Family Planning—the Past and the Future".*

Institution of Electrical Engineers, Measurements Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. L. Hartshorn: Chairman's Address.

Society of Chemical Industry, Chemical Engineering Group (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. P. S. Williams: "The Flow of Concentrated Suspensions (related to Chemical Engineering Problems)".

Textile Institute, London Section (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Mr. F. Courtney Harwood: "Modern Detergency".

Wednesday, October 22

Aslib (at Friends House, Euston Road, London, N.W.1), at 5.30 p.m.—Mr. J. E. L. Farradane: "Psychology of Classification".

British Psychological Society, Medical Section (at the Medical iety of London, 11 Chandos Street, Cavendish Square, London, 1), at 8.30 p.m.—Dr. N. Tinbergen: "Some Recent Work on tinct".

Thursday, October 23

nstitution of Electrical Engineers, Utilization Section (at oy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.— J. W. T. Walsh: Chairman's Address.

Friday, October 24

Biochemical Society (in the Department of Biochemistry, St. omas's Hospital Medical School, London, S.E.1), at 2 p.m.—ntific Papers.

hemical Society, Glasgow Section (joint meeting with the hemist's Club and the Andersonian Chemical Society, at the yal Technical College, Glasgow), at 3.30 p.m.—Prof. D. H. Hey: ubstitution at an Aromatic Carbon Atom".

hemical Society, Birmingham Section (joint meeting with the University Chemical Society, in the Chemistry Lecture Theatre, The University, Edgbaston, Birmingham), at 4.30 p.m.—Dr. V. C. Barry: "Studies in the Chemotherapy of Tuberculosis".

British Glaciological Society (in the Department of Geography, Downing Place, Cambridge), at 8.15 p.m.—Prof. R. Finsterwalder: "Glacial Recession in the Eastern Alps since 1850, with special reference to Recent Times". (Members of the University are invited.)

Friday, October 24—Saturday, October 25

Institute of Physics, X-Ray Analysis Group (at the Royal Institution, 21 Albemarle Street, London, W.1).—Autumn Conference.

Saturday, October 25

British Glaciological Society (joint meeting with the Scott Polar Research Institute, at the Institute, Cambridge), at 8.30 p.m.—Dr. G. de Q. Robin: "The Norwegian–British–Swedish Antarctic Expedition, 1949–1952". (Members of the University are invited.)

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Bacteriologist (science graduate, non-medical)—The Secretary and Administrative Medical Officer, Northern Regional Hospital Board, Raigmore, Inverness (October 25).

Engineers (with good research experience) at the new Research Establishment at Isleworth, Middx, to undertake research work on underground mining problems—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/540 (October 25).

Lecturer in the Mechanical Engineering Department of the Municipal Technical College—The Chief Education Officer, Guildhall, Kingston-upon-Hull (October 25).

Senior Experimental Officer at the Aeronautical Research Laboratory, Fishermen's Bend, Victoria, Australia, to be responsible under a P.S.O. (instrumentation) for the design, development, and manufacture of special instrumentation required for laboratories—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1, quoting No. 268 (October 25).

Senior Scientific Officers: (Position No. 3) to be responsible under direction of a P.S.O. for supervising a chemical section for research and investigations related to materials for rocket motors and rocket propellants; (Position No. 14) to be responsible under direction of a P.S.O. for supervising internal ballistics research in the field of rocket propulsion, including determination of ballistic properties of propellants and design of charges for rocket motors; Principal Scientific Officers: (Position No. 24) to be responsible for initiation of research on the theoretical aspects of rocket propulsion and to supervise mathematical, thermodynamic and heat transfer studies in this field; (Position No. 34) to be responsible for the organization and direction of a propulsion engineering group, to initiate and supervise research and development on the engineering aspects of rocket motor design and exercise general supervision over an experimental workshop, drawing office and static firing emplacements; at the Propulsion Research Laboratory, Salisbury, Australia—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1, quoting the appropriate Ref. No. (October 25).

Research Assistants (2, with a first- or second-class honours degree, preferably in chemistry or biochemistry) in a newly formed Unit of Insect Biochemistry, to undertake research upon the biochemistry of locust blood—The Registrar, The University, Leeds 2 (October 27).

Senior Physicist in the Department of Medical Physics—The Secretary to the Board, United Bristol Hospitals, Royal Infirmary Branch, Marlborough Street, Bristol 2 (October 27).

Museum Assistants in the Science Museum and the British Museum—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 143/229/52 (October 30).

Assistant Lecturer in the Department of Agriculture (Crop Husbandry)—The Registrar, University College of Wales, Aberystwyth (October 31).

Assistant Lecturer or Lecturer in the Department of Mining—The Registrar, University College, Cathays Park, Cardiff (October 31).

Demonstrator (honours graduate with previous experience of demonstrating to B.Sc. standard) in the Physics Department—The Registrar, King's College, Strand, London, W.C.2 (October 31).

Foulerton Research Fellowship in Medicine—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (October 31).

Junior Lecturer in Anatomy—The Registrar, King's College, Strand, London, W.C.2 (October 31).

Lecturer (Grade II) or an Assistant Lecturer (Grade III) in the Department of Physics—The Secretary, The University, Birmingham 3 (October 31).

Lecturer in Palæontology and Stratigraphy—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (October 31).

Lecturer or Assistant Lecturer in the Department of Geology—The Registrar, University College of Wales, Aberystwyth (October 31).

Lecturer in Metallurgy—The Registrar, King's College, Newcastle-upon-Tyne (October 31).

Scholarship for Training in Industrial Research—The Director, Institute for Industrial Research and Standards, Glasnevin House, Ballymun Road, Dublin (October 31).

Head of the Department of Biochemistry—The House Governor, Children's Hospital, Ladywood Road, Birmingham 16 (November 1).

Technical Officer, Grade II (with a good general training in chemistry, preferably up to degree standard; experience in fuel technology and fuel analysis would be an advantage) at the Coal Survey Laboratory in Scotland—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/539 (November 1).

Senior Principal Scientific Officer and Principal Scientific Officers at the Army Operational Research Group, West Byfleet, Surrey, and a Principal Scientific Officer or Senior Scientific Officer at the Ordnance Survey Office, Chessington, Surrey—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4165/52 (November 6).

Assistant Lecturer (temporary) in the Department of Anatomy—The Registrar, University College, Cathays Park, Cardiff (November 8).

Research Studentship in the Department of Biochemistry—The Secretary, Lister Institute of Preventive Medicine, Chelsea Bridge Road, London, S.W.1 (November 8).

Senior Research Officer (chemist or chemical engineer) at the Wool Textile Research Laboratory, Geelong, Victoria, Australia, to establish a section for research into certain processes of the textile industry, particularly felting and scouring—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3880 (November 8).

Brotherton Lecturer in Chemical Engineering—The Registrar, The University, Leeds 2 (November 10).

Rose Sidgwick Memorial Fellowship for a year's postgraduate study in the U.S.A., and the Aurelia Henry Reinhardt International Fellowship for a year's research in some country other than the holder's own—Research Applications, British Federation of University Women, Ltd., 17a King's Road, London, S.W.3 (November 15).

Director of Research at the Australian Leather Research Association at Lane Cove, near Sydney, New South Wales—The Australian Leather Research Association, c/o the Chief Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (November 22).

Lecturer in Philosophy at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Melbourne, December 1).

Postdoctorate Fellowships for research in pure chemistry and physics, tenable in the National Research Council's laboratories at Ottawa, and Postdoctorate Fellowships in the biological sciences, tenable in the Prairie Regional Laboratory of the National Research Council at the University of Saskatchewan and in the Laboratories at Ottawa—The Secretary, Laboratories Awards Committee, National Research Council, Ottawa, Canada; or the Chief Scientific Liaison Officer, National Research Council of Canada, Africa House, Kingsway, London, W.C.2 (February 15).

Assistant (Grade A) in Biology (qualified to take botany and/or zoology to Intermediate Degree standard), and an Assistant (Grade A) in Physics—The Principal, Technical College, Queen Street South, Huddersfield.

Assistant Technical Secretary (with a degree in metallurgy; some industrial experience essential, and a knowledge of sheet metal products an advantage) by the Metallurgy (General) Division—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Technical Secretary'.

Bacteriologist to undertake research work on the classification and identification of rumen bacteria by serological methods—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

Chair of Mathematics—The Secretary, Royal Technical College, George Street, Glasgow, C.1.

Chemist (with good honours degree and Ph.D., or equivalent research experience) for work involving isolation and purification of new antibiotics and other substances of biological interest—The Director, Antibiotics Research Station (Medical Research Council), 4 Elton Road, Clevedon, Somerset.

Civil Engineer in the Hydrological Survey Department, Uganda—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting C.S.D.64/9/01.

Demonstrator in Agricultural Zoology in the Department of Agricultural Sciences, School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

Demonstrator in Chemistry and Biology—The Registrar, Technical College, Sunderland.

Entomologist in the Department of Agriculture, Trinidad, for investigation of plant damage by insects and other animals and formulation and application of control measures; also plant quarantine work—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting C.S.O 63/38/01.

Geologist (with honours degree in geology) for service in the Antarctic with the Falkland Islands Dependencies Survey—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.33272.B.

Graduate Chemist for investigations of cleaning and lubrication in metal working processes (location, Sheffield)—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, quoting 'Lubrication'.

Hugh Wood Memorial Fellowship in Mining—The Registrar, The University, Leeds 2.

Industrial Chemist at Harwell, to assist in problems associated with treatment of radioactive material, water supplies, and general chemical service—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House 26 King Street, London, S.W.1, quoting F.046/52A.

Lecturer in Biology in the Department of Applied Science, Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton, Staffs.

Lecturer in Mechanical Engineering, including heat engines and hydraulics—The Principal, Faraday House College, Southampton Row, London, W.C.1.

Lecturer in Organic Chemistry, to teach organic chemistry to the standard of the Special Degree in Chemistry of London University, and the A.R.I.C.—The Registrar, Municipal College, Portsmouth.

Lecturer or Assistant Lecturer in the Department of Aeronautical Engineering—The Secretary and Registrar, The University, Southampton.

Mycologist (with an honours degree in botany, with experience of research in mycology and economic botany) in the Forest Department, Kenya, to study pathology in forests and plantations and the fungal diseases of timber—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSO.61/7/01.

Professor of Mechanical Engineering and a Professor of Electrical Engineering at the University of Roorkee, U.P., Northern India, to teach and organize their departments on modern lines with up-to-date undergraduate and postgraduate courses and research—The Ministry of Labour and National Service, Technical and Scientific Register (A.8.12), Almack House, 26 King Street, London, S.W.1, quoting A.12/1.65,66E/52.

Research Assistant (with a good honours degree in physics, mathematics or chemical engineering, and some research experience) in the Department of Mining and Fuels—The Registrar, The University, Nottingham.

Research Assistant (with a good degree in zoology and, preferably, a special interest in physiology and histology)—The Professor of Zoology, The University, Glasgow, W.2.

Research Demonstrator (honours graduate in botany) in the Department of Biology—The Registrar, University College, Singleton Park, Swansea.

Research Manager at Sellafield, Cumberland, to take charge of Laboratories engaged on metallurgical development of radioactive materials and welding processes for atomic energy—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 376.

Research Physicist (with at least a second-class honours degree in physics) for work in the field of Solid State Physics—The Professor of Physics, The University, Reading.

Scientific Officer or Senior Scientific Officer for an investigation on the soundness of iron castings—The British Cast Iron Research Association, Alvechurch, Birmingham.

Senior Engineer, Water Supply and Irrigation Department, Cyprus—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting C.S.D.64/17/01.

Senior Physicist (with experience in medical physics) for Radiotherapy Service of the Southampton area—The Secretary, Southampton Group Hospital Management Committee, Bullar Street, Southampton.

Surveyors in Uganda, to carry out and supervise cadastral and topographical surveys—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting C.S.D.72/9/01.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Standard 1864: 1952, Milk Piping and Milk Pipe Fittings. Pp. 34. (London: British Standards Institution, 1952.) 5s. net. [306

Eighty-eighth Annual Report on Alkali &c. Works. By the Chief Inspectors. Proceedings during the Year 1951. Pp. 64. (London: H.M. Stationery Office, 1952.) 2s. net. [17

British Empire Cancer Campaign. Twenty-ninth Annual Report, covering the Year 1951. Edited by Sir Heneage Ogilvie. Pp. xxix + 358. (London: British Empire Cancer Campaign, 1952.) [17

Colonial Office. Fishery Publications, Vol. 1, No. 2: Report on the Tilapia and other Fish and Fisheries of Lake Nyasa, 1945–47. By Rosemary H. Lowe. Pp. x+126+7 plates. (London: H.M. Stationery Office, 1952.) 40s. net. [27

Bulletin of the British Museum (Natural History). Zoology, Vol. 1, No. 7: The Cestodes of Seals from the Antarctic. By Stanislaw Markowski. Pp. 123–150+plates 10–21. (London: British Museum (Natural History), 1952.) 12s. 6d. [27

Flora of Tropical East Africa. Editors: Dr. W. B. Turrill and E. Milne-Redhead. Part 2: Oleaceae. Pp. 31. (London: Crown Agents for the Colonies, 1952.) 2s. 6d. [27

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Western Australia. Report of the Government Chemical La
atories for the Year 1949. Pp. 40. (Perth: Government Prin
1951.)

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Control of Panic, held under the joint auspices of the New Y
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Fieldiana. Anthropology, Vol. 37, No. 2: Bibliography of Afr
Anthropology, 1937–1949. Supplement to Source Book of Afr
Anthropology, 1937. By Wilfrid D. Hambly. Pp. 153–292. (Chica
Chicago Natural History Museum, 1952.) 1.50 dollars.

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Research Conference for Biology and Medicine of the Atomic En
Commission, sponsored by the Biology Division, Oak Ridge Nat
Laboratory, Oak Ridge, Tennessee, April 11–12, 1949. Pp. 128.
Ridge, Tenn: Oak Ridge National Laboratory, 1952.)

Queensland Institute of Medical Research Sixth Annual Re
Year ended 30th June 1951. Pp. 18. (Brisbane: Queensland Insti
of Medical Research, 1952.)

Ontario Research Foundation. Annual Report, 1951. Pp.
(Toronto: Ontario Research Foundation, 1952.) [306

Scientific Papers of the College of General Education, University of Tokyo. Vol. 1, No. 1, October 1951. Pp. ii+102. (Tokyo: University of Tokyo, 1951.) [306

Ministry of Public Works, Egypt: Nile Control Department. Paper No. 1: Probability in the Hydrology of the Nile. By Naguib Boulos. Pp. vii+67. (Cairo: Government Press, 1951.) P.T. 50; 10s. [306

Proceedings of the American Academy of Arts and Sciences. Vol. 80, Part 1: Contributions to the Analysis and Synthesis of Knowledge. (Published in co-operation with the Institute for the Unity of Science.) Pp. 112. (Boston, Mass.: American Academy of Arts and Sciences, 1951.) 2 dollars. [306

Annotated List of Animals and Plants of Mie Prefecture, Japan. Pp. vii+352. (Tsu: Committee of the Biological Survey of Mie Prefecture, University of Mie, 1951.) [27

Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture. Comptes rendus de recherches, No. 7: Travaux de la Section de Pathologie du Fonds de la Recherche sur la Pomme de Terre. Pp. 118. 135 francs. Rapport Annuel, 1951. Pp. 196. (Bruxelles: Institut pour l'Encouragement de la Recherche Scientifique dans l'Industrie et l'Agriculture, 1952.) [37

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Vitreosil Hydrogen Discharge Lamps. (Ref. No. LL/14/5/52.) Pp. 4. (Wallsend: The Thermal Syndicate, Ltd., 1952.)

Mullard Ultrasonic Soldering Equipment. Pp. 8. (London: Mullard, Ltd., 1952.)

Astronomy, Mathematics, Physics. (Catalogue 19.) Pp. 64. (London: B. Weil, c/o National Provincial Bank, 9 Market Place, N.W.11, 1952.)

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DEVELOPMENT OF BACKWARD COUNTRIES

PROF. A. V. HILL'S presidential address to the British Association should dispel any facile optimism as to the ability of science and technology to increase the world's food supplies—or to develop world resources generally—sufficiently rapidly to overtake the demands of a rapidly increasing world population. Whatever view is taken of the possibility of controlling the expansion of population, there can be no doubt as to the urgency of expanding as rapidly as possible, and with regard to long-term at least as much as to short-term needs, the world's food supplies, and developing world resources with equal regard to such long-term requirements rather than immediate exigencies. So far as Britain is concerned, when all that is possible has been done to improve the efficiency of food production and to remove waste—whether due to the destruction of crops in the field, or in transport or storage—the largest hope for increased production lies in the more backward countries. Only as the standards of cultivation are raised in those areas and the fullest use is made of available knowledge can there be any hope of raising the standards of living in those countries, or of making any contribution to the needs of the rest of the world.

Two recent broadsheets by Political and Economic Planning dealing with technical assistance have thus appeared at a time when Prof. Hill's address has directed general attention to a most important topic. The first of these broadsheets (No. 346) deals with agencies and programmes ; the second (No. 347) with policy and method. Both, however, are in direct sequence of an earlier broadsheet (No. 340. "The World's Food." April 7, 1952), which itself continued a discussion initiated in "Prospect of a Decade" (No. 328) and "The Strategy of World Development" (No. 327). They reiterate warnings already given, and bring to the examination of these problems the same sense of urgency and realism as characterizes Prof. Hill's address.

Much of the broadsheet "The World's Food" was occupied by a discussion of three recent books on world population and food supply which have attracted considerable attention. The view is accepted that unless starvation and malnutrition are to become very much more serious even than they are now, food supplies in many parts of the world will require to be more than doubled in the next fifty years. The earlier estimate, in "Prospect of a Decade", that less than three per cent of the earth's acreage is more or less satisfactory for the support and shelter of mankind is now regarded as too pessimistic ; but in reviewing the possibilities of increasing the area of land devoted to food production or increasing the production from a given area of land, P E P emphasizes the strong temptation in the present situation to farm for the greatest immediate yields, at the risk of reducing the fertility of the soil and exposing it to erosion.

If the human race continues to multiply at the present rate, catastrophe will only be avoided if methods of cultivation are used which, far from destroying the fertility of the soil, maintain or even increase it. Nor will it be possible to countenance the continuance of laws and customs regulating inheritance which in some countries lead to a fragmentation of land holdings and the prevention of efficient methods of cultivation. It is true that a limited number of people from the over-crowded areas of the world could feed themselves better if they were allowed to migrate to much less intensively settled areas; but apart from this, more food for the poorer people of the world means, for all practical purposes, more production in the areas where they live.

Here we are led to the question of technical assistance. Such increased production depends at first on the technically advanced countries providing the cost of such assistance and equipment. They must also assist by teaching improved methods of cultivation. Moreover, there is the question whether, even by such improved methods, sufficient food can be grown for all the peoples of the world without decreasing the land available for crops which are wanted by advanced countries as a source of raw materials for their industries. As population increases, it may become increasingly difficult for the richer countries to maintain or improve their standards of living without depressing people in other parts of the world below the subsistence level.

It is, of course, possible that the amount of cultivable land or the yields which can be obtained without exhausting fertility will prove to be considerably greater than can be safely predicted. Even if, however, the rate of growth in the world's population decreased sharply and sooner rather than later, or the use of novel sources of food gave greatly increased supplies, it is improbable that a clash of interests between the richer and the more backward parts of the world will be entirely avoided. Plans for technical assistance must, as P E P wisely insists, take full account of such possible conflict if they are to be realistic and effective, and must aim at reducing the clash or tension as much as possible.

The importance of this factor is well brought out in the two broadsheets on technical assistance. The first recognizes that some such areas may be able to develop their economy from their own resources, provided they can secure the highly trained men from outside to teach the new techniques and secure their adoption, and emphasizes the multiplicity of agencies at present available to supply such assistance. Even so, the importance of confidence is not obscured. Unless the government of the backward area can be trusted to honour its undertakings, the schemes break down, and men of integrity and ability are unlikely to be forthcoming.

Technical assistance provided through the specialized agencies set up under the United Nations, which is co-ordinated through the Technical Assistance Board, is provided only to, and at the request of, the government concerned, though many of the governments needing technical assistance require also to be helped to formulate reasonable requests. Such technical assistance is not to be used as a means of economic or political interference, and it is also laid down that the experts provided should possess some understanding of the needs, aims and social and cultural background of the country they are sent to assist. Normally, also, governments requesting assistance are expected to assume responsibility for a substantial part of the cost of the technical assistance provided.

Under such international agencies, 797 experts were recruited for under-developed countries by the end of 1951; of these, 271 were provided through the Food and Agriculture Organization, 155 through the World Health Organization, 109 through the United Nations Educational, Scientific and Cultural Organization, 65 through the International Labour Organization and 32 through the International Civil Aviation Organization. There are no figures to indicate the distribution of experts by activities or areas; but besides the technical assistance afforded in this way there is also that provided through the bilateral programmes of individual advanced countries, such as the United States Point Four programme and the British schemes promoted by the Colonial Office. Thirdly, there are the regional agencies and programmes exemplified by the Colombo Plan Council for Technical Co-operation, the Pan-American Union and the Inter-American specialized agencies, and the regional economic commissions for Asia and the Far East, and Latin America, set up by the Economic and Social Council of the United Nations, though the latter regional commissions have much broader functions as well.

By January 1952, under the Point Four programme, general agreements had been made with more than thirty governments, and some 619 United States technical experts were in the field; this figure ha[illegible] risen to 972 in thirty-three countries by June 30, 1952 Further, at the end of 1951, some 372 persons fro[illegible] other countries were receiving training in the Unite[illegible] States under the Technical Co-operation Administration. Besides the 35 million dollars appropria[illegible] for the Point Four technical assistance programm[illegible] the year ending June 30, 1951, the United States [illegible] contributes to technical assistance through such ot[illegible] means as the Fulbright Training Scheme, the Rockefeller Foundation and the Near East Foundation.

No comprehensive account of British technical assistance in the Colonies is available, and although the P E P broadsheet estimates expenditure on thi[illegible] as approaching £8 millions for the year endin[illegible] March 31, 1952, no estimate is given of the demand made for staff. No such estimate was attempted, it may be recalled, in the House of Lords debate on this question last May, when Lord Milverton quoted a figure of 150,000 for the annual output of trained men in the Commonwealth centres of South and South-East Asia. Under the Colombo Plan, however, only 45 out of 177 experts requested were secured in 1951, and only 309 trainees were placed out of 781 proposed. The Plan set a maximum of £8 millions, for technical assistance to be given in the three years from July 1, 1950; but by the end of 1951 expenses and commitments totalled no more than £400,000, and in general the Colombo Plan Council has concentrated on the supply of those types of technical assistance which are not available from other sources.

The first of these broadsheets thus illustrates the need for co-ordination between the numerous agencies concerned with technical assistance—a need which is fully recognized. Of requests for 242 experts made under the Colombo Plan up to the end of 1951, 65 were withdrawn, and out of 833 requests for places for trainees, 52 were withdrawn, mostly because the requests had been met through other channels. The fourth report of the Technical Assistance Board stressed the need for avoiding duplication of effort and competition between the programmes which recruit experts and use training facilities in the same countries. "Wide divergencies in the salary scales and allowances of experts or stipends of fellows, and notable differences in the contributions expected from under-developed countries to the local costs of projects under the different programmes can," the report observes, "seriously embarrass and slow down operations."

The Technical Assistance Board is endeavouring to mitigate the effects of any such competition by arranging exchange of information on administrative practices between the various bodies concerned; but there is general agreement that the main task of co-ordination must be undertaken in the under-developed countries themselves. Here, especially, the giving of technical assistance is bound to be a matter of considerable delicacy. In some under-developed countries, P E P frankly points out, economic progress may be impossible while the existing methods (or lack of methods) of government and tax collection remain. Such countries may be said to need technical assistance in reforming their government organization; but they may not welcome it, and meanwhile their imperfect standards hinder alike the co-ordination of technical assistance and the recruitment of experts. The latter, as the first annual report on the Colombo Plan emphasized, is by far the most difficult part of any scheme for technical co-operation.

To secure the services of the right kind of men is probably the most important single factor in the success of technical assistance. To this factor this second P E P broadsheet gives the attention it deserves, though the analysis is qualitative rather than quantitative. P E P does not consider the relation between what it terms the present 'infantile' demands of the technical assistance programmes for personnel and the shortage of scientific and technical man-power already existing in the United States and in Great Britain, for example. A present total of 2,500 or more experts is by no means a negligible drain on man-power resources, even if it were not expected to grow considerably.

If, as is rightly emphasized, the under-developed countries are insistent on demanding able men of established reputation and, at the same time, it is desirable that the experts supplied should be not only technically competent, but also able to apply their knowledge in the circumstances of an under-developed country or train people of very different backgrounds, it must be remembered that for such men there may be a great demand. Remunerative posts are likely to be available in their own countries, and it is not easy at best to induce them to transfer to the comparative discomfort of the backward areas. Some sense of vocation or call to disinterested service may be an essential motive, and undoubtedly would be the ideal. Integrity and tact, in fact, are as important as skill and ingenuity, for if technical assistance is to achieve its purposes, a new attitude of partnership must be fostered.

Political and Economic Planning has done well in this broadsheet to stress the critical importance of the technical expert and the need for careful training as well as selection, and it is welcome news that the Technical Assistance Board of the United Nations is studying methods of briefing experts both on the technical aspects of their assignments and on the social and economic conditions of the countries to which they are to be sent. The Institute of Social Studies, established by the Netherlands Universities through the Foundation for International Co-operation, also gives training and conducts research in matters relevant to technical assistance.

There are other factors which bear on this question of obtaining the right type of technical expert. The good conditions of service which it is essential to offer are related to the policy of requiring technical assistance to meet certain local costs. While this is sound from the point of view of stimulating interest and responsibility on the part of the receiving countries, such a policy can cause real hardship. One possible suggestion mooted in the P E P broadsheet is to institute some sort of deferred salary scheme. This might mitigate some of the disparity in standards of living, but admittedly it might fail to attract the very men whose assistance is most desired.

Insufficient experience is yet available for a sound judgment on such points as these. Other thorny problems are provided by the supply of equipment and of capital for development, while even more difficult are those that arise in regard to priorities and the balance of programmes. Officially the aim is still to provide assistance to all countries which request it, while allowing each country the final decision on the purposes for which it requires assistance. Nevertheless, as requests for technical assistance outrun the resources at the disposal of the various agencies, the danger may grow that technical assistance will be spread too wide and thinly to do any real good anywhere.

These and other questions are faced realistically in these broadsheets, which make no attempt to disguise the dangers which may attend the attempt to distribute assistance wisely and altruistically rather than in response to pressure of any kind. On the whole, the survey leaves room for hope. Instances are cited to illustrate the far-reaching effects of quite small projects launched with imagination and conducted with sympathy by the right type of expert. The emphasis on quality in technical assistance is already justified by experience as well as by theory; but if the right schemes are to be selected and launched at the right level, if they are to be staffed by men and women of the calibre desired, and carried through to success with imagination and understanding, unceasing scrutiny and vigilance will be required.

Ultimately much must depend on the interest taken in technical assistance by the scientific man and technologist. Clearly any proposals for a Commonwealth or international technical service should engage the close attention of their professional associations, to ensure that satisfactory conditions of service are laid down. Clearly, too, if the demands which technical assistance makes on trained man-power in Britain and in other advanced countries are to be accepted, steps must be taken to ensure that the limited man-power available is not wasted on projects which offer little prospect of success, whether through political, economic or technical reasons. It is perhaps through imaginative and sympathetic selection of enterprises, rather than grandiose schemes for new international agencies with financial resources geared to military expenditure, that the backward areas will be able to develop the resources which will both raise the standards of living for their own peoples and minimize the dangers to which the demands of increasing world population expose the whole world.

STABILIZING SELECTION IN EVOLUTION

Factors of Evolution

The Theory of Stabilizing Selection. By I. I. Schmalhausen. Translated by Isadore Dordick. Edited by Theodosius Dobzhansky. Pp. xiv+327. (Philadelphia: The Blakiston Company, 1949.) 6 dollars.

ALTHOUGH I. I. Schmalhausen's book appeared in Russian in 1947, and in an American translation as long ago as 1949, it has received rather little attention in Great Britain, and it still seems worth while to review it. It is a ponderous work, written in a style which, one suspects, was even before translation heavy and repetitious, and the translator has not succeeded in making it easy to read. But the labour brings rewards. The book contains accounts of most of the recent experimental and theoretical work on the genetical mechanisms of evolution; but it is not in this that its main value lies: indeed, better summaries of this material will be found in the well-known monographs of Dobzhansky, Huxley and others. Schmalhausen provides rather fuller references than most such publications to recent Russian work, which is not so accessible, and this already gives his book certain distinctive usefulness.

The main value of the work, however, lies in the particular point of view which Schmalhausen has derived from his studies as an embryologist, and which differentiates him from most of the other recent writers on evolution. He makes a consistent attempt to envisage the evolving animal, not as a mere adult form, nor as an assemblage of genes, but as a developing being characterized by a certain norm of reaction to its surroundings. This leads him to emphasize the conservative role of selection. He lays stress on the distinction between 'dynamic selection', which brings about changes in the animals submitted to it by favouring certain new types, and 'stabilizing selection', which perpetuates the norm by eliminating deviants. He points out that stabilizing selection does not merely conserve the *status quo*; it will actually entrench the prevalent and well-adapted norm, rendering its development more stable and less responsive to disturbing influences. It would have made Schmalhausen's thought clearer if he had distinguished these two aspects, both of which are included in his use of the term 'stabilizing selection'; as Simpson has pointed out in a review in the *Journal of Heredity*, it is also used in still other different senses.

Schmalhausen directs attention to the importance of stabilizing selection as a mechanism for the evolution of adaptations. He suggests that an originally variable but adaptive response to an environmental stimulus may become stabilized and will then eventually arise autonomously—that is, by heredity. Owing to the lack of precision of the general phrase 'stabilizing selection', it is not easy to make quite certain how Schmalhausen envisaged the passage from the 'acquired' to the 'inherited' status of the character. Sometimes he seems to be thinking along the lines of the theory of 'organic selection', suggested some fifty years ago by Baldwin, according to which an adaptive environmental response acts by enabling a species to occupy an otherwise unsuitable niche until such time as a mutation turns up which endows it with a hereditary adaptation. In other places he seems to imply, but perhaps never quite clearly states, what is surely the more fruitful suggestion, that if a response to an abnormal environment becomes stabilized in the sense of being rendered less susceptible to disturbing influences, this means that it will be less easily abolished when the abnormal environmental influence is removed, and will in this way pass from being dependent on the environment to being relatively independent of it. Similar ideas were put forward in a short article by me, using rather different terminology, at about the same time as Schmalhausen's book first appeared; but in this latter work they have received for the first time a full-length discussion against the background of the relevant embryological, genetical and evolutionary facts.

C. H. WADDINGTON

PROBLEMS AND POSSIBILITIES IN FOOD TECHNOLOGY

Advances in Food Research

Vol. 3. Edited by E. M. Mrak and George F. Stewart. Pp. xii+518. (New York: Academic Press, Inc., 1951.) 9.50 dollars.

THIS, the third volume of "Advances in Food Research", presents monographs on ten subjects. References, which total about fourteen hundred, usually bring information up to 1950; early work, however, is not neglected.

Two papers relate to discoloration of foodstuffs. M. A. Joslyn and J. D. Ponting deal with enzyme-catalysed oxidative browning of fruit products, which may be a serious problem to the manufacturer when fruit requires peeling or slicing. The varied enzyme systems involved are discussed, and suggestions for controlling the trouble in manufacture are put forward. The well-known 'browning' reaction which discolours products such as condensed milk is considered by J. P. Danehy and W. W. Pigman in an article on reactions between sugars and nitrogenous compounds and their relationship to certain food problems. The aldehyde–amine reaction is followed from its simplest form to the production of melanoidins and of protein-saccharide compounds. It is suggested

The [illegible] tive, and the printing and product[illegible] The use of regular hexagons for benze[illegible] to be commended. Only one formu[illegible] l as in error—that of terylene (p. [illegible] ersonalities of organic chemistry are [illegible] brief biographical footnotes that accom[illegible] st mention of a "named reaction", etc. The [illegible] appendix on the pronunciation (American a[illegible]) of organic chemical words which is scarcely necessary if the text is to be used in conjunction with a lecture course.

A chapter devoted to organic peroxides, autoxidation and antioxidants is a commendable innovation, while the chapter on organometallic compounds contains an account of the newer developments in organosilicon chemistry. The chapter on stereoisomerism contains an admirable introduction to the topics of absolute and relative configuration. The description of the boat and chair conformations of *cyclo*hexane as *cis* and *trans* forms (p. 562) is deprecated. The *cis–trans* terminology was introduced to describe the isomerism, about an ethylenic bond and within a single plane, exemplified by maleic and fumaric acids. The subsequent extension of this terminology to describe the isomerism in three dimensions of disubstituted *cyclo*alkanes, etc., was unwarranted, but has become sanctioned by long usage. The further extension of this terminology to include the boat and chair conformations of *cyclo*hexane would confuse fundamentally different phenomena and would seriously weaken the value of established *cis–trans* usage. This is a criticism of a point of detail, however, and the book as a whole can be warmly recommended as a reasonably priced text-book of organic chemistry for students in British universities. S. H. HARPER

LABORATORY TECHNIQUES IN THE TESTING OF MILK

Milk Testing

The Laboratory Control of Milk. By Dr. J. G. Davis. Pp. 260. (London: Dairy Industries, Ltd., 1951.) 15*s*.

THIS book is described in the preface as a "practical manual for the bench worker", but many, including the reviewer, will no doubt also keep it as a ready form of reference on all dairy subjects where laboratory technique of a specialized nature is required. The manual is not merely a collection of methods, for Dr. J. G. Davis has given the reader the benefit of his many years of experience both as a practical chemist and bacteriologist, and also as a technical director of one of the largest dairy companies in Great Britain. The methods for the control of the quality of milk are therefore one of the book's main purposes. Many of the methods embodied in British Standards have been quoted *in toto*. Since these are the result of collaborative study by dairy chemists, public analysts and independent analysts, they can be accepted as authoritative. Dr. Davis can quote from personal knowledge of the many discussions and tests which preceded the formulation of these methods, since he is a member of long standing of the relevant committees of the British Standards Institution.

Dr. Davis has described a number of interesting personal observations which may be new to the reader; for example, the experience of a milk having a 'disgusting' odour which changed to that suggesting mushrooms in a few hours, and which finally vanished completely. It is to be hoped that the bench worker will profit from the many references in the text, for these are a mine of information for the willing searcher. How many, however, will realize the possibilities of Meihuizen's oven, or trouble to look up the reference when told on p. 103, "For a description of an oven designed for the determination of moisture see Meihuizen (1929)"? Several tobacco laboratories and my own laboratory have adopted this oven, which passes evenly a forced draft of air heated, and if necessary dried, at a predetermined temperature over all the samples in a cylindrical oven, provision being made for evacuating if required.

Prominence has been given to the freezing-point depression as the most reliable guide to the presence of added water. Dr. Davis has given a well-reasoned and unbiased review of the literature on the subject, rightly pointing out the empirical nature of the Hortvet test. In his remarks on the use of sugar solutions for testing the accuracy of the thermometer, I could have wished that the operator in possession of a thermometer calibrated by the National Physical Laboratory were also told that, with the aid of such an instrument as a standard of temperature, sugar solutions could even more usefully be used as a check on technique. The false view is currently held in some quarters that the freezing-point depression of milk is measured in 'Hortvet' degrees. On the contrary Hortvet used, as his standard, thermometers calibrated by the U.S. Bureau of Standards on the International Temperature Scale. When an empirical test relies on accurate standardization of apparatus, technique, etc., and cannot be checked by any absolute method, it is of fundamental importance that the one factor which can be standardized independently, namely, the thermometer, should have the benefit of this standardization.

As might be expected from a bacteriologist of Dr. Davis's standing, particular attention has been devoted to modern bacteriological testing of milk. His summary of comparisons of various bacteriological tests in the form of table on p. 119 is the outcome of many years of careful observation. The resazurin test, of which Dr. Davis has made a special study, is described with a wealth of practical detail, and with many hints on the correct interpretation of results. An unusual feature of such a book is a chapter on the organization and equipment of a dairy control laboratory, and the author has obviously given careful thought to the suitable design of such laboratories. Many of his ideas could, in fact, usefully be employed in any modern analytical laboratory.

For a book so packed with data, the errors are comparatively few, and fortunately these will not worry the bench worker. On p. 31, fat is described as having a specific gravity of 0·93 per cent. While sodium thiosulphate is employed to break up any mercury-amino body in Kjeldahl determinations, it is scarcely necessary to use it with a copper–selenium catalyst (p. 59). The inexperienced laboratory worker might be confused by the wording in the directions for preparation of standard solutions, as in some cases this suggests that the reagent is added to a volume of water and not dissolved and the solution bulked to the volume (pp. 230, 231).

The book is profusely illustrated and contains such a mass of useful data that it will surely find an indispensable place in the library of all dairy laboratories and form a most ready guide to all analysts who have to test milk and its products.

J. KING

Encyclopedia on Cathode-Ray Oscilloscopes and their Uses

By John F. Rider and Seymour D. Uslan. Pp. vii+982. (New York: John F. Rider Publisher, Inc.; London: Chapman and Hall, Ltd., 1950.) 75*s.* net.

THIS impressive volume, in common with most Rider publications, is not an advanced textbook. It has been compiled for those users of oscilloscopes—students, teachers and others—who have had a limited training in electronics and who can profit by obtaining a thorough understanding of the principles involved in the design and application of an instrument that is nowadays one of the most important items of apparatus in the lecture room, laboratory and factory.

The first half of the book contains a thorough account of the construction of the cathode-ray tube and the design of the associated circuits, as employed in American commercial equipment. The British reader may find the continual reference to American types of cathode-ray tubes and valves rather disconcerting; but this is more than compensated for by the clarity of the exposition. The more advanced reader will notice that there is no reference in the chapter on time bases to the Miller type of circuit that is frequently used in British oscilloscopes, and that a description of the wide-band chain amplifier has been omitted. No doubt these omissions will be corrected in the next edition.

The second section of the book covers the main applications of the oscilloscope to the testing of radio receivers and transmitters and to the measurements commonly made in the laboratory and factory. These chapters are well illustrated with oscillograms showing the wave-forms due to typical faults in the circuits under test.

There is a long chapter illustrating the wave-forms of oscillations containing harmonics up to the sixth, and this should enable the reader to identify the various wave-forms he may encounter in his experimental work. The book concludes with a chapter giving the circuits and a brief explanation of each of some seventy commercial oscilloscopes of American manufacture.

Although a book covering such a vast subject as oscillography cannot contain details of every aspect, the authors have produced a volume that will prove to be of great value to those for whom it has been compiled. G. E. ASHWELL

Vorlesungen über Theoretische Physik

Band 4: Optik. Von Prof. Arnold Sommerfeld. Pp. xvi+390. (Wiesbaden: Dieterich'sche Verlagsbuchhandlung Inh. W. Klemm, G.m.b.H., 1950.) DM. 18.50.

THIS volume on optics follows the other parts of Sommerfeld's lectures on theoretical physics in its mathematical elegance and clarity, while never allowing the reader to forget the connexion of the mathematical problems with physical reality. The material is deliberately arranged in a somewhat unorthodox sequence. The theory of plane waves and plane interfaces (including refraction, reflexion and interferometers) is followed by relativistic theory and the optics of moving media. Dispersion theory is treated using the results of wave mechanics of the atom, and the section dealing with phase, signal and group velocity is of very convincing simplicity and completeness. Crystal optics is covered fairly briefly, but two full chapters deal with diffraction, one of the subjects to which Sommerfeld made decisive contributions. There is a short list of problems, mostly to derive generalizations of results mentioned in the text, and instructive notes on their solution.

In the review of earlier volumes (see *Nature*, 168, 887; 1951) I remarked on the desirability of having the series completed and of making a translation into English. Several correspondents have since informed me that the last volume is in course of publication, and that a translation is being prepared.

R. E. PEIERLS

The Apple and the Spectroscope

Being Lectures on Poetry designed (in the main) for Science Students. By T. R. Henn. Pp. xix+166. (London: Methuen and Co., Ltd., 1951.) 12*s.* 6*d.* net.

THOSE who devote their lives to the pursuit of natural science often realize how little they know of English prose and poetry, which contribute so much to the thought of people educated in the humanities. A few years ago, a group of young Cambridge scientists asked for instruction during the 'long vacation' in English literature and language. The series of lectures that was arranged proved very popular, and the lectures given by Mr. T. R. Henn as part of this course have now been published. The first eight chapters are about poetry, and an appendix contains the poems and passages examined in the text. Two chapters are entitled "Notes on a Background to English Literary History", with an appendix of authors and their dates. The concluding chapter, full of interesting reflexions and suggestions about reading, is accompanied by a list of works suggested for casual reading.

This delightful little book can be recommended to those who wish to know something of the qualities which distinguish good poetry and prose. It is full of interest in its matter and approach, while its consideration of the significance of words may prove of practical value to those who write scientific papers and lecture notes. There are some pleasing illustrations, and it is easy to see why the author's lectures to Cambridge scientists were so popular.

H. H. T.

The Bird Lover's Week-End Book

By Eric Hardy. (Week-End Library.) Pp. 444. (London: Seeley, Service and Co., Ltd., n.d.) 15*s.* net.

THIS "Week-End Book" is an ambitious volume, its author trying to cover a very big field. The first chapter on the bird-watcher's year is a lengthy review of the passing months as seen by the author and recorded in weekly notes. He then gives a key to bird identification under such headings as "What the bird looks like", "the bill", "upper parts" and so on. It will be gathered that the book is written for the amateur ornithologist, and the beginner at that. There is no doubt that the tyro will find it a real help.

The chapter on the bird-watcher's equipment contains much useful information on subjects varying from binoculars to bird-baths. Reference to subjects is here facilitated by their alphabetic arrangement. Bird haunts and bird holidays are among the topics dealt with, and there is a long chapter on "nicknames" of British birds. The reader wanders on through chapters on migration, British birds abroad, etc., and winds up with a glossary of the bird-watcher's terms. There is no doubt that the amateur ornithologist spending a week-end in the countryside will find this a helpful book. FRANCES PITT

PROPERTIES OF VITREOUS WATER

By Dr. J. A. PRYDE and Dr. G. O. JONES
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THERE are a number of analogies[1] between the structure of water and that of vitreous or liquid silica, and many suggestions exist in the literature to the effect that water (like silica) can exist in the glassy or vitreous state. Vitreous pure water has not previously been obtained in bulk (though aqueous solutions can often be supercooled into glasses), but very thin films of water in an apparently amorphous non-crystalline state well below 0° C. have been obtained in various ways—for example, by very rapid cooling in liquid air[2,3], or by deposition from the vapour on a surface cooled below about $-100°$ C. Burton and Oliver[4] showed that films formed by the latter method gave X-ray diffraction patterns typical of liquids and glasses. However, on heating, crystallization—or 'devitrification'—occurred, being complete at $-80°$ C. As reported by Brewer, Cwilong and Dobson[5,6], deposition of very thin layers of this 'vitreous ice' on the cooled thimbles of hygrometers is a common and unwanted occurrence in meteorological experiments when the thimbles are below about $-100°$ C.

The intention in the present work was to attempt to prepare sufficient vitreous water to allow some of its properties to be determined, especially its 'glass transformation temperature' T_g[7,8]. As shown in Fig. 1 (after Simon[9]), substances which form glasses show large discontinuities in first-order derivative properties such as the specific heat over a narrow range of temperature located by T_g. Below T_g the substance is conventionally called a glass, is not in internal equilibrium, and its first-order derivative properties are nearly identical with those of the crystal. Above T_g it is a (metastable) supercooled liquid, and its properties are continuous with those of the normal liquid above the freezing point. Of course, both as supercooled liquid and glass the substance is unstable relative to the crystal, and crystallization may occur at any temperature. For substances which form glasses, this is usually very slow except over a certain temperature-range, and if T_g is well below this temperature-range, as it is for most inorganic oxide glasses for example, it is possible to carry out real property/temperature measurements on the (metastable) equilibrium liquid over wide ranges of temperature well below the freezing point. (Sometimes, as with glycerol, devitrification is so slow at all temperatures that these measurements can be extended continuously down through the freezing point as far as T_g.) The many anomalous properties of water make such measurements especially desirable.

We must emphasize that in our experiments on water, carried out well below $-100°$ C., the temperature was always below that at which the rate of nucleation is a maximum for this substance. Here, high viscosity is the barrier to crystallization, and the onset of crystallization sets an upper limit of temperature above which the experiments cannot be extended. In the experiments of other workers on the properties of supercooled water in bulk between the freezing point and about $-20°$ C.[10], or on condensation in cloud chambers down to about $-40°$ C.[11], maintenance of the liquid state depends essentially on the absence of nuclei, and the onset of crystallization sets a lower limit of temperature upon the measurements. The properties of the liquid between about $-100°$ and $-40°$ C. seem to be almost inaccessible to experiment, although droplets of liquid 'dew' can be formed from the vapour within this range on certain types of clean surface and persist for a short time[12].

Experimental Methods and Results

In the first experiments, carried out by one of us (G. O. J.) at the Clarendon Laboratory, Oxford, in collaboration with Prof. F. E. Simon, attempts were made to produce quantities of the order of one gram of vitreous water by rapidly cooling in liquid oxygen a block of porous copper containing water held in a fairly fine state of sub-division (of the order of a few microns). (It was hoped that a substantial proportion of the pores might be free of freezing nuclei so that crystallization could not spread throughout the liquid.) The block and its contents could afterwards be quickly transferred to a vacuum chamber for controlled heating. On the first occasion, the heating curve showed a quite sharp decrease in slope, corresponding to a sudden increase in heat capacity, at $-147 \pm 2°$ C. As soon as this was obvious, the block was re-cooled to liquid-oxygen temperature and a new heating curve taken, again with the same result. We believe that these were real observations of the characteristic behaviour of the glass transformation, but cannot attach much importance to the actual estimate of T_g because of the rather fine state of sub-division of the water and the possibility that it contained impurities such as the products of reaction with copper.

Unfortunately, these observations could not be repeated. In all later attempts the water formed ordinary ice in the pores—as could be confirmed by observing the 'flat' in the heating curve at 0° C. It was suspected that the copper must now be 'seeded' by some particularly effective type of nucleus for crystallization, so new samples were used. A 'book'

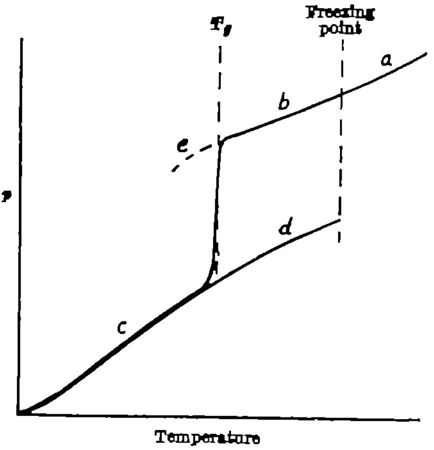

Fig. 1. Specific heat–temperature curves for a substance in the following forms (after Simon): (*a*) liquid, (*b*) supercooled liquid, (*c*) glass, (*d*) crystal, and (*e*) start of equilibrium (metastable) curve for supercooled liquid

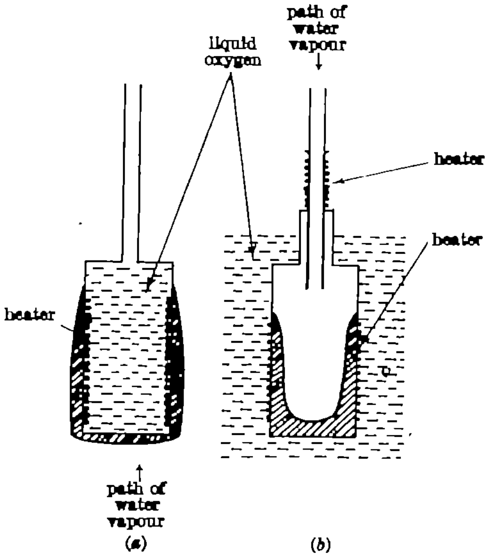

Fig. 2. Calorimeters used for measurement of thermal properties of vitreous water, showing method of deposition from water vapour

of nickel foil holding about a gram of water between its leaves was also tried, and many other variations introduced in the procedure (such as the use of stagnant liquid oxygen or nitrogen below their boiling points for more rapid cooling, and the application of strong heating in vacuum to attempt to destroy 'seeds' in the pores) without any further success.

In all subsequent experiments the method of deposition from the vapour was employed. The water was always double-distilled and freshly boiled before use. Fig. 2 shows two types of calorimeter used, and indicates how the temperature was maintained at that of liquid oxygen during deposition. The liquid oxygen could then be removed and the space surrounding the calorimeter evacuated for controlled heating. The advantage of type (*a*) was that the layer of water-substance, being on the outside, could be seen (it was noted that films prepared in this way were transparent at small thicknesses but imperfectly so at greater thicknesses). Type [illegible] was, however, more suitable for quantitative measurements because it enabled a known quantity of water to be deposited, and to be retained throughout the experiment; for greater accuracy in measurement, a radiation shield was used in conjunction with this calorimeter.

No behaviour characteristic of the glass transformation could be detected in any of a large number of such runs (some extending upwards from about −210° C.); but in every case an evolution of heat began when the calorimeter reached −129 ± 1° C., causing a rapid rise in temperature. This was clearly an irreversible phenomenon, since it was not repeated after re-cooling. We attribute it to crystallization into ordinary ice (ice I)—a process which at this temperature would, of course, be irreversible—because no further irreversible evolution or reversible absorption of heat occurred until the temperature reached 0° C. This is of interest in view of reports[12,13] that another form of ice (with cubic symmetry) can be formed by deposition from the vapour on cold surfaces.

Crystallization at −129° C. was observed twenty-nine times in all. The quantity of heat evolved per unit mass of water varied from run to run between about 2 and 7 cal./gm., smaller values being observed with thicker layers. The specific heat of the water-substance below and above the temperature of the irreversible crystallization was found to be the same, within the possible errors of measurement (a few per cent), and agreed to the same degree of accuracy with known values for crystalline ice at the same temperatures.

As a control, the whole experiment was performed twice with pure ethyl alcohol, which is known to form a glass for which T_g is −178° C.[14]. It was found that a glass was obviously formed by deposition from the vapour at the boiling point of liquid oxygen, and the measured values of T_g, and of c_p below and above T_g agreed well with the published values (this is of interest because a glass deposited from the vapour at a given temperature might be expected to differ from one formed by supercooling the liquid to the same temperature). Crystallization occurred at −150° C. (the normal freezing point is −117° C.) with the evolution of a much greater quantity of heat than observed by us with water.

Discussion of Results

Crystallization. The remarkable constancy of temperature at which crystallization occurred might at first suggest the existence of a real transition point at this temperature. In fact, the change was found to be irreversible; indeed, a reversible transition from a low-temperature to a high-temperature modification cannot be accompanied by an evolution of heat. (The existence of characteristic temperatures for irreversible crystallization in particular circumstances has frequently been reported[5,8,10,11,15], but has apparently not been observed at temperatures below that at which the rate of nucleation is a maximum. It is normally thought to be due only to the fact that rates of crystallization varying very rapidly with temperature may cross the 'time-scale' of observation over a very narrow temperature range.) The actual temperature (−129° C.) is somewhat lower than the values (−90° to −80° C.) usually reported for the temperature at which crystalline ice appears during the heating of layers of 'vitreous ice' on the thimbles of dew-point hygrometers as used for observations on very dry air. However, as pointed out to us by Dr. A. W. Brewer, of the Clarendon Laboratory, Oxford, these layers are usually only of the order of molecular thickness and the ice cannot be seen until it has collected (by migration over the surface) into much thicker localized aggregates; it is not surprising that a higher temperature is required for an effective rate of migration.

The estimates of the latent heat of freezing at −129° C. varied from one run to another, as we have seen, being of the order 2–7 cal./gm. Before we can judge whether these are reasonable values, we have to know something of the form of the specific heat/temperature curve for liquid water below 0° C.—a difficult extrapolation since the specific heat has a minimum at about 35° C. and is still increasing with falling temperature at 0° C. Making use of Simon's suggestion[8] that the curve of specific heat against temperature for the equilibrium (metastable) liquid should be drawn to the origin in such a way that the entropy at absolute zero becomes the same as that of the crystal (see Fig. 1), we have a means of 'normalizing' the hypothetical curve. It is reasonable to assume also that the specific heat of the liquid does not fall below that of the crystal. Drawing the two extreme curves which, while meeting these conditions, give the largest possible difference between the two estimates that they provide of the latent heat at $-129°$ C., we arrive at values of about 20 and 40 cal./gm. If the liquid is, in fact, not in its metastable equilibrium state but is a glass at this temperature, the latent heat of freezing would be increased. We are forced to conclude, therefore, that the samples of water in our experiments were only partly vitreous, being, in fact, like badly devitrified pieces of glass (this was indeed their appearance). This conclusion follows rather obviously also from the fact that the amount of heat evolved per gram varied from one run to another, being much smaller than that observed for alcohol, and apparently depending on the thickness. It is known that the result of deposition from the vapour is very sensitive to the condition of the surface, and it would be expected to depend also on the speed of deposition. The 'latent heat of sublimation' to be dissipated is very large, and with a growing film of glassy substance of very low thermal conductivity the danger of local crystallization at 'hot spots' would increase. Better results might be expected if it were possible to deposit layers over very much longer times than those (of the order of hours) employed by us.

Glass Transformation. If we were to accept the results of the present specific heat measurements at their face value, we should conclude that T_g was not below the temperature at which crystallization sets in (since c_p for the deposited layer is the same as that of the crystal and shows no discontinuity) and was therefore impossible to locate exactly. It can scarcely be much above this temperature, and the two temperatures must therefore be quite close to each other, since a certain amount of mobility is possible at T_g—the temperature at which the adjustments necessary to reach configurational equilibrium can occur rapidly. Indeed in silica—structurally the closest copy of water—it is very difficult to conduct experiments in the transformation region because of devitrification. There is an element of doubt in our conclusion because it seems clear that only a fraction (say, between one-twentieth and one-third) of the material in our samples was actually vitreous, and it is by no means certain that the discontinuity in specific heat of the vitreous part could have been detected.

Fortunately we have a confirmatory estimate from the work of Kobeko, Kuwshinsky and Shishkin[16]. They pointed out that water as an impurity raised the value of T_g of ethyl alcohol ($-178°$ C.) but lowered it in the case of glycerol ($-88°$ C.). The value of T_g for water itself would therefore probably lie between these two temperatures. Moreover, T_g for pure hydrogen sulphate was the same as for a mixture of this substance with water of composition $H_2SO_4.2H_2O$. They therefore proposed this value, $-127°$ C., as T_g for water. Kobeko had previously shown[17] by several examples that when mixtures of two substances in any proportions could be obtained as glasses, the value of T_g for the mixture varied smoothly and monotonically with composition, and we do not find any difficulty in accepting this estimate as being at least nearly correct. (There is no direct relation between the phenomena of glass transformation and crystallization, and no reason to doubt the reality of T_g for a substance because it cannot easily be obtained as a glass.) Our own estimate ($-147°$ C.) from the first experiments with porous copper is lower, as would be expected if the water contained impurities, in themselves not glass-formers. It seems reasonable to assume that T_g for water lies at any rate in the range $-150°$ to $-125°$ C.

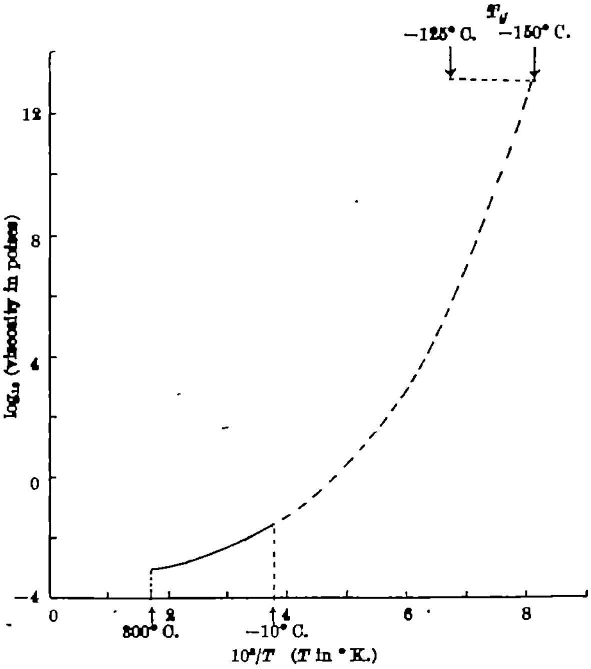

Fig. 3. Viscosity-temperature curve for water, extrapolated to T_g

Structure of Water and Mechanism of Viscous Flow. The above estimate of T_g leads to certain conclusions of interest. It is a quite general observation[8,18] for all glasses that the viscosity at T_g is of the order 10^{13} poises. This enables us to locate another part of the viscosity/temperature curve for water, as shown in Fig. 3, where $\log_{10}$ viscosity is plotted against reciprocal absolute temperature. The short full line represents values obtained[18] in the range $-10°$ to $300°$ C., and the broken line is an extrapolation drawn to meet the value corresponding to 10^{13} poises at $T_g = -150°$ C. The slope of this curve is usually regarded as an 'activation energy', and it will be seen that its value, which increases from about 1·5 to 5 kcal./gm. mol. over the temperature-range covered by the experiments, must continue to increase very

Substance	Freezing point (° C.)	T_g (° C.)	$L_{vap.}$ at boiling point (kcal./gm. mol.)	$E_{vis.}$ at freezing point (kcal./gm. mol.)	$E_{vis.}$ at T_g (kcal./gm. mol.)	Source of estimate of $E_{vis.}$
Water	0	-150 to -125	9 7	5 1	>16	Present work
n-Propyl alcohol	-127	-172	9 8	9·7	20	Graphical estimate from published results[24]
iso-Butyl alcohol	-108	-155	10·3	11 2	22	,, ,,
Glycerol	17	-88	18*	12 7	29	,, ,,
Glucose	146	30	—	19	125	Recent unpublished results[25]. See also ref. 26.
Silica	1,713	1,200	—	—	175	See ref. 22

* Estimated from vapour-pressure data

considerably as the temperature falls further. We estimate its value at T_g as greater than 16 kcal./gm. mol. (a minimum figure obtained by a linear extrapolation between 0° C. and T_g); it will be noted that this is considerably greater than the latent heat of evaporation (9·7 kcal./gm. mol. at 100° C.).

It is well known[20-22] (see also table) that the activation energy for viscous flow, $E_{\text{visc.}}$, is large and increases continuously with falling temperature for liquids which are able to form glasses. These liquids are characterized by low co-ordination and markedly 'structural' nature and owe their coherence to strongly directed bonds such as the 'hydrogen bond' (in water, alcohols, etc.) or the ionic-homopolar Si-O bond (in silica). As shown by A. G. Ward[20], the increase of $E_{\text{visc.}}$ with falling temperature implies an increase in structural character—a change actually observed by Bernal and Fowler[23] in X-ray studies on water.

Values of $E_{\text{visc.}}$ greater than the latent heat of evaporation ($L_{\text{vap.}}$) do not appear to have been reported previously, on account of the difficulty of measuring $E_{\text{visc.}}$ for low-temperature glasses and $L_{\text{vap.}}$ for high-temperature glasses. Fortunately, however, the viscosities of three alcohols have been measured nearly to T_g[24], and in the accompanying table we list our own estimate, made from the published graphs, for $E_{\text{visc.}}$ at T_g for these liquids, together with values of $L_{\text{vap.}}$ and some other data of interest.

It will be seen that in *n*-propyl alcohol, *iso*-butyl alcohol and glycerol, as in water, $E_{\text{visc.}}$ can greatly exceed $L_{\text{vap.}}$ at low temperatures (the variation in $L_{\text{vap.}}$ with temperature is relatively small and does not affect the argument). This supports the suggestion of various authors[20,21,27,28] that the flow process in these liquids involves the breaking of strongly directed bonds rather than the movement of molecules. (In 'normal' liquids such as the metals, 'rare gases', non-polar organic substances and ionic salts, $E_{\text{visc.}}$ is always much smaller than $L_{\text{vap.}}$—usually about 1/3–1/4 of its value, or 1/8–1/25 in metals.) In the case of silica, $E_{\text{visc.}}$ at T_g is about twice the energy of the only type of bond present, the Si-O bond (~90 kcal./gm. mol.), and for water and these alcohols it is 3–4 times greater than the strength of the hydrogen bond from hydroxyl groups (6–8 kcal./gm. mol.) which is assumed to be responsible for their cohesion[20-31]. In glucose, which has a complicated molecule containing five hydroxyl groups, the value of $E_{\text{visc.}}$ is remarkably high.

Conclusion and Summary

In spite of the great difficulty of producing completely vitreous pure water, there is evidence that under favourable conditions water forms a glass, with the transformation temperature T_g lying between −150° and −125° C. The main implication of this conclusion is that the increase in structural character of water with falling temperature, already detectable above 0° C., must continue to a very marked extent as the temperature is lowered still further. As in other liquids containing directed bonds, the value of activation energy for viscous flow can exceed the heat of evaporation and the strength of a single bond by a large factor.

An unexpected result is that specimens of glassy water containing varying proportions of crystalline ice complete their crystallization (apparently into ice I) precipitately when the temperature is raised to −120° C.

We acknowledge the interest and collaboration of Prof. F. E. Simon, of the Clarendon Laboratory, Oxford, in the early stages of this work, and later the help and facilities given us by Prof. H. R. Robinson, at Queen Mary College, London, and the careful work of Mr. W. A. G. Baldock in making the calorimeters used in the experiments. We are indebted to the Central Research Fund of the University of London for the loan of apparatus, and to Imperial Chemical Industries, Ltd., for a grant-in-aid.

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FACTORS INFLUENCING CHANGE IN HUMAN BEHAVIOUR

A FULL morning's session at the recent Belfast meeting of the British Association was devoted to the problems of "Resistance to Change", more especially resistance to the application of well-founded scientific knowledge in industry and agriculture. In the first half of the morning some of the more general questions were discussed by Section J (Psychology); in the second part of the proceedings, this Section joined with Section M (Agriculture) in a symposium on resistance to change in farming. Most of the speakers were more particularly concerned with the problems encountered by research, educational and advisory services.

Opening the general subject, Prof. C. A. Mace (Birkbeck College, London) developed the thesis that much of what is called 'resistance to change' is, in fact, failure in the process of communication. The sources of failure are not entirely at the receiving end; some are in the process of transmission. Quoting Prof. Georges Friedmann's observation that "there has been no technological revolution in most of the professions", Prof. Mace went on to explore the prospects of such a revolution in the educational and advisory services. This revolution is coming, he said, through the use, not of precision machines, but of precision techniques. He cited the B.B.C. "Audience Research", a recent report on "Foremanship Training" by A. J. Flook, and a study of "Human Relations Training" by P. Castle, of the National Institute of Industrial Psychology. The essential features of these new techniques of 'precision education' are threefold: the communication, instead of being diffused, is directed to a selected target audience; it is adapted in content and form to actual needs empirically ascertained; and by suitable 'feed-back' devices the impact of the communication is accurately assessed. As the word 'broadcasting' has come to be almost a synonym for 'mass communication', broadcasting the thing is "becoming a technique for focusing a beam of specific intelligence upon a particular public with particular ends in view". The importance of these developments lies in the generality of the principles involved. These principles apply to every form of communication from the poster as simple as "Mind how you go" to the whole curriculum of studies for a B.Sc. degree. They apply to every form of advisory service. Advisory services are essentially concerned with combating resistance to change; but sometimes they themselves are resistant to suggestions for change in the methods they employ. They themselves need to be serviced by advisory research in their problems of communication.

Passing reference was made in the opening paper to certain critical phases in the life of an individual at which variations occur in his "coefficient of resistance to change", and one of these phases was the subject of the second paper, in which Miss M. Woodward (Bedford College, London) reported evidence of "changes in social participation following the birth of a child". In the respects considered, this is a more important event than that of marriage. A survey was made of the membership of societies, the informal relations with friends and working associates, and the leisure pursuits and the interests of 186 women attending a clinic in a dormitory area of London. Impressive facts were adduced regarding the general decrease in a mother's social activity outside the immediate family circle after childbirth. The consequent sense of isolation and increased dependence on the husband for the satisfaction of social needs may, it was suggested, place a serious strain upon marital relations. The findings in this survey acquired additional significance in the context of the symposium. Later speakers were to stress the importance for the diffusion of change of social participation in the life of a group larger than the immediate family circle, and Miss Woodward's observations may contribute to the explanation of the characteristically conservative influence of family life as such.

In the second half of the morning's session, Mr. J. M. Mogey (director of the Oxford Pilot Social Survey) introduced the discussion of resistance to change in agriculture by a historical and anthropological analysis of factors affecting rate of change in the agriculture of Northern Ireland. Owing to physical and historical conditions, Northern Ireland is a country of small-scale farming, and one in which the basic social unit is the farming family. These units have in part been informally organized in clusters of from ten to twelve farms co-operating on the basis of ties of kinship and proximity. New ideas and techniques filtered through to the ordinary farmer only in so far as they fell within the economic potential of the single small farm. In the face of resistance arising from a tradition of informal co-operation, government action in wage control and the promotion of marketing schemes has had only a limited effect. The resistance to official action has been greatest in respect of agricultural education. There has been a failure to work through the informal groups of the countryside. The conclusion was drawn that in a community of small owner-occupiers improvements in farm techniques must be demonstrated by equals. A raising of the level of skill can be expected only through local experiments on the basis of a complete farm. A few successful farms assisted by an advisory service scattered over the countryside and open to visits from neighbours, with the farmer himself explaining the methods employed, would arouse interest and create a desire for more instruction.

Prof. R. Rae (director of the National Agricultural Advisory Services) followed with a discussion of the farmer's attitude to technical advances. He placed high among the factors that influence the farmer's attitude the prospect of reasonable profit from the business of farming. The success of an advisory service depends on the general standard of education of the farmers, and on the introduction of agricultural science to young men in the formative period of their lives. He, too, stressed the importance of demonstrating new methods on farms open to visits from neighbours. He thought that there is no section of the community more receptive to new ideas than the top-grade farmer. In the lowest grade little can be done. In this group there are too many who suffer from the combination of two disabilities old age and lack of experience. It is the middle group, the majority, that offers the greatest promise to the advisory services. Farming is essentially a complicated business, and the farmer must be a business man able to organize labour, and so something of a psychologist. In addition, he must be something of an engineer and an economist and must also be a craftsman; and it is an advantage for him to have some understanding of agricultural science. It is this complexity of requirements which constitutes the reason for the existence of advisory services.

The session concluded with a paper by Dr. Roland Harper (University of Leeds) on psychological aspects of the application of new knowledge and techniques in agriculture. Dr. Harper was concerned with the problems arising in passing scientific knowledge "down the line" from the research laboratory to the farm. The expression brought out the close analogy between the problems of an advisory service and those of the management consultant in promoting communication from higher management to the worker at the bench. It is mainly the psychological factors, Dr. Harper suggested, which prevent the established results of agricultural research from being applied with expedition. He proceeded to review some of the more relevant psychological studies—Lewin's investigation of factors influencing food habits, Ryan and Gross's study of the diffusion of seed corn in Iowa, and Wilkening's "socio-psychological approach to the study of the acceptance of innovations in farming". Expanding the survey, Dr. Harper elucidated some of the general psychological concepts relevant to the problem—motivation and attitudes, social participation and the cognitive aspects of communication. He concluded with some practical suggestions. His analysis reinforced the arguments of previous speakers for operating through informal groups. Much more, he thought, could be done through the guided discussion group. Special emphasis should be placed on means for assessing the success or failure of the methods used by advisory services. He advocated co-operative research in Great Britain similar to that which he had cited from the United States. He suggested that greater attention should be paid to the attitudes of farmers towards new procedures, and very special attention given to their "uninhibited reactions to our present advisory services".

Contributions to the discussion from the floor were, very appropriately, in the form of such uninhibited reactions of the practical farmers themselves. They reinforced what Dr. Harper and others had said regarding the importance of understanding the needs of those for whom advisory services are provided. It seemed clearly to emerge that scientific advice administered neat is apt to be ineffective. The scientific advisory officer needs to be not only a man of science but also something of a management consultant, competent to advise the farmer in costing the procedures suggested, and able to assist him in adapting general principles to the special circumstances and the particular economy of his farm. This conclusion was in close accordance with an opinion expressed in a conference on farm management organized by the British Institute of Management earlier in the year. A combined scientific and management advisory service is what is most needed. Such a service is of especial importance for the small farmers who comprise the vast majority of those for whom these services are provided.

There would appear, too, to be a substantial body of opinion which favours more detailed and intensive advisory services to a smaller number of farms in preference to a wider service spread more thinly. If it is indeed true that farmers learn more readily from practical demonstrations of successful farming than from the spoken or written word, a well-distributed selection of farms serviced in detail might be more effective than more diffused methods. It is agreed, however, that, whether focused or diffused, advice must be followed up by inquiries whether the advice has been acted on: If not, why not; and if so, with what effect? Follow-up provides the 'knowledge of results', the 'feed back', upon which success depends; and to make this a routine procedure may be more useful and less expensive than the organization of special attitude and opinion surveys of consumers' needs and reactions.

It is of interest to note that, although the symposium was especially concerned with advisory services to the farmer, the policies and principles discussed were of universal application. Regulations continue to multiply, but in all modern civilized societies there is a greater proportionate increase in the use of methods based on advice and persuasion. Advisory services are developing for agriculture, for building and most of the manufacturing industries, and the ordinary citizen has an immense variety of advisory services concerned with his health, his education, his vocational needs, his civil rights and responsibilities. In all these advisory services there is a need for better understanding of the sources of friction and resistance in the channels of communication from the laboratory or the field station to those who have to turn the results of scientific research to practical account.

This was the first joint meeting of the Agriculture and Psychology Sections in the history of the British Association; but with the continued expansion of research and advisory services, it may well be the precursor of many symposia on the psychological aspects of the technique of applying the methods and results of science to human affairs.

BIOLOGICALLY SIGNIFICANT MACROMOLECULES

A MEETING of Section B (Chemistry) of the British Association took place in Belfast on September 9 before a packed audience under the chairmanship of Prof. M. Stacey (professor of organic and biological chemistry in the University of Birmingham), the subject being "Biologically Significant Macromolecules".

Prof. Stacey spoke on "Polysaccharides of Medical Importance". In the normal functioning of the animal body the synthesis of macromolecules and their subsequent breakdown is of obvious importance. Continuous biological polymerization and depolymerization are essential in growth processes and provide a fascinating study especially in the polysaccharide field. It is perhaps not surprising that the medical applications of complex carbohydrates are becoming of increasing importance.

A good deal is now known regarding the so-called immunologically specific bacterial polysaccharides, especially in the Salmonella and Pneumococcus groups. In the pneumococcus the polysaccharides occur mainly on the surface of the bacterial cell as a capsule from which they may pass into solution in the growth medium of the organism. When they penetrate into the animal body, they stimulate the production of immune proteins, and *in vitro* in very high dilution they give rise to a specific precipitate on reaction with homologous immune serum. There are more than fifty of these specific polysaccharides, each possessing a different chemical structure, though their physical properties may be similar. A special characteristic is that many of them possess hexosamines and hexuronic acids, in addition to hexoses, as constituent building-units. During recent years, Prof. M. Heidelberger and his colleagues in the United States have shown that the pneumococcus polysaccharides free from protein will immunize human beings against infection, and a mixture of polysaccharides may be used as a prophylactic vaccine against pneumonia. The protection will last up to twelve months, and in large communities the incidence of many types of pneumonia can be lessened.

Vaccines against typhoid, dysentery and cholera, etc., mainly owe their immunizing properties to the presence of a complex carbohydrate residue which contains glucosamine and galactose and which is conjugated to phospholipids and amino-acids.

Seven distinct polysaccharides have been obtained from the mycobacterium which causes tuberculosis in humans, and their specific serological reactions are being studied. When freed from protein, they do not appear to give rise to any immunity. When polysaccharides having molecular weights of the order of a million are degraded by acid or by enzymes, they can often be injected into animals without setting up any immunity in the host. They may, however, cause skin reactions in sensitive individuals, and some forms of allergy can be traced to distinct chemical structures or even groupings, though protein constituents or nucleoproteins are more likely to be incriminated in such cases.

The bacterial polysaccharide dextran has been degraded by a variety of means, and a fraction having a molecular weight not greater than a hundred thousand has been used successfully as a blood plasma substitute. It is being used extensively, particularly in Britain and Sweden, in conjunction with natural plasma against shock, burns and loss of blood. The polysaccharide is composed entirely of glucose units, and it is completely metabolized in the body within a few days.

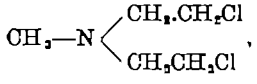
Another valuable dextran product is the sulphate made from a fraction having a molecular weight of about twenty thousand. This is essentially non-toxic, and it prevents the coagulation of blood and is likely to become valuable in post-operative work and in thrombosis. It has an action like heparin, the natural anticoagulant. Blood-group substances present in the red cells and tissues of individuals of groups A, B or O, etc., are mainly of a polysaccharide nature. Their study by chemical means will give valuable information on inheritance characters.

Body 'building' constituents, such as bone, cartilage, tendons and joint fluids, are polysaccharides containing hexuronic acids, amino-sugars, sulphate and acetyl residues. They can be depolymerized by enzymes such as hyaluronidase, lysozyme, etc., and the state of polymerization appears to be important in certain rheumatic conditions. The enzymes may be under the control of cortisone or the adrenocorticotropic hormone, and it is of great importance to make structural studies in the group.

The biosynthesis of one macromolecule may depress that of another type in its immediate vicinity. There is some evidence that certain bacterial polysaccharides will suppress the formation of the nucleoproteins in some tumours, and efforts have been made for some years by Dr. M. J. Shear and his colleagues in the United States to apply this in the attempted cure of some forms of cancer. In a somewhat similar way microbial and other polysaccharides may cause the slowing-down or may suppress the growth of viruses such as the influenza virus. Physical factors come into play, and efforts are being made to investigate virus multiplication and inhibition along these lines.

Dr. B. E. Conway (Chester Beatty Institute, London) then gave an account of the "Physical Chemistry of Deoxyribonucleic Acid". The probable importance of deoxyribonucleic acid conjugated with basic proteins to form the chromosomal nucleoproteins and in the process of cell division was stressed, and the action of ionizing radiations and radiomimetic substances such as the 'nitrogen mustards' on dividing cells was briefly indicated. Attention was directed to the great amount of information to be gained by studying the effects of these agents on isolated deoxypentosenucleic acid. However, prior to investigations of this type it is necessary to have some information concerning the physical condition of nucleic acid solutions. Dr. Conway briefly reviewed experimental studies by various workers in which the ultracentrifugal, diffusion, viscosity, streaming birefringence and light scattering behaviours were observed. These experiments led to a picture of nucleic acid solutions as consisting of a dispersion of highly elongated, fairly rigid particles, between which there is considerable electrostatic and/or van der Waals' interaction. The marked effect of simple uni-univalent salts on the viscosity of the nucleic acid, together with the observation of Signer and Schwander that the orientation of the nucleic acid particles in streaming birefringence experiments is independent of sodium chloride concentration in the solution, emphasizes the apparent importance of electrostatic interactions between particles in nucleic acid and its solutions. In addition to these effects with simple salts, the addition of hydrogen-bond competing agents (or 'denaturing agents'), such as urea or phenol, to the nucleic acid solutions produces an irreversible effect in which it appears that the nucleic acid, although unchanged in molecular weight by these agents, becomes more compact by a loosening of intramolecular hydrogen bonds which appear to stiffen the extended rod-like structure.

Both radiomimetic agents, for example, the nitrogen mustard



$$CH_3{-}N\begin{cases}CH_2.CH_2Cl\\ CH_2CH_2Cl\end{cases},$$

and X-rays have an apparent depolymerizing effect on nucleic acid. However, the chemical effects of these two types of agents are very different, and only the physical changes of viscosity and molecular weight are similar. In the case of the nitrogen mustard, direct alkylation of the nucleic acid alters the molecule to a more compact form. At the same time and afterwards, further fission of the nucleic acid chain occurs giving fragments of lower molecular weight. The chemistry of these processes was briefly discussed. In the case of the action of X-rays on aqueous solutions of nucleic acid, the reactive agents are the hydroxyl, hydrogen and hydroxylonium free radicals, the latter being formed only in oxygenated solutions. The chemical action of hydroxyl radicals on nucleic acid and simpler analogues was described. There is a wide variety of reactions which can be brought about by these hydroxyl radicals interacting with nucleic acid. The effects of X-irradiation of nucleic acid in oxygen are of particular interest, for here degradation continues long after cessation of the irradiation. The importance of hydrogen peroxide formed during the irradiation under these conditions was discussed, and the possible relation of the increased radiosensitivity of organisms in the presence of oxygen was pointed out. Dr. Conway's talk was beautifully illustrated by slides showing stages of cell division.

In the final paper, Dr. G. A. Gilbert (University of Birmingham) spoke of the work in the Birmingham laboratories and elsewhere on "Enzymes for Building Natural and Synthetic Starch". He said that natural starch contains two distinct kinds of polymer—a long straight-chain polymer (two hundred units) termed 'amylose', and a highly ramified polymer termed 'amylopectin'. Amylose tends to come out of solution in hot water in the form of a granular powder (retrogradation), whereas amylopectin forms a thick gel. Tough fibres resembling cellulose can be made from amylose. It gives a blue-coloured complex with iodine, the molecules and ions of which may fit inside a helix-type of chain structure. Amylopectin gives a reddish colour with iodine, and the amylose content of a starch may be measured by the 'blue value' of the iodine complex measured spectrophotometrically. Separation of amylose from a starch paste may be achieved by the addition of a variety of reagents, including thymol, paraffins, aluminium phosphate, etc.

Amylose may be synthesized by the action of an enzyme (Hanes's phosphorylase or *P*-enzyme) acting upon glucose-1-phosphate under appropriate conditions. The phosphorylase may be extracted readily from potato juice and obtained in a highly purified form. The synthesis using purified materials will not begin until a 'primer' consisting of several glucose units with the starch-type pattern is added. The synthesis starts from the non-reducing chain ends, and the glucose units are joined by 1 : 4 α-glycosidic linkages. Amylose may be converted into amylopectin by a second 'branching' enzyme termed *Q*-enzyme which has been obtained in Birmingham in a crystalline condition. The branching may involve 1 : 6-linkages which are now termed 'cross' linkages. The synthesis of the starch components by these enzymes, alone and in admixture in varying proportions, gives a valuable means of studying an important biological synthesis. The depolymerization of starch components can be studied by means of the 'amylase' enzymes, which have some commercial importance. There is a good deal of overlap in the mode of action of starch-synthesizing and -depolymerizing enzymes obtained from microbial, protozoal, plant and animal tissues.

The meeting concluded with a lively discussion.

OBITUARIES

Prof. C. B. Fawcett

PROF. C. B. FAWCETT, who held the chair of geography at University College, London, for twenty-one years until his retirement in 1949, died on September 21 at the age of sixty-nine.

A graduate of University College, Nottingham, he later studied under Herbertson at Oxford before becoming lecturer in geography at University College, Southampton, in 1914. He moved in 1919 to the University of Leeds, where he was in charge of the young Department of Geography until he was appointed in 1928 to succeed Prof. L. W. Lyde in London.

Fawcett was a leading member of the group of pupils of Mackinder and Herbertson who pioneered the modern development of honours schools of geography in British universities, and he was for many years prominent in the counsels of the Geographical Association, Section E (Geography) of the British Association, and the Institute of British Geographers, of which he was one of the founders and an early president.

A faith in the essential reasonableness of his fellow men, as well as his own rationalism, permeated all his work, and were revealed, for example, in his interest in the development of an auxiliary world language and calendar reform. They found particular expression in "The Bases of a World Commonwealth", published in the darkest period of the Second World War. His emphasis upon the unity of the Atlantic community combined with his personal qualities to make him a ready and welcome visitor to New England. Having already been visiting professor at Clark University, Worcester, Mass., in 1931 and again in 1947, he returned there for two years after retiring from the chair at University College, London.

It is perhaps too soon to attempt an assessment of his contribution to the development of geographical thought; but the significance of his early work, "The Provinces of England" (1919), in the history of the regional concept is already evident. That it should have been specifically written to point a reasonable basis for devolution of government and reform of administrative areas was typical of his essentially practical outlook. Geography claimed his absorbing interest not for its own sake, but also as a social science which in its application to social and political problems could increase the sum of human happiness. To the studies of population problems and political geography, which increasingly engaged his attention, he brought an insistence upon appreciating the realities of hard facts. His own command of facts was an unfailing source of wonder to his students, who will remember the encyclopædic knowledge on all manner of topics which illumined or diverted his lectures, as they will his unfailing kindliness and outstanding fairmindedness.

A. E. SMAILES

Prof. Aikitu Tanakadate

FRIENDS and acquaintances of Prof. Aikitu Tanakadate will learn with regret of his death on May 21 in Tokyo, after a long and active life of ninety-five years.

He was born in 1856 at Fukuoka town in the present Iwate Prefecture, Japan. Entering the University of Tokyo in 1878, he studied physics under J. A. Ewing and T. C. Mendenhall, and afterwards under C. G. Knott, who were at that time visiting teachers of the University. His interest was particularly directed towards geophysical phenomena, and soon after graduation he started gravimetric and magnetic surveys over Japan, which had not been explored scientifically by that time. "A Magnetic Survey of Japan", which was written by him with admirable thoroughness and completeness and was published in 1904, is universally known as a monumental work of this kind. In 1888 he went to Glasgow, where he studied physics as a pupil of Sir William Thomson (Lord Kelvin). He returned to Japan in 1891 and in that year was appointed a professor in the University of Tokyo, a post which he held until 1917.

Prof. Tanakadate was the oldest member of the Japan Academy of Science, an emeritus professor of the University of Tokyo, the first recipient of the Order of Cultural Merit, sometime vice-president of the National Research Council of Japan, and a member of the House of Peers. He also held important positions in many learned societies. For more than seventy years of his career as a scientist he literally devoted himself to initiating and promoting natural sciences in Japan. His activity covered fields in a wide range of subjects—to mention a few, geodesy, variation of latitude, seismology, terrestrial magnetism and aeronautics. Japan urgently needed such a pioneer as Prof. Tanakadate, particularly towards the end of the nineteenth century, after the Meiji Restoration of 1868, which brought to an end the three hundred years of Shogunate feudalism. His love of science as well as of his native country seems to have been the primary motive which drove him to this honourable duty. This does not mean that he was a man of narrow-sighted nationalism. On the contrary, he is known as a strong advocate of international friendship and co-operation. He travelled abroad no less than twenty-three times and attended a number of scientific assemblies and presided at several of them. He was the first president of the International Association of Terrestrial Magnetism and Atmospheric Electricity. C. E. Guillaume, of France, is said to have one day announced with mock seriousness that the second moon was newly born; his explanation to rather puzzled hearers was this: "It is Prof. Tanakadate. He makes a revolution around the world every year".

Prof. Tanakadate was liked by everybody who had the opportunity of becoming acquainted with him, and admired for his unfading love of science as well as for his logical and brilliant way of thinking, intermixed occasionally with a good sense of humour. Many old friends all over the world will honour his memory.

CHUJI TSUBOI

WE regret to announce the following deaths:

Dr. W. E. Gye, F.R.S., lately director of the Imperial Cancer Research Fund, on October 15, aged sixty-eight.

Sir Frederick Keeble, C.B.E., F.R.S., formerly Sheradian professor of botany in the University of Oxford, on October 19, aged eighty-two.

NEWS and VIEWS

Sir William Ramsay and University College, London

REFERENCE has already been made (see *Nature*, October 4, p. 554) to the appeal for funds which has been made on the occasion of the centenary of the birth of Sir William Ramsay. The appeal was well and truly launched at a Ramsay Memorial Dinner held at University College, London, on October 15, at which H.R.H. The Duke of Edinburgh was guest of honour and proposed the toast "to the immortal memory of Sir William Ramsay". He took as his theme the importance of fundamental research and its significance for industrial progress, quoting from his experience of recent work going on in State research institutions, and using Sir William Ramsay's discovery of the rare gases as an example of the manifold and unsuspected uses which may be made in everyday life and industry of the results of fundamental research. The reply to the toast was made by Dr. B. Ifor Evans, provost of University College, who outlined the purpose of the appeal, and stated that £57,000 has already been promised towards the £100,000 which it is hoped to raise. During the dinner, it was announced that Lady Tidy (a daughter of Sir William Ramsay) and Prof. Morris Travers—both of whom, with other associates of Ramsay, were present —had decided to present to the College the collection of Ramsay letters, papers and other materials which Prof. Travers has been accumulating over a long period. Incidentally, it may be added that Prof. Travers has prepared a fascinating account of Ramsay's life and work which has been issued by the College in connexion with the centenary appeal.

The appeal is being issued jointly by the University College Committee and the Ramsay Memorial Fellowships Trustees. After Ramsay's death in 1916, funds were raised by public subscription and were devoted partly to building a chemical engineering laboratory in the College and partly for the endowment of Ramsay Memorial General Fellowships to enable advanced students of chemistry from any part of the world to carry out research at any approved centre in the United Kingdom. Fellows from overseas are supported by funds raised in the country of their origin, and in this way Canada, Denmark, France, Greece, Holland, Italy, Japan, Norway, Spain, Sweden, Switzerland and the United States have sent distinguished young students to Great Britain. Funds subscribed in Britain were mainly devoted to British students, and the capital fund available for that purpose is now inadequate to maintain the normal award of one fellowship of two-years tenure every year. It is therefore proposed to devote £25,000 from the £100,000 which the appeal is hoped to produce to augment the Fellowship Trust General Fund, so that the normal number of British fellowships may be restored. With the remaining £75,000 it is hoped to make a substantial addition to the laboratory accommodation at University College and to provide additional equipment. When Ramsay went to the College, the facilities for research were meagre. By his personal exertions he supplemented what was available to him in the College, until he led a famous school of research. He would surely have approved the purpose of this centenary-appeal to industry and others to augment the resources of the College, so badly damaged during the Second World War, and to provide more funds for the maintenance of that world-fellowship of distinguished chemists who are proud to acknowledge their association with the Ramsay Memorial Trust.

The Royal Sanitary Institute: Dr. J. W. Dudley Robinson

AT a luncheon given in his honour on October 14, Dr. J. W. Dudley Robinson, who will be retiring at the end of this year, was presented with an inscribed silver rose-bowl and a cheque on behalf of the Fellows, Members and Associates of the Royal Sanitary Institute as a token of their appreciation of his valued service as secretary of the Institute since 1928. Dr. Robinson has also been secretary of the Royal Sanitary Institute and Sanitary Inspectors Examination Joint Board since 1928 and of the National Nursery Examination Board since its formation in 1945. Since he went to the Institute from the secretaryship of the Institution of Municipal Engineers, he has been responsible for much of the former's successful development. In addition to organizing the annual health congresses of the Royal Sanitary Institute, which are attended by upwards of two thousand delegates, he has also arranged a number of special conferences, notably on the Midwives Act in 1936, and on the administration of the Milk (Special Designations) Order in the same year. During his service with the Royal Sanitary Institute, Dr. Robinson has been responsible for its examination system under which some sixty-eight thousand candidates have been examined. In the same period, the membership of the Institute has increased from 4,700 to well over 9,500. In 1950 he was appointed an officer of the Ordre de la Santé Publique by the President of the French Republic.

New Fellowships in Microbiological Biochemistry at Oxford

THE University of Oxford has been able to establish three research fellowships in microbiological biochemistry in the Department of Biochemistry, owing to the generosity of Arthur Guinness, Son and Co., Ltd., who have offered to pay the University £2,500 a year for seven years for this purpose. The Guinness Research Fellows must be British subjects who are graduates of a university and who have had experience in research. They will be appointed by the Board of the Faculty of Biological Sciences in the University of Oxford, on the recommendation of the Whitley professor of biochemistry and the reader of microbiology in the Department of Biochemistry. It is anticipated that Fellows will hold their appointments for three years, receive a salary between £600 and £800 a year and carry out fundamental research in the field of the biochemistry of micro-organisms.

Centenary of the Royal Photographic Society

The Royal Photographic Society of Great Britain will be celebrating its centenary next year and will hold an international conference on the science and applications of photography in London during September 19–25, 1953. The conference will cover many aspects of the science, technique and applications of photography and will be divided into five sections dealing with the following topics: photographic science—including the theory of the latent image and development, sensitization, sensitometry, resolving power, granularity and the properties of photographic materials; cinematography and colour photography; technique and applications of photography—including industrial radiography, photomicrography, spectroscopy, aerial photography, photogrammetry, high-speed photography, nuclear track recording, and other physical, chemical and biological applications, as well as photocopying and photographic apparatus, processes and manipulations; photomechanical processes; history, literature—including abstracting and documentation—and training in photography. All persons taking an interest in photography or its applications are invited to attend the conference, and to submit papers for discussion. Titles and indications of the scope of such papers should be submitted before February 1, 1953, and the full paper before May 1, 1953; it is intended to publish the papers in full before the conference. All communications regarding the conference should be addressed to the Honorary Secretary, R.P.S. Centenary Conference, 16 Princes Gate, London, S.W.7.

Isotope School at Harwell: Course of Instruction

Since the opening in April 1951 of the Ministry of Supply's Isotope School at Harwell, a steady succession of courses has been held there in the technique of handling and using radioactive isotopes. So far, a hundred and fifty scientific workers, medical men and engineers have passed through the school, nearly three-quarters being from Great Britain, and of the remainder one-third being from South Africa, India and Australia and the other two-thirds from European countries. The students come in nearly equal numbers from five main groups: universities, technical colleges and research institutions; industrial research laboratories; industry; medical centres; and the Department of Scientific and Industrial Research and government departments. Nearly two-thirds of the total have been chemists and biochemists, and the remainder have been made up of engineers, physicists and medical men in roughly equal proportions. During the sixteen months of its existence the School has continually developed and attempted to have in its laboratories equipment which is abreast of the very latest developments all over the world. To house the additional equipment the School was moved from its original quarters, a converted wooden hut, and has, since January of this year, been installed in a permanent brick building where there are now ample facilities for carrying out all the physical and chemical manipulations required when working with radioisotopes. The courses last for four weeks, and in that time, by means of lectures and especially by working in the laboratory, a sound grounding in the principles of working with radioactive materials is given; the training is intended to be of a fundamental nature and does not deal with the very specialized techniques which have been developed for application in industry and medicine. The next courses in the School will begin in January 1953, and applications for admission and further information can be obtained from Dr. J. E. Johnston, Isotope School, A.E.R.E., Harwell.

Revival of Japanese Botany

Evidence that the vigorous interest in botanical science that was a feature of pre-war Japan is renewing itself is shown by the publication of "An Address Book of Japanese Botanists" (1951), edited by the National Committee of Botany, and published by the Science Council of Japan, Tokyo (no detailed address given). Some 350 names are given, with ages, addresses, qualifications, interests and publications, and the object is "to recover and further promote our scientific friendship with foreign botanists and relevant societies".

New Photoelectric Absorptiometer

The firm of Hilger and Watts, Ltd. (48 Addington Square, London, S.E.5), has recently started to produce a new photoelectric absorptiometer to be known as the 'New Biochem Absorptiometer'. It is a compact direct-reading instrument of the single-cell type designed for routine use in the laboratory. The controls comprise an on–off switch, a light control for setting the full scale reading, a shutter for the photocell, and a filter selector drum. The latter contains eight spectrum filters of narrow band-width. The photocell is connected to a sensitive reflecting galvanometer the white opaque screen of which enables readings to be taken more easily than with the usual semi-transparent type. Flat-sided cells or special test-tubes can be used, the mount for the latter being optically compensated for the refractive index of the solution. Spilt solutions merely drop through to the work bench; also the cell mounts are made of polythene. The instrument is either battery- or mains-operated with built-in constant-voltage transformer.

Inter-Library Microfilm Catalogue of the Scientific Libraries in Israel

A bi-lingual guide (in English and Hebrew) to the Inter-Library Microfilm Catalogue of the Scientific Libraries (Natural and Applied Sciences) in Israel has been issued by the Research Council of Israel, Jerusalem (pp. 100; 1952). The catalogue itself is the first part of a scheme to improve the scientific information services of Israel, and, for the present, copies are distributed only to the Research Council of Israel, Jerusalem, the Hebrew University (Terra Santa, Jerusalem), the Agricultural Research Station (Rehovot), the Bett Gordon Library (Dagania A), the Hebrew Institute of Technology (Haifa), and the

Engineers Institute (Tel Aviv). The guide indicates the scope of these libraries and the classification used in their several catalogues, so that application for the appropriate section of the microfilmed catalogue is facilitated. The present format and pagination of the guide are cumbersome and inconvenient to the user; the bi-lingual reports by, for example, the National Research Council of Canada or the South African Council for Scientific and Industrial Research are in a much better style.

Institute of Education Library, Birmingham

The Institute of Education Library, University of Birmingham, has issued a Supplement (No. 1, pp. 83; February 1951–March 1952) to the basic catalogue of 1951, mainly for the assistance of readers who cannot visit the Library. Items of less than 51 pages are indicated by the symbol [P]. The entries are classified under such heads as, for example, reference books (which cannot be borrowed), history of education, principles and philosophy of education, sociological aspects of education, national systems of education, universities and university education, adult education, vocational guidance, the curriculum, exceptional children, etc. A complete list of the Library's holdings of periodicals is included, and there is an author index.

Institute of Metals: New Officers

The following have been elected to fill vacancies on the Council of the Institute of Metals, with effect from the annual general meeting in 1953: *President*, Prof. F. C. Thompson (professor of metallurgy, University of Manchester); *Vice-Presidents*, Major C. J. P. Ball (chairman, Magnesium Elektron, Ltd.) and Prof. G. V. Raynor (professor of metal physics, University of Birmingham); *Members of Council*, W. A. Baker (research manager, British Non-Ferrous Metals Research Association), J. C. Colquhoun (chairman and managing director, Manganese Bronze and Brass Co., Ltd.), E. R. Gadd (chief metallurgist, Engine Division, Bristol Aeroplane Co., Ltd.) and the Hon. John Grimston (director and general manager, Enfield Rolling Mills, Ltd.). The Council of the Institute has elected Dr. S. F. Dorey (chief engineer surveyor, Lloyd's Register of Shipping) to serve as senior vice-president for the year 1953–54, and he will be nominated for the presidency for the year 1954–55.

Colonial Service: Recent Appointments

The following appointments in the Colonial Service have recently been announced: D. F. Davidson (assistant conservator of forests, Cyprus), senior assistant conservator of forests, Cyprus; J. K. Ross (assistant conservator of forests, Sierra Leone), assistant conservator of forests, Nigeria; J. M. Waterston (senior botanist, Nigeria), principal research officer, Agricultural Department, Nigeria; J. D. Birkett (senior veterinary officer, Nigeria), director of veterinary services, Sierra Leone; G. F. Darnell, agricultural officer, Federation of Malaya; G. E. Dixon, plant breeder, Kenya; P. Greening, agricultural officer, Northern Rhodesia; W. G. Plaistowe, agricultural officer, Nyasaland; R. M. Sister, entomologist, West African Cocoa Research Institute, Gold Coast; M. E. H. Vickers, agricultural officer, Kenya; P. E. Wheatley, agricultural entomologist, Kenya; R. C. Norris, chemist, Federation of Malaya; J. A. B. Stewart, geologist, Somaliland Protectorate; L. A. J. Williams, geologist, Kenya; A. D. McKelvie, plant physiologist, West African Cocoa Research Institute, Gold Coast; G. R. Robson, scientific officer, Trinidad (seismological observer in charge of recording station, Windward and Leeward Islands); D. J. Taylor, entomologist, West African Cocoa Research Institute, Gold Coast; R. Wilson, veterinary officer, Somaliland Protectorate; P. H. Gulliver, sociologist, Sociological Research Provincial Administration, Tanganyika; H. F. Lamprey, biologist, Game Department, Tanganyika; N. G. Shaw, assistant conservator of forests, North Borneo; R. Tavener-Smith, geologist, Northern Rhodesia; G. Webbe, entomologist, Medical Department, Tanganyika; E. Wigura, computer, Surveys and Town Planning Department, Tanganyika.

Announcements

Prof. M. von Laue, who will be addressing a meeting of the Physical Society at 5 p.m. on October 29 at the Science Museum, South Kensington, London, S.W.7, will first present the Max Planck Medal for 1952 to Prof. P. A. M. Dirac on behalf of the Association of German Physics Institutes.

Mr. N. D. Riley, keeper of entomology in the British Museum (Natural History), is relinquishing the editorship of *The Entomologist*, a post he has held for thirty-one years, and will be succeeded in the new year by Mr. D. Leston. The journal is to be increased in size and widened in scope to include all aspects of pure and applied entomology; all inquiries regarding it should be directed to the editor at 44 Abbey Road, London, N.W.8.

The National Science Foundation (2144 California Street, N.W., Washington 25, D.C.), in co-operation with the University of Chicago, is organizing a conference on the "Abundance of the Elements", to be held at the Yerkes Observatory, Williams Bay, Wisconsin, during November 6–8. The conference will bring together some forty leading astronomers, chemists, geochemists and physicists, drawn from university, industrial and government research organizations, who will consider the effect of recent research in stellar and terrestrial measurements on current theories of the abundance of elements in the universe. It is hoped that, as a result of this conference, fresh light will be brought to bear on the origin and material limits of the universe.

A fellowship and a number of scholarships for work on arctic or sub-arctic research are being offered jointly by McGill University and the Arctic Institute of North America, with the financial support of the Carnegie Corporation of New York. The fellowship, which is worth 4,000 dollars, is for a senior research worker who has completed his studies in the field and requires a year's residence in a centre of learning to prepare his results or acquire specialized knowledge. The scholarships are normally tenable for one year, being worth on the average 750 dollars with 1,500 dollars field expenses, and are for graduates intending to undertake active field research. Further information regarding these awards can be obtained from the Carnegie Arctic Program, Arctic Institute of North America, 3485 University Street, Montreal, P.Q. Applications must be sent in by January 1, 1953, except that scholarship candidates not intending to do field-work in the summer of 1953 need not send their applications until April 1, 1953.

EXHIBITION OF THE WORK OF W. STANLEY JEVONS

By DR. W. MAYS and DR. D. P. HENRY
Department of Philosophy, University, Manchester

IN *Nature* of January 27, 1870, Jevons's paper "On the Mechanical Performance of Inference" read before the Royal Society in the previous week was reported. The paper is a historic one, as it contains an account of the first logical machine. Built in 1869, this was used for teaching purposes while Jevons was at Owens College (now the University of Manchester) and in London. It was eventually deposited in the Museum of the History of Science, Oxford, and has been lent to the Philosophy Department at Manchester, which has arranged an exhibition in the Christie Library of the University (October 15–31).

The exhibition shows that the truth-table method of solving logical problems was introduced by Jevons in 1864. Indeed, without the use of this method he could not have constructed his logical machine. Mary Hesse, in her recent study of Boole's unpublished manuscripts (*Annals of Science*, March 1952), after speaking of Boole's attempt to arrive at a non-algebraic expression of his logical calculus, says (p. 79): "The suggestion was developed independently by Jevons, who solved Boole's general problem without the use of algebra by writing down all possible combinations of the terms. . . . The result is in the form of a truth-table from which any question regarding terms or combinations of terms can be answered. Jevons made this the basis of his logical machine. It is clear from the MSS. that although Boole was feeling after some such method, there is no real anticipation of Jevons in his work". Further light is thrown on this matter by a series of unpublished letters in the exhibition, containing an exchange of views between Boole and Jevons on the publication of the latter's "Pure Logic". Boole's letters confirm Miss Hesse's judgment that it is to Jevons that we owe the introduction of the tabular method which led to his mechanization of logic.

Allen Marquand (1853–1924), fellow in philosophy, Johns Hopkins University, and afterwards professor of archæology and the history of art at Princeton University, constructed an improved four-variable machine (*Proc. Amer. Acad. Arts and Sci.*, 1885). Letters of Marquand in the exhibition show his indebtedness to Jevons. Marquand's manuscripts, now in the Princeton University Library, were examined by Prof. Alonzo Church, the well-known logician, who selected the material on logical machines, photostats of which are included in the exhibition. There are details of an eight-term machine, a syllogistic variation machine, and notes showing the advantages of Marquand's machine over that of Jevons. A copy of Marquand's wiring diagram for a four-term electrical machine was also sent. Prof. Church thought it important for us to see it, as it was not mentioned in any of the published papers he could recall. The diagram is of great interest; prepared about 1885, it is probably the first circuit of an electrical logical machine. It is wired in series and parallel, and among its components are sixteen electromagnets, eight one-way switches, one three-way switch, and a rheostat. Jevons's principles thus received their electrical translation at least half a century before present developments in relay computing machines.

Exhibited together with Jevons's machine is the modern three-variable electrical relay computer built for the Philosophy Department of the University of Manchester by Messrs. Ferranti (see Mays and Prinz, *Nature*, 165, 197; 1950), based on similar logical principles. Jevons's machine to-day is as portrayed in the frontispiece of the "Principles of Science". It looks like a miniature upright piano; on both the front and back are slots through which can be seen the letters representing the sixteen possible combinations of the four terms *A*, *B*, *C* and *D*, and their negations, thereby constituting a truth-table. It has a keyboard with twenty-one keys for terms and operations, by means of which the machine rods which bear these combinations can be classified, selected or rejected. The machine can deal with 65,536 possible logical selections. As the original report in *Nature* in 1870 says: "When once a series of propositions is thus impressed upon the machine, it is capable of exhibiting an answer to any question which may be put to it concerning the possible combinations which form any class. The machine thus embodies almost all the powers of Boole's logical system up to problems involving four distinct terms . . . demonstrating in the simplest and most evident manner the character and powers of a universal system of logical deduction, of which the first, although obscure solution, was given by Dr. Boole."

Jevons's logical notebooks are also exhibited. In one of them he works out all the 256 possible logical selections generated by three terms. They are displayed in the form of four panels drawn on graph paper. The notation is a binary one: dots indicate the existence of a combination, spaces their absence. In the "Principles of Science" (2nd edit., p. 135) and in some of his notebooks, he uses the 1 and 0 notation which has become so familiar to-day in logical and mathematical computers.

The exhibition also includes the manuscripts of many of Jevons's writings on economics and logic, and copies of his published works. Of direct interest to the economist are coloured charts of great complexity prepared for his "Statistical Atlas". There are letters from Gladstone, Bagehot, J. S. Mill, H. Spencer, Galton, Babbage, Venn, C. S. Peirce and many documents of economic interest. Notes on his experiments on Brownian motion (1878) further illustrate the variety of his interests. His journal during 1853–67, parts of which have appeared in the "Letters and Journal" edited by his wife, is also to be seen, as well as his drafts of class reports at Owens College, his memorandum books, personal reference books, photographs taken during his stay in Australia and family and University photographs.

W. Stanley Jevons was born in Liverpool in 1835, and died at the early age of forty-seven in 1882. He was professor of logic, mental and moral philosophy, and Cobden professor of political economy in Owens College (1866–76), and professor of political economy in University College, London (1876–80). To Jevons are due many important innovations in economics and logic; these, together with his researches in numerous other fields, reflect his versatility and brilliance.

The exhibition of the Jevons manuscripts and correspondence has been made possible by the kindness of his son and daughter, Mr. H. S. Jevons and Miss H. W. Jevons. Mrs. Eleanor Marquand Delanoy gave permission for the use of her father's manuscripts, and Dr. Tyson, librarian of the University of Manchester, allowed the use of the Christie Library for the exhibition.

TRANSPORT IN GREAT BRITAIN

IN a paper on "The Troubles of Transport", read on September 9 to Section F (Economics) of the British Association at the recent meeting in Belfast, Prof. C. F. Carter (professor of applied economics in Queen's University, Belfast) discussed some current problems of road and rail transport in Great Britain. Figures were quoted showing that transport is an expanding activity (thus making adjustment easier); that it is mostly by road; and that 45 per cent of the 'activity' of transport is organized as an ancillary to some other activity. "It is most unlikely," said Prof. Carter, "that the ownership of ancillary vehicles would have developed to this point if it were not an efficient way of organizing transport. There is . . . no evidence that it would be advantageous to break it down. It follows that the possible field for public ownership of the carriage of goods by road is only a minor part of that activity."

The discussion of transport problems in the past year, continued Prof. Carter, has been concentrated on organization and ownership, and has avoided the fundamental issues, which are the relation of charges to costs, the problem of public obligation, and the principles of taxation of road transport.

In theory, the charge for an item of transport should be proportional to the cost of providing an extra unit flow of transport service of that type, when the system has been fully adapted to supply the extra services effectively and conveniently. The ratio of two charges should equal the ratio of costs, taking no account of interest on the cost of 'permanent' assets such as the road bed. The difficulty of costing transport services is very great, and the results must be in part arbitrary. With the railways, enough is known to show that "the present pattern of charges not only bears no relation to costs, but often works the other way". On the road, the difficulty is to find a true economic cost when taxation is so important. Prof. Carter pointed out that "the 'cost' of the roads should for our purposes mean the cost of maintaining and improving them so that next year they can carry traffic as speedily and safely as this year"; with road vehicles increasing in number by 5 per cent per year, this cost would much exceed the sums at present being spent on maintenance. A National Roads Council is needed, charged with the duty of advising on road development and of keeping running estimates for five years ahead of the least expenditure necessary to maintain the roads and to adapt them to expected traffic requirements. Part of the taxation of road vehicles should be segregated as a Roads Tax, paid into a revived Road Fund, which would be autonomous and would carry forward balances from year to year. The Fund should receive what the National Roads Council estimates to be the proper sum to be spent on the roads—whether or not the economic situation allows this amount to be actually spent.

"A more fearsome dragon now lies in our path, called the Public, who are supposed to insist on various uniformities which flatly contradict the principles we have been discussing." Thus rail passenger fares are expected to be proportional to distance, whereas they should be tapered. Uniformity of rates over the whole of a public organization's system prevents any reflexion of the large differences in cost between different routes. Proposals for dealing with this on the railways were made in Prof. Carter's paper.

After traders have chosen to carry what is convenient to them in their own vehicles, and road hauliers have given preference to profitable traffic, the common carrier by road or rail is left with the odd lots, the awkward cross-country journeys; in particular, the railways are left with precisely the traffics which economically they are least fitted to handle. "If we reject any solution to this problem which involves forcing users to use a particular kind of transport, there seems to me to be only one solution: substantial differential taxation of those parts of transport which have the privilege of choosing their traffic."

The proper taxation of road transport thus has four parts: the general requirements of the Chancellor of the Exchequer; a tax on petroleum, as long as the state of the balance of payments is deemed more grave than the coal supply; a roads tax; and a levy on those not accepting public obligations.

Towards the end of his paper, Prof. Carter remarked: "I think we need a cooling-off period, to help transport to recover its commercial commonsense after a surfeit of politics; and the best cooler would undoubtedly be a weighty Royal Commission, charged with the duty of giving the whole matter up-to-date and careful study".

SHAPES OF AEROPLANE WINGS

A PAPER on "The Shape of Wings to Come", by Mr. D. Keith-Lucas, chief designer of Short Bros. and Harland, Ltd., was read on September 8 before Section G (Engineering) of the British Association at the recent meeting in Belfast. The paper has since been published in full in *Engineering* (174, 349; 1952). It is of considerable interest as it goes a long way towards explaining the departures from orthodoxy of wing form which can be seen daily by persons who live near certain airfields.

Mr. Keith-Lucas explains that the main purpose of sweep-back is the reduction and the postponement to higher speeds of compressibility effects normally met with on straight wings at high subsonic speeds. The velocity of the wing relative to the air may be resolved into components normal to and parallel to the span. It is shown that the main aerodynamic effects are fixed by the former, so that the effective air speed of the wing can be made low by the use of sweep. End effects, at the root and the tips of the wing, reduce this benefit by half. It is also shown that at high supersonic speeds the unswept wing can be made efficient again, providing only that it is very thin; for example, the thickness of the sections may have to be as little as 3 per cent of the chord. Sweep-back was first introduced, however, in order to stabilize the all-wing aeroplanes which it was hoped to use before the penalty of severe drag of the resulting thick wing was fully appreciated. There is an interesting discussion in the paper of an Australian project for an all-wing airliner using a 30 per cent thick wing fitted with boundary-layer suction in order to reduce the drag.

The thin swept-back wing is shown to be peculiarly susceptible to aeroelastic effects; that is, to the aerodynamic consequences of structural distortion in flight. A simple example of such an effect is the so-called aileron reversal. This is also met in unswept wings. If the extra lift produced by the downward deflexion of an aileron acts towards the rear of the wing, it produces a 'nose down' twist of the structure which will cause a net loss of lift at sufficiently high speeds. An academically interesting solution to the general problem is the 'aeroisoclinic' wing invented by G. T. R. Hill. This leads to a swept wing which is weak in torsion. Aileron reversal is to be avoided by obtaining lateral control from wing tips the incidence of which to the wind can be varied, instead of the conventional ailerons. The case for crescent wings is also made. It seems, however, that at moderate supersonic speeds there is little to beat the delta planform with its large internal volume, especially at the wing root. This allows ample space for a stiff structure, the load, the fuel, the undercarriage, and the whole variety of apparatus and equipment carried by modern aeroplanes.

It is a big problem to get highly swept wings to give adequate lift at slow speeds, and the possible solutions of the landing problem are the subject of controversy among aeronautical scientists and engineers. An American aeroplane with sweep which is variable in flight has recently been flown. There are advocates of the use of parachutes, stowed helicopter blades, etc. In fact, the shape of wings to come is as yet indeterminate because of the difficulties of flying slowly.

HARNESSING KNOWLEDGE

ANNUAL CONFERENCE OF ASLIB

THE fact that Aslib could choose "The Significance of Information in Present-Day Industrial Society" as the theme of its twenty-seventh annual conference, held recently at Swanwick in Derbyshire, clearly indicates that the day is past when 'information' could be dismissed as the concern of the chemist or physicist alone. The very phrase has an Aristotelian ring that nevertheless yields nothing in emphasis to the twentieth century's pre-occupations with men as minders of machines. So, indeed, it should be, for as Sir Stephen Tallents declared in opening the conference, "ideas have to-day become not only the most potent of forces but also the most precious of cargoes". Those same ideas, communicated and applied, are the life stream of an industrialized society, which must perish unless it can produce more goods more cheaply than ever before.

In this modern industrial and scientific society, the key to future development is the speed with which new ideas can be put to work—such was the burden of the principal paper at the conference, presented by Prof. T. U. Matthew, who holds the chair of engineering production in the University of Birmingham—the only one of its kind in Great Britain. We have, he said, achieved a new type of chain-reaction in which new knowledge and ideas, travelling at a rate governed by the effectiveness of our information services and means of publication and communication, give rise to an endless succession of transmutations and further ideas in an ever-widening range of specialized fields of research and development. For the truth of this, one need not look beyond the post-war capital development programmes in coal, steel and chemical production, which have all felt the impact of modern methods of communication on a large scale.

These, it is true, are fields in which, for the most part, large industrial units are engaged. It is encouraging to know that, according to the recent survey "Research and Development in British Industry", produced by the Federation of British Industries, some £30,000,000 is now being spent on research each year compared with £5,500,000 just before the Second World War. But responsibility for bringing into the production stage the vast stores of new knowledge that become available in this way still lies generally with a comparatively small group of larger companies. Behind them stretch the thousands of firms of intermediate and smaller size, the majority of which have not, as yet, got to grips with the concept of increasing productivity, let alone the definitive shape that can be given to that concept by the utilization of published facts and figures. Add to this picture of the production side of industry the stimulus that can come from the communication of data and ideas in connexion with home and foreign markets, internal and external freight facilities, international trade and currency regulations and, not least, industrial labour relations—the vision is stirring indeed.

Here, as Prof. Matthew indicated, arise both the immediate obstacle and the long-term challenge. It is already clear, he said, that the present rate of discovery arising from fundamental research in physics, chemistry and the applied sciences, far exceeds the digestive capacity of existing development resources—hence the growing pressure for a new technological university and more technologists to bridge the gap between scientific research and industrial application. On a wider stage, the rate of exploration of the world's raw material resources has outstripped the nations' capacity to finance and organize their development. To this fact can be traced such schemes as the United Nations technical assistance projects, the 'Point 4' plan of the U.S. Government and the Colombo plan. Both nationally and internationally, these far-sighted proposals mean a mounting pressure on information services. Steps to encourage the interchange of knowledge and to speed up the processes of accumulating, abstracting, classifying and disseminating information on research and technical developments, production processes, raw material resources and market opportunities have already been taken, nationally, by Aslib, the Department of Scientific and Industrial Research and the research associations and, internationally, by the Office for European Economic Co-operation and the British Commonwealth Scientific Offices. The danger is that, in the smaller firms which have not yet established information departments of their own, these existing facilities may pass unnoticed, at least until the supply of technologists has increased. For the immediate future, he said, it is a question of assisting individual managers, who are not yet alive to the great wealth of recorded information open to them, to exploit it with only their present resources of staff. To Henri Fayol's six activities of management of fifty years ago, it is now time to add a seventh—the information function; and on the performance of it in the next decade or so the long-term future of British industry may well depend.

If, indeed, information services are destined to play such a crucial part in the future of British industry, much of the credit for an early realization of their potential value must go to the Royal Society's Information Services Committee and to Aslib, the work of both of which since 1948 was reviewed in papers presented by Dr. D. J. Urquhart and Mr. Leslie Wilson. The story of their achievement in barely four years is, perhaps, one of the most creditable on the less sensational side of British recovery since the War. Yet there can be no room for complacency while it can be said, as Dr. Urquhart did, that "there do not appear to be any major faults in the system [that is, of information services] as significant as the fact that so many who might use the system more, hardly use it at all". A recent survey indicated that 75 per cent of all industrial organizations have less than five periodicals of any sort and less than fifty books. At the same time, it has never been clearly demonstrated that the kind and size of firms that one might reasonably expect to find among the 75 per cent could and should be able to make use of published information on a scale likely to affect turnover materially. The firms themselves are mostly inarticulate or unaware of their need of information, technical or otherwise. The next step is surely to reduce this diffuse problem to measurable proportions, to ascertain at what level information services should operate in order to make the greatest contribution to the numerous and varied groups of potential information users. This is research of a kind in which, it is to be hoped, Aslib may be enabled to give an early lead.

MINERAL DRESSING

SYMPOSIUM IN LONDON

AT the beginning of this century the extraction of valuable minerals from their host rocks and ore complexes was a craft rather than a science. With the mounting demand, first for more and more engineering metals, and later for alkali earths and the oxidized earths of the rarer metals, it became necessary to exploit low-grade ore-bodies hitherto considered uneconomical. Two World Wars accelerated industrial demand, and at the same time forced the crude processes of those days on to a more scientific basis. It is a far cry from the 'préparation mécanique' and the 'ore dressing' of the past generation to the precise process engineering of the modern mineral-dressing plant. A satisfactory title for the wide range of activities embraced by this phrase 'mineral dressing' remains to be found. Treatment starts with the reduction of large pieces of rock to an average particle size of anywhere down to a few microns, and then uses such forces as gravity (simple or reinforced by centrifugal acceleration), magnetism and electrostatic deflexion, and, above all, the differences between the surface tension effects on minute particles in order to render them amenable to the froth flotation process and allied techniques. The field of application in industry is constantly being enlarged by the fundamental technological research work now actively in process in a number of laboratories. This again is reflected in the increasing exploitation of ore deposits hitherto considered too low in grade to be worth treating. Industrial specialization has moved mineral dressing into the position where it takes over practically everything produced underground or in open-cast work and rejects suitable quantities of valueless material, while bringing up the balance to a closely controlled specification which aims at optimum technical preparation for subsequent processes such as smelting or leaching, the production of a variety of finished substances (for example, asbestos) or the purification of such earths as phosphates to the point where wet chemical processes can best be applied to the upgraded concentrates.

Evidence of the wide scope of these technical developments was supplied by the first symposium on mineral dressing ever to take place in Great Britain, which was held during September 23–25 under the auspices of the Institution of Mining and Metallurgy at the Imperial College of Science and Technology, London, an inaugural lecture (the Sir Julius Wernher Memorial Lecture) being delivered at the Royal Institution the previous afternoon by Prof. A. M. Gaudin (see *Nature*, October 18, p. 656). Thirty-nine papers were presented, covering the international field of research and application. Size, surface area, shape and lattice structure were brought together in a series of papers which dealt with discontinuity lattices and their effects on minerals chemically almost identical. The mathematics of crushing and grinding are at present statistical rather than fundamental, and are showing that the hypotheses of Kick and Rittinger, which during the past century have aged unobtrusively into 'laws', are not entirely satisfactory. Papers on comminution and precise measurement of products down to the 5-μ range discussed the role of stresses shown at the surface of the particle as 'crack tips', and defined and described the principles and laboratory techniques now available for the measurement of sizes and surface areas of the crushed products. Sub-sieve methods using sedimentation and elutriation in gaseous and liquid columns were compared. The practical aspects of this work in its extension to process control were covered in another group of papers. One important aspect of this branch of technical research is its use in the reduction of huge tonnages of low-grade ore to a closely controlled size-range of particles having a suitably differentiated condition at their individual surfaces as a prelude to separation by froth flotation, a process which can operate in suitable cases with high efficiency on particles as small as 3 or 4 μ in diameter.

The limitation of 'heavy media separation', as the process is industrially called, has been progressively reduced until to-day suitable material down to 20 mesh (Tyler) can be treated, although such a small size is exceptional. In one of the papers describing plant operation, a daily tonnage of 12,800 was mentioned, treating diamondiferous 'blue clays' down to 10 mesh by this method. The operating characteristics of the hydro-cyclone received new elucidation in two papers. This instrument applies controlled centrifugal force to a moving stream of particles and aids them to segregate in accordance with their difference of mass. Provided there is a marked difference of density in the + 100-mesh field, simple gravitational force can be used for this work; but as the Newtonian laws of settlement give place to Stokesian sedimentation, accelerated gravitational fields must be used if large quantities are to be handled quickly. The fundamental work of the Dutch and British laboratories in this intricate research is important. Two papers reported developments in the use of air as a commercial separating medium in desert country.

The largest group dealt with the froth flotation process, at all levels from that of the fundamental worker in surface chemistry to that of the specific problems handled in exploiting plants. The physics of frothing, aeration and attachment of a hydrophobic particle to an air-bubble in water were well represented. The effects of minute traces of soluble ions on the specific development of hydrophilic and hydrophobic surfaces were also considered. Other papers dealt with ion-migration study involving radioactive isotopes and the application of electrochemical methods to flotation research.

The present position of magnetic, electrostatic and photometric techniques was discussed in three papers. A striking symptom of change is the fact that only one paper dealt with the chemistry of cyanidation, although two others discussed plant practice in gold extraction. If mineral dressing had been of sufficient importance twenty years ago to bring together an international gathering of this calibre, the cyanide process might have dominated the scene. Even on the Rand, where the technology was first established, the main interest is now in the flotation of uranium from cyanide tailings—a process still on the secret list and therefore not presented at this symposium. Among the papers dealing with commercial practice was one on lead–zinc concentration, one on a gold–copper–zinc–pyrite complex, one on the design of small plants and one on the milling of asbestos.

The symposium brought a large gathering of scientific workers and engineers from all over the world, and discussion and interchange of views were sustained at a high level throughout the three days of the meeting. Appropriately to the occasion which had brought so distinguished a gathering of experts to Britain, the partly completed sections of the reconstructed Bessemer Laboratory of the Royal School of Mines were open. The 1910 layout, which contained what may have been the earliest pilot plant for industrial teaching and research, is being modernized to meet the need for specialized training of students and to provide further facilities in Britain for research in ore concentration, one development of which is the new degree course of the University of London in mineral dressing. E. J. Pryor

NEW RESEARCH TECHNIQUES IN PHYSICS

SYMPOSIUM IN BRAZIL

A SYMPOSIUM on "New Research Techniques in Physics" was jointly organized by the Academia Brasileira de Ciencias and the Centro de Cooperación Científica para América Latina (Unesco) and was held in Rio de Janeiro during July 15–22 and in São Paulo during July 24–29. The meeting had a double purpose: to provide for Latin American physicists an opportunity of discussing their problems, as part of a more general programme of the activity of Unesco in Latin America, and to stimulate and help the development of modern research in Brazil, by inviting a number of distinguished foreign scientific workers. The meeting was sponsored by the Conselho Nacional de Pesquisas (National Research Council; president, Admiral Alvaro Alberto), and, in São Paulo, by the University of São Paulo.

The number of foreign participants was very encouraging, and Latin American physicists came from Argentina, Bolivia and Mexico, of whom the strongest group was that from Mexico, giving seven papers out of a total of sixty-seven. Prof. M. S. Vallarta (Mexico) reported on an injection mechanism of charged particles due to the variable magnetic field of sunspots. He pointed out that protons in a sunspot could be accelerated up to 6×10^{9} eV.; while electrons, in the same field, would lose most of their energy by electromagnetic radiation.

I. Escobar (Bolivia) reported on work he had done at Echo Lake on the east–west asymmetry of positive and negative mesons. He expects to be able very soon to continue this work on the geomagnetic equator, at the high-altitude station at Chacaltaya (5,300 m.) which will be operated jointly by the Universidad Mayor de San Andrés (La Paz) and by Dr. C. Lattes, Centro Brasileiro de Pesquisas Físicas. Two papers were read by Argentine physicists: K. Fränz has constructed in Buenos Aires an electronic multiplier, which gives 1,000 multiplications per second with a precision of about ·1 per cent, and R. Gans showed how he has been able to solve Hallén's integral equation for the current in a linear antenna in the neighbourhood of resonance frequencies, obtaining a remarkable agreement with experiments.

Prof. J. Costa Ribeiro (University of Brazil) gave a detailed report on a new phenomenon which he has called the thermodielectric effect. He has found that the transition of many dielectric substances from the solid to the liquid state is accompanied by a weak electric current. In the case of naphthalene, the effect is of the order of one electron charge liberated for 10^{19} molecules passing from one phase to the other. Prof. Ribeiro pointed out that the detailed mechanism of the phenomenon is, however, not clear and that it has not yet been possible to establish to what degree the effect is characteristic of a pure substance and how it becomes, eventually, influenced by adding foreign ions.

Several papers dealt with work in Prof. B. Gross's laboratory at the Instituto Nacional de Tecnología. Prof. Gross reported briefly on the behaviour of an electret under variation of temperature and, in another communication, dealt with the work which leads him, alternately, to consider the transformations which connect creep and relaxation of elastic substances and admittance and impedance of electric circuits. He also dealt with electric networks connected either in parallel or series. H. Barbosa (University of São Paulo) reported on certain semiconductors which he has found to be very sensitive to elastic deformations. Prof. R. M. Fuoss (Yale University), who spoke in Portuguese, gave an account of work on polyelectrolytes, in which large polymer molecules carry several charged atoms. Chain molecules are known to influence the viscosity of a solution and, in the case of polyelectrolytes, electrostatic forces, which modify this influence, have to be considered.

A considerable fraction of the symposium was devoted to new apparatus. In the inaugural session H. L. Anderson reported on the new 170-in. synchrocyclotron at Chicago, and D. W. Kerst (University of Illinois) described the three betatrons which are now in operation in Urbana, reaching X-ray energies of 22, 80 and 320 MeV. M. D. Sousa Santos (University of São Paulo) reported on the betatron which he has put into operation in São Paulo and which furnishes X-rays up to 29 MeV.; it is the first instrument of that power which has been set up in Latin America. A series of communications of his collaborators dealt with results which have been obtained so far with the São Paulo betatron, using the excitation function of ^{63}Cu (γ,n) ^{62}Cu in order to test the energy spectrum and the angular distribution of the X-ray beam.

R. G. Herb (University of Wisconsin), F. Alba (University of Mexico) and O. Sala (University of São Paulo) discussed electrostatic generators. In Mexico a 2-MeV. Van de Graaff generator, made in the United States, has been put into operation, while the São Paulo generator, designed to give 3·5 MeV., is still under construction. J. Marshall (University of Chicago) described his Čerenkov counter for cosmic rays, and this was followed by a number of papers dealing with experimental observations noted during the construction of Geiger–Muller counters. S. de Benedetti (Carnegie Institute of Technology) described a coincidence circuit which, in connexion with scintillation counters, permits him to obtain a time resolution of 10^{-9} sec., sufficient to determine the time of flight of a gamma-ray quantum over a distance of a few centimetres. P. Ribeiro de Arruda (University of São Paulo) showed a diffusion cloud chamber operating at a constant temperature gradient.

G. P. S. Occhialini (Brussels) replaced his report on nuclear emulsions by a more detailed seminar in that field. The results which were communicated at the symposium showed clearly four different lines along which modern physics is progressing, namely, modern quantum electrodynamics, nuclear forces, mesons and high-energy phenomena.

Dealing with the first of these, though modern quantum electrodynamics was not represented at the meeting, it intervened in the report of M. Deutsch (Massachusetts Institute of Technology) on positronium. The transfer of momentum between an electron and positron by means of virtual annihilation was studied many years ago by Bhabha, and its influence on the hyperfine structure of the electron–positron system has been discussed by J. Pirenne. But when Dr. Deutsch recently succeeded in determining this hyperfine structure by registering the annihilation radiation of positronium-levels, he not only verified directly the existence of these forces, but he was also able to measure the radiative corrections for them. Dr. de Benedetti has been able to measure the life-time of positrons in metals and has found the surprising result that this life-time does not depend on the particular metal used. He has also been able to register three photon disintegrations of positrons, a phenomenon which, in agreement with theory, is about 370 times less frequent than two photons disintegrating. We can already expect that a new chemistry will be found, one in which hydrogen becomes substituted by positronium, though the substances to be studied will have an extremely short life-time.

Nuclear forces were dealt with in Prof. E. P. Wigner's report. Recent work in Princeton University has led him to the conclusion that the strong spin-orbit coupling, characteristic for the nuclear shell model, can be understood, at least by sign and order of magnitude, as a result of the action of central and tensor forces. A similar result has been found by R. Oehme (Instituto de Física Teórica, São Paulo), who considered the motion of a nucleon in the pseudoscalar meson field of a core. Prof. Herb described the precautions he has had to take in order to make sure that at 4·2 MeV. a small amount of proton scattering appears in the proton–proton collision. Prof. Kerst mentioned in his report the possibility of studying the photodisintegration of deuterons in the energy-range 150–300 MeV.

Important progress has been made in the study of the meson field. A target, beryllium, aluminium or liquid hydrogen, placed in the proton beam of the Chicago synchrocyclotron, has been instrumental in obtaining π-mesons from proton–proton collisions up to 220 MeV. Both Dr. Anderson and Mrs. L. W. Marshall reported on work done with meson beams. Cross-sections were determined for the processes:

$$\begin{aligned} &\pi^+ + p \rightarrow \pi^+ + p, \\ &\pi^- + p \rightarrow \pi^0 + n, \\ \text{and } &\pi^- + p \rightarrow \pi^- + p. \end{aligned}$$

Comparison between these cross-sections was possible at 135 MeV. The elastic scattering was found to be about isotropic, while the charge exchange leads to a marked backward scattering. The cross-section of the first process has been found to be several times larger than that of the last. The observed values agree well with a charge-symmetric interaction which makes the total isotopic spin an integral of motion.

Prof. Kerst's large betatron gives photoproduction of π-mesons, a subject which is under investigation. A search has been made to detect V-particles, so far without result; there is certainly less than one V-particle per 2,500 photomesons at 300 MeV. The difficulties of meson theory were emphasized by J. Leite Lopes (Centro Brasileiro de Pesquisas Físicas), who reported on an attempt made by himself and R. P. Feynmann with the aim of accounting for the deuteron structure by means of pseudoscalar mesons. An interesting point was brought forward by G. Fialho (Centro Brasileiro de Pesquisas Físicas), who, following the suggestion of Prof. G. Tiomno, showed that the, eventually anomalous, magnetic moment of the μ-meson accounts for most of the weak γ-radiation which accompanies the $\pi \rightarrow \mu$ decay.

Finally, high-energy phenomena, in particular the multiple production of mesons, were discussed in two papers. G. Molière (Centro Brasileiro de Pesquisas Físicas) reported on work he had done in Göttingen together with J. Budini—a phenomenological theory of the development of a nucleon cascade. G. Wataghin (University of Turin), outlining what has grown out of the pioneering work he had done during fifteen years in São Paulo, discussed a field theory with non-localized interaction, which promises to account for multiple meson production.

It is perhaps surprising that no new meson was reported during the symposium, though almost a month had passed since a previous meeting of nuclear physicists in Copenhagen.

Among the many other interesting papers, mention must be made of a report by Dr. D. Bohm (University of São Paulo) on his attempt to give a causal interpretation to the formalism of quantum mechanics.

The symposium was judged by all concerned to have been very successful, and not the least credit for this is due to Dr. A. Moses, president of the Brazilian Academy, and to Prof. J. Leite Lopes, who devoted several months to the work of organizing it.

EXPERIMENTS ON THE USE OF DDT, BHC AND DIELDRIN AGAINST ADULT MOSQUITOES AT TAVETA, KENYA

By G. DAVIDSON
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DURING the past two years, simple mud-walled, thatch-roofed huts fitted with exit window traps and occupied by volunteer Africans have been sprayed with various formulations of the three insecticides, DDT, BHC and dieldrin, and the effect on the *Anopheles gambiae*, *A. funestus* and culicine mosquitoes entering them observed. Daily mortalities among the mosquitoes were determined by counting the dead individuals on the floors of the huts, and counting those dying later (within 12 hr. of capture) which were caught alive inside the huts in the morning and in the window traps during the night.

In these huts, before any insecticide was applied, it was found that most of the female *A. gambiae* and *A. funestus*, which entered during the night to feed on the occupants, rested inside the huts after feeding until their blood was digested and their ovaries matured. The gravid mosquitoes then left the hut in the evening. Except during the season of peak production of these species, more mosquitoes left the huts in the evening than during the rest of the night. Nearly all those leaving during the rest of the night and early morning were unfed individuals; very few were fed and showing ovarian development.

In the first series of experiments, an attempt was made to repeat the observations made by Muirhead Thomson[1] in similar huts in Tanganyika. This author, using the DDT wettable powder 'Ditrene', at an estimated dosage of 400 mgm. DDT per square foot, and the BHC wettable powder 'P.530', at 200 mgm. BHC per square foot (26 mgm. of the gamma isomer), concluded that DDT applied to the internal surfaces of a hut only irritated resting *A. gambiae* and *A. funestus*, causing them to leave the huts without actually killing them. BHC, on the other hand, proved a most efficient residual insecticide and, during the period of his observations (up to thirteen weeks after spraying), no mosquitoes were observed to escape its killing action.

In these experiments, where the insecticide dosages were chemically estimated at 98 mgm. DDT per square foot for 'Ditrene' and 153 mgm. BHC (20 mgm. of the gamma isomer) per square foot for 'P.530', the almost complete absence of kill with 'Ditrene', recorded by Muirhead Thomson[1], was not confirmed, even with the much lower dosage employed. The overall mortality among female *A. gambiae* and *A. funestus* in the 'Ditrene'-treated hut was 40 per cent in the first month after treatment, falling to approximately 20 per cent in the following two months. The results did show, however, that a large proportion of the mosquitoes escaped the action of this insecticide. In the hut treated with BHC, the mortalities in the first three months were much higher, namely, 99 per cent, 95 per cent and 60 per cent respectively.

Later experiments, using other formulations of DDT and BHC, confirmed these findings. In all the huts treated with DDT, a significant proportion of the female *A. gambiae* and *A. funestus* entering them escaped unharmed, even immediately after treatment. This proportion was always more than 20 per cent, but never as high as in the hut treated with 'Ditrene'. The DDT formulations and their chemically estimated dosages used in these later experiments are shown in Table 1.

TABLE 1

Formulation	Dosage (in mgm. DDT per sq. ft.)
Suspension of crystals, 0–30 microns	124
Suspension of crystals, 30–70 microns	51
'Murphy Paste'	238
'Murphy Wettable Powder'	229

For six months after treatments with these DDT preparations, the overall mortalities among female *A. gambiae* and *A. funestus* remained, for the most part, between 50 and 70 per cent, and even in the seventh to ninth months, between 40 and 60 per cent.

The suspension of smaller crystals produced higher kills in the first two months after treatment than did that of larger crystals, confirming the laboratory findings of Hadaway and Barlow[2]. The relatively poor kill produced by the 'Ditrene' in the first series of experiments is accounted for by the fact that this preparation contains a high proportion of large DDT crystals of the order of 80 microns.

The marked irritant properties of DDT were indicated by the fact that the majority of the mosquitoes were caught leaving the huts treated with DDT during the night and early morning, that is, in the window traps, and many of these were freshly blooded individuals. The proportions found dead on the floors of these huts were relatively small.

Two huts treated with BHC—the wettable powder 'P.520'—at 21 mgm. of the gamma isomer per square foot, and the oil-bound suspension 'Supona B' (TP.725), at 18 mgm. of the gamma isomer per square foot, produced similar results. In the first month after treatment, no female *A. gambiae* and *A. funestus* escaped the effect of these preparations. In the second and third months the overall mortalities among these two species fell from about 90 to 70 per cent, and in the fourth to sixth months from 50 to 30 per cent. In these huts treated with BHC, in the first four months after treatment a higher proportion of the mosquitoes were found dead inside the huts and a lower proportion in the window traps than occurred in huts treated with DDT.

A hut treated with a mixture of BHC and DDT in an oil-bound suspension (TP.726) at calculated dosages of 54 mgm. BHC (7 mgm. of the gamma isomer) and 223 mgm. DDT per square foot, showed the high initial kill of BHC (94 and 88 per cent overall mortalities among female *A. gambiae* and *A. funestus* in the first two months after treatment) and the moderately high, long-lasting kill of DDT (76, 63, 82 and 59 per cent in months three to six). The irritant effect of DDT was again indicated by the high proportion of the mosquitoes collected from the window traps.

In the later experiments a hut was also treated with the new insecticide, dieldrin. This was applied in the form of a wettable powder at a calculated dosage of 50 mgm. dieldrin per square foot (chemical estimations yielded the very low average figure of 7·2 mgm. of dieldrin per square foot, but this was entirely incompatible with the calculated dosage). Results showed this insecticide to be the most efficient of those tested. For three months after treatment, mortalities among female *A. gambiae* and *A. funestus* were 100 per cent, and in the following six months they remained greater than 80 per cent. For the greater part of this period the majority of the mosquitoes collected were found dead inside the hut.

Little difference in the effects of the insecticides on *A. gambiae* and *A. funestus* females was observed. Against *Culex fatigans* all the DDT preparations gave very low kills (10–30 per cent), the BHC ones high initial kills (85 per cent in the first month, 7–30 per cent in months two to six) and dieldrin high, long-lasting kills (between 60 and 95 per cent for seven months after treatment).

In the later series of observations, *A. gambiae* and *A. funestus* females, caught from untreated houses in the area, were suspended in cages inside the huts without actual contact with the treated surfaces. After varying lengths of time the cages were removed and the mortalities among the mosquitoes determined 24 hr. later. The BHC preparations (P.520 and the oil-bound suspension) produced high kills among mosquitoes suspended for two to twelve hours for three months after treatment, especially among those nearest the treated surface. In two huts treated with DDT (the two Murphy formulations) the kills varied considerably but were generally low, even when the mosquitoes were left overnight (12 hr.). On the other hand, dieldrin produced very high kills among these suspended mosquitoes throughout the nine months observations.

DDT and dieldrin are both relatively non-volatile insecticides, and these kills among mosquitoes suspended without actual contact are probably due to the presence of airborne particles of the insecticides in the huts. If these particles occurred in similar numbers in both the huts treated with DDT and those treated with dieldrin, higher kills would be expected in those treated with dieldrin because of the greater toxicity of this insecticide.

Kills in the huts treated with BHC, where the insecticide is a volatile one, are probably due to a combination of fumigant and particulate effects.

In conjunction with these hut experiments, observations were also made on the resting times of individual mosquitoes on cardboard surfaces treated with the various insecticides. With all three insecticides, *A. gambiae* and *A. funestus* females were irritated by contact and after varying periods left the treated surface and flew towards light. These irritated mosquitoes were then caught and kept for 24 hr. and the mortality among them recorded. It was clearly demonstrated that a high proportion of these specimens were irritated and left a surface treated with DDT before they acquired a lethal dose of the insecticide. The longest contacts and the highest kills occurred with dieldrin, and slightly lower figures were recorded for BHC. With the mixture of BHC and DDT, a short contact occurred as with DDT alone, but a higher mortality was produced than with DDT alone. Table 2 summarizes the results obtained with surfaces treated with various formulations of the three insecticides in varying dosages up to two weeks after treatments.

TABLE 2

Insecticide	Total mosquitoes tested	Average contact time (min.)	Percentage mortality after 24 hr.
		A. gambiae	
BHC	51	22	75
DDT	71	8	82
BHC and DDT	7	8	57
Dieldrin	30	28	97
		A. funestus	
BHC	61	27	82
DDT	87	10	51
BHC and DDT	6	7	67
Dieldrin	17	36	94

A detailed account of these experiments, which were carried out on behalf of the Colonial Insecticides Committee, Colonial Office, London, is to be published shortly. [April 23.

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'DOUBLE FRONTING' IN PAPER CHROMATOGRAPHY OF PROTEINS

By HANS G. BOMAN

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DURING the first half of the present year, several authors have reported separations of proteins and enzymes by paper chromatography[1]. However, no investigations concerning the mechanism of this chromatographic process have as yet been published.

In this communication a few simple experiments are described which seem to indicate that there is a sort of 'double fronting' which appears to be the result of a displacing effect, and which has a great influence on the movement of the protein. Recently, E. Lester Smith[2] and also T. C. J. Ovenston[3] pointed out the possibilities of getting double zoning in partition chromatography. In spite of the analogy, it seems difficult to judge at present if the mechanisms in the two cases are similar.

The experimental procedure has been as follows. On a paper strip 12 cm. × 20 cm. (Whatman 54), six spots of commercial human serum albumin are placed on a line drawn obliquely across the paper (see Figs. 1–3). The chromatogram is then developed (temp. + 4° C.) with a mixture of 30 per cent ethanol and 70 per cent phosphate buffer ($\mu = 0 \cdot 10$), pH 7·7, and after the run the protein spots are made visible by staining with bromphenol blue[4]. Instead of falling on an oblique line as at the start, all the spots appear at the same distance from the front of the developing liquid (Fig. 1*b*). If the run is stopped at an earlier stage, the appearance of the chromatogram is somewhat different (Fig. 1*a*).

It is, however, also possible to apply the serum albumin behind the solvent front in the following way. The paper (without protein) is developed until

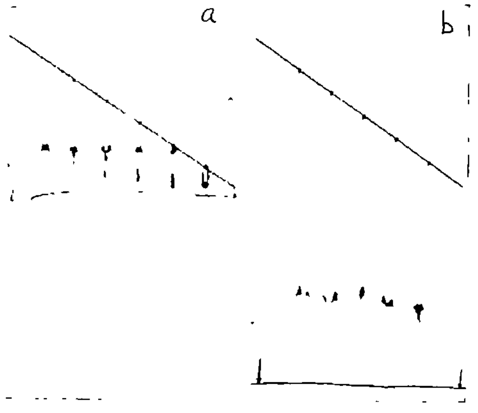

Fig. 1. Serum albumin placed on an oblique starting line and developed with ethanol and buffer (30 : 70)

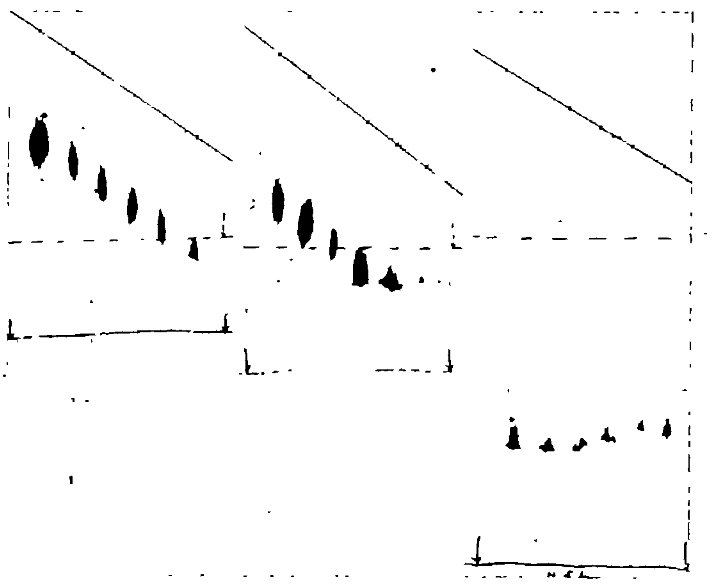

Fig. 2. Chromatograms with the albumin applied behind the solvent front

the solvent front has passed about 4 cm. beyond the last mark on the oblique starting line (that is, reached the dotted line in Fig. 2). The paper is then quickly taken out and serum albumin is applied to the starting marks by means of a capillary pipette. Development is then continued. Fig. 2 shows three such experiments which have been stopped at different times.

Two things may be specially noted. First, in the early stage of the process the spots occur obliquely, as is to be expected in ordinary chromatography, and have the usual oval shape. This gradually changes as if the spots were taken up by 'an invisible front' behind, but parallel to, the front of the developer. At the same time as the spots reach this 'front', they change to a more compressed shape. Secondly, all the oval spots are moving faster (R_F 1·2) than the front of the developing liquid, which means that part of the developer is adsorbed by the paper. This is in agreement with the results of Kowkabany and Cassidy[5].

Further, if, before the run, the paper is exposed to the atmosphere in the chromatographic vessel for at least eight hours, the adsorption of the albumin is decreased to such an extent that it follows the front of the developing liquid. In this way it is also possible for the albumin to pass the 'invisible front'. The rate of travel of this second front seems fairly constant; the R_F value as measured from the end of the paper is about 0·8.

These experiments can be explained as follows. Fig. 1*a* shows that at first the albumin travels closely behind the front, but that it is partly adsorbed on the paper. After a time, all the albumin has been adsorbed and the appearance of the chromatogram should be a series of narrow fingers of the same length (compare Fig. 3*a*). When, however, the developer travels through the paper, it causes some changes in it, possibly in the charge, which almost completely prevent serum albumin from being adsorbed behind this 'displacing front'. Thus the spots are taken up one by one by this front during the run. The shape of the spots also depends on the fact that the albumin is adsorbed before, but not after, this front. According to this view, the same changes in the paper should take place when it is exposed to the vapour.

In an early stage, when only some of the protein has been adsorbed and the 'displacing front' has passed the starting point, it is possible to get two spots (see Fig. 3*d*). In this way one can consequently split a homogeneous substance into two components—an artefact that may be of some interest.

As both serum albumin and the paper at *p*H 7·7 are negatively charged, *p*H changes towards the isoelectric point would be expected to cause increasing adsorption. Fig. 3 shows four chromatograms developed with the same concentration of ethanol (30 per cent) but with different phosphate buffers (μ = 0·10) : (*a*) *p*H 5·2, (*b*) 6·0, (*c*) 6·9 and (*d*) 7·7. It is easy to follow the decreasing effect of the 'displacing front' the more strongly the albumin is adsorbed.

Preliminary experiments have given the same result for another paper (Whatman 1) and for phycoerythrin using acetone buffer as the developing agent.

The phenomena described here indicate that great care must be exercised in the interpretation of the results obtained by filter-paper chromatography of proteins.

I wish to express my thanks to Prof. A. Tiselius for his interest and advice. [June 20.

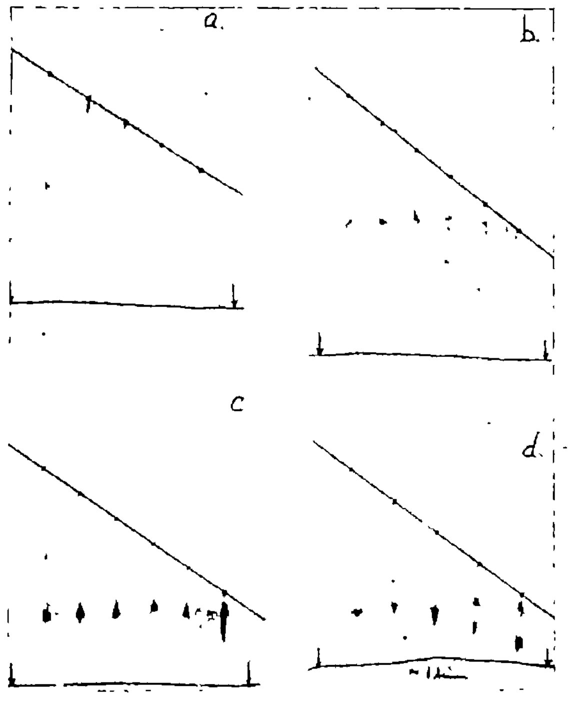

Fig. 3. Chromatograms developed with 30 per cent ethanol and different phosphate buffers, *p*H being (*a*) 5·2, (*b*) 6·0, (*c*) 6 9 and (*d*) 7·7

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Relativistic Theory of a Rigid Body

GARDNER[1] has recently given a new relativistic theory of a rigid body, and Synge[2] has applied this theory to the earth considered as a rigid body in rotation. He predicts, on the basis of the Gardner theory, that the fringes in a Michelson interferometer with one arm inclined at 45° to the horizontal should shift on rotating the interferometer about a vertical axis—provided that the interferometer is rigidly attached to the earth. The fringe shift predicted is $\left(\frac{E}{c}\frac{D}{\lambda}\right)\sin\theta$, where E is the velocity of earth's rotation, D is the length of the arm of the interferometer and θ is the angle between the projection of the direction of the inclined arm on a horizontal plane and a line pointing north[3].

We have made the following experiment to look for the predicted shift. A Michelson interferometer (made by Messrs. Hilger–Watts) was modified: (*a*) by mounting it on a suitable stand so that the arm along which the light enters is horizontal and the other arm is tilted so that the observer looks downwards along a line at 45° to the horizontal; (*b*) by clamping the movable carriage to the bed of the interferometer to give an arm of fixed length (approximately 12 cm.); (*c*) by extending the other arm to about the same length. The apparatus was clamped to the table of a large drilling machine. This table could be unclamped for rotation or clamped to the base of the drilling machine. The floor was of bituminous material, into which the feet of the machine were embedded. Underneath this was a concrete raft resting on earth.

The 5461-A. line of mercury obtained from a low-pressure source mounted on the drilling table was used. The instrument was adjusted to give about three straight-line fringes in the field of view. They could be regarded as localized on the mirror opposite the observer, who looked in through a pinhole. A line drawn in the silvering of the mirror was used as a reference mark.

The interferometer was arranged so that the observer looked along a line pointing westwards (and downwards). The position of the fringes was observed (1) with the table clamped and (2) with it unclamped. The table was then slowly rotated by hand, the observer viewing the fringes during rotation. When the table had been rotated through 90° so that the observer looked in a northerly direction, the rotation was stopped and the position of the fringes noted with the table clamped and with it unclamped. The table was then rotated through a further 90°, and the position of the fringes was again observed with the table clamped and with it unclamped.

The following results were obtained: (1) no significant change in the position of the fringes was obtained on clamping or unclamping the table, (2) during rotation the fringes vibrated with an amplitude of about 0·1 fringe, but on stopping the rotation they came to rest in the original position. In the best tests, a shift of 0·05 fringe should have been observable and no shift was observed. The shift calculated from the above formula is 0·42 fringe, and since 0·1 fringe could easily have been detected we conclude that the predicted shift does not take place.

We wish to thank Prof. J. L. Synge for a private communication in which he discussed the conditions to be fulfilled in testing the theory.

R. W. DITCHBURN
O. S. HEAVENS

Physics Department,
University of Reading. Sept. 3.

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Permafrost Drilling and Soil-Temperature Measurements at Resolute, Cornwallis Island, Canada

IN August 1948, a drilling programme was carried out at Resolute, N.W.T., Canada, lat. 74° 41′ N., long. 94° 54′ W., to locate a suitable site for a future seismological station. When this had been completed, a series of shallow holes was drilled about 100 ft. north of the weather station operations building, and ceramic resistance thermometers were inserted at depths of 8, 18, 39 and 60 in.

In 1950 it was decided to extend the scope of this investigation and attempt to obtain information from much greater depths in the permanently frozen ground. A maximum depth of 1,000 ft. was set as the objective. This project was made possible by the joint efforts of the Meteorological Division of the Canadian Department of Transport, the United States Weather Bureau, and the Dominion Observatory of Ottawa, Canada.

To begin each hole, a 2½-in. pipe was driven to bedrock with a 350-lb. hammer. It was found in each case that the overburden was approximately 6 ft. thick and consisted of frozen gravel. The bedrock was limestone with occasional faults and cracks. The drill hole had a diameter of 1½ in. and recovered core with diameter 15/16 of an inch.

Holes were drilled to depths of 6, 11, 23, 30, 50 and 103 ft. and cables with temperature elements were inserted in each. All the core was recovered from the 103-ft. hole. The most serious problem encountered was the maintenance of an adequate circulation of hot water in the drill hole to prevent frost formation.

An improved hot-water boiler and pumping equipment were provided in 1951 and a further attempt was made to drill to a depth of 1,000 ft. Water for the drilling was obtained by pumping it directly from a lake 1,500 ft. distant, and drilling operations were carried on around the clock. As the drilling proceeded to greater depths, the circulating water had to be heated to a correspondingly higher temperature. The valves and plungers of the pump did not stand up too well under the increased heat and pressure, and breakdowns occurred frequently.

Out of a total of seven holes which were drilled during the period from the first week of July until August 20, five holes were lost. Three were lost due to cave-in, another owing to breakdown of the pumping equipment, and the fifth when mud formed at the bottom of the hole and the line pressure was insufficient to wash the mud to the surface.

The remaining two holes were drilled to depths of 307 ft. and 453 ft. respectively. Thermistor elements were lowered into each of these and regular temperature readings are being taken. The 453-ft. hole was completed in four days. A greater depth could have been reached; but so much drilling equipment had been lost in the other holes that no drill rods were available to progress farther. A continuation of the permafrost drilling programme is being carried out during the present summer, when it is hoped that the objective of 1,000 ft. will be reached.

The average conductivity of the bedrock as determined from the core samples by Prof. A. D. Misener, of the University of Western Ontario, London, Ontario, is :

$$K = 0\cdot0066 \text{ c.g.s. units at } 31\cdot2^\circ \text{ C.}$$

A thorough analysis has not been made as yet of the soil temperature observations from Resolute. Nevertheless, a number of interesting features has been noted.

(1) The temperatures at the 8-in. level show short-period fluctuations which reflect the fluctuations of the air temperature above the surface. However, these fluctuations from ambient air temperatures are rapidly damped out with increasing depth and are practically negligible at the 60-in. level.

(2) There is a marked lag in seasonal temperature changes with depth. For example, the temperatures at the 8-in. and 18-in. levels reach a maximum about the second week in August, whereas the temperature at the 60-in. level continues to rise until mid-September. The temperatures from the surface to the 60-in. level fall at varying rates after mid-September, so that by the last week in September there is a reversal in sign of the temperature gradient.

(3) The temperatures in the layers near the surface begin to rise in early March, and about May 1 there is again a reversal in sign of the temperature gradient from the surface to the 60-in. level.

(4) From about August 25 to September 15, the temperatures within 18 in. of the surface remain near the freezing point, indicating that the complete freezing of the water in the active layer takes about three weeks.

(5) The temperatures at the 98-ft., 300-ft. and 450-ft. levels remain practically constant with the following values: 98 ft., $-13\cdot50^\circ$ C.; 300 ft., $-11\cdot59^\circ$ C.; 450 ft., $-9\cdot54^\circ$ C.

(6) The layer from 50 ft. to 98 ft. is nearly isothermal.

(7) Seasonal temperature changes are perceptible to near the 50-ft. level; but the lag at this level amounts to about six months.

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Reaction between Diethyl Peroxide and Nitric Oxide

In the hope of trapping the radicals probably produced during the photolysis of diethyl peroxide, the vapour of the latter was mixed with a several-fold excess of nitric oxide in a 3-litre 'Pyrex' bulb. The mixture was then passed through a water-cooled helical silica tube surrounding a mercury arc into a trap immersed in 'Drikold'. Suspiciously large amounts of ethyl nitrite were found in the trap, and even larger quantities were collected in a blank run without the arc. After the mixture had been stored in the dark for twenty-four hours, spectrophotometric examination showed that a major portion of the peroxide had been converted into nitrite.

The inhibition by nitric oxide of the thermal decomposition of diethyl peroxide[1] is clearly no evidence for a free radical mechanism.

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[1] Moriya, *Rev. Phys. Chem., Japan*, 143 (1946).

Inhibition of the Thermal Decomposition of Diethyl Peroxide

The mechanism of the thermolysis of diethyl peroxide is uncertain. Harris and Egerton believed the reaction to be a straightforward, unimolecular decomposition, although they observed short induction periods with some samples and generally much longer ones in the presence of nitric oxide[1]. The products suggest the occurrence of reactions involving free radicals, and in the opinion of Neumann[2] the decomposition is a chain reaction. It is, however, difficult to reconcile a significant participation of free radicals in the decomposition with the first-order kinetics and the low activation energy (c. 31 k.cal.); compared with accepted dissociation energies of O—O bonds (HO—OH, 54 k.cal.[3], *t*.BuO—O*t*.Bu, 39 k.cal.[4]).

A re-examination of the reaction in a spherical 2-litre 'Pyrex' vessel using peroxide pressures of a few millimetres of mercury has, in the main, confirmed the results obtained by Harris and Egerton. Our velocity constants, derived from initial rates, were however about 25 per cent greater than those of Harris and Egerton, and the activation energy, a little smaller. An appreciable reaction of zero order appeared to be superimposed on the first-order reaction at temperatures below 160° C. During the course of individual reactions, the first-order law was not well obeyed by the pressure change, and the energy of activation derived from the 'half lives' of the pressure change were considerably less than that obtained from the initial rates, and was, indeed, close to the value of about 22 k.cal. obtained by Russian authors[2].

When hydrogen iodide was added to the peroxide vapour at c. 140° C., the rate of change of pressure was reduced and iodine was formed. Excess hydrogen iodide reduced the rate to zero. Addition of iodine also inhibited the pressure change, although not completely, a limit of about 40 per cent of the uninhibited rate being attained with excess iodine.

In view of the reaction observed with nitric oxide[5], caution is required in the interpretation of these observations, which are being extended.

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[2] Blat, Gerber and Neumann, *Acta Physicochim., U.R.S.S.*, 10, 273 (1939). Neumann and Tutakin, *Acta Physicochim., U.R.S.S.*, 9, 861 (1938).

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A New Method of Melting Ferromagnetic Semiconductors. $BaFe_{18}O_{27}$, a New Kind of Ferromagnetic Crystal with High Crystal Anisotropy

In recent years, ferromagnetic oxides have become of great interest for electrotechnical applications[1,2]. They are used in the form of polycrystalline sintered materials. In order to get a better insight into the properties of the material itself, without the additional influence of air pores, we started to prepare these oxides from the melt. Moreover, we hoped to grow from these melts single crystals large enough for magnetic measurements.

Smiltens *et al.*[3] melted magnetite, Fe_3O_4, in an electric furnace at about 1,600° C. By moving the platinum crucible through a temperature gradient, large single crystals were obtained. Galt *et al.*[4,5] grew small single crystals of nickel ferrite and manganese zinc ferrite from a borax melt.

We have applied the high-frequency melting technique common in research on metals. Special problems arise in using this high-frequency technique when dealing with oxides, which are mostly semiconductors with a high resistivity at room temperature. All ferromagnetic materials investigated were composed of several oxides, one of which was always iron oxide. As magnetite is an iron oxide with a relatively low resistivity ($\rho = 0{\cdot}01$ ohm cm. at room temperature[6]) it has been used as a starting material for the melts, instead of α-Fe_2O_3.

In order to prevent oxidation of the material and the resultant loss of conductivity during heating, the melting process is carried out in a nitrogen atmosphere containing less than 10^{-4} parts of oxygen. Sintered magnetite disks are placed in a quantity of a metal oxide powder such that the desired ratio of the metal ions in the final product is obtained. When the contents of the crucible have completely melted in the nitrogen atmosphere, this atmosphere is gradually changed to the equilibrium oxygen atmosphere of the ferromagnetic oxide at its melting point. The conductivity of the ferromagnetic oxides in the neighbourhood of this temperature is sufficiently high to make the high-frequency induction currents keep these oxides in the molten state. An advantage of this method of melting is the possibility of inserting the high-frequency coil in a high-pressure apparatus, so that when the contents of the crucible have melted in a reducing atmosphere, the nitrogen can be replaced by oxygen at a pressure much higher than atmospheric. Another advantage is that it is not the crucible itself that is directly heated, but its contents; thus the crucible has a slightly lower temperature than is the case when using the electric furnace technique, and thus contamination of the melt by the crucible material will be slower. Several kinds of crucibles have been used, the best results being obtained with one of alumina preheated to a temperature slightly below its melting point. The top of the melt was kept at the same or even at a higher temperature than the bottom by putting a disk of rhodium or iridium metal as a lid upon the crucible. In the high-frequency field, this metallic disk attains a higher temperature than that of the contents of the crucible, thus causing additional heating of the surface.

Disk-shaped surface crystals grow when the melting process described above is followed by a reduction of the high-frequency current and consequent slow cooling below the temperature at which the contents solidify. The accompanying illustration is a photograph of the surface of the contents of the crucible, showing several crystals of manganese ferrite (diameter of the crucible 32 mm.). One of these materials has a [100] plane parallel to the surface, while all other planes shown are [111] planes.

Surface of the contents of a crucible showing several disk-shaped single crystals of manganese ferrite (crucible diameter, 32 mm.)

Magnetite crystals containing less than 2 per cent ferrous ions in excess are obtained from the melt if the melting process is carried out in an atmosphere having less than about 10^{-4} atm. oxygen pressure. In order to prevent oxidation during cooling, the melt is rapidly cooled (within 10 min.) from just below the melting point (1,600° C.) to about 1,000° C., after which it is cooled to room temperature in about five hours. The equilibrium oxygen pressure at the melting point appeared to differ greatly from that given by Darken and Gurry[7] (about 0·06 atm. oxygen), but is in good agreement with the figure given by Smiltens[3]. The equilibrium atmosphere of manganese ferrite at its melting point (1,600° C.) appeared to be about 1 atm. of oxygen (crystals containing 0·17 per cent ferrous ions by weight were obtained), which was also found recently by Gurry and Darken[8].

Another interesting ferromagnetic material is $BaFe_{12}O_{19}$, which has a hexagonal structure[2] and shows a very high magnetic crystal anisotropy. Experiments on the melting of magnetite with different amounts of barium carbonate gave three kinds of hexagonal phases with different *c*-axes, respectively 23·2, 32·8 and 28 A. Mostly these phases formed thin alternating layers of parallel-oriented crystals, and a single type of crystal could not be separated. Braun (see ref. 2) found that the first kind has the magnetoplumbite structure already described by Adelskold[9]. From a melt of 12 gm. Fe_3O_4 and 1·8 gm. $BaCO_3$ in oxygen, a single crystal with a *c*-axis of 32·8 A. was separated. The dimensions of this crystal were 4 × 5 × 0·3 mm. An account of the X-ray examination of this crystal is given by Braun[10]. This crystal proved to have the composition $BaFe_{18}O_{27}$ and a structure resembling that of $BaFe_{12}O_{19}$. It has the hexagonal axis perpendicular to the surface of the disk, and in a homogeneous magnetic field this *c*-axis becomes oriented parallel to the lines of force, which suggests a very strong crystal anisotropy. Results of magnetic measurements are given elsewhere[2].

I wish to thank Dr. J. J. Went for his interest and advice during the experiments.

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June 12.

[1] See, for example, Snoek, J. L., "New Developments in Ferromagnetic Materials" (Elsevier, 1947).

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[4] Galt, J. K., Matthias, B. T., and Remeika, J. P., *Phys. Rev.*, 79, 39 (1950).

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[8] Gurry, R. W., and Darken, L. S., *J. Amer. Chem. Soc.*, 72, 3906 (1950).

[9] Adelskold, V., *Ark. Kemi, Mineral. Geol.*, 12A, 1 (1938).

[10] Braun, P. B., see following communication.

Crystal Structure of BaFe$_{18}$O$_{27}$

IN the course of an investigation[1] into the properties of substances with magnetoplumbite structure[2], Wijn[3] of these laboratories tried to prepare single crystals of BaO.6Fe$_2$O$_3$. Mixtures of barium oxide and magnetite (Fe$_3$O$_4$) were melted and slowly cooled. In one of these melts a single crystal of about 4 × 5 × 0·3 mm.^{3} developed.

The results of the X-ray investigation of this crystal are shown below. The notation used is that of the "International Tables for the Determination of Crystal Structures" (1935).

Composition, BaFe$_{18}$O$_{27}$
$a = 5{\cdot}88$ A. $c = 32{\cdot}84$ A.

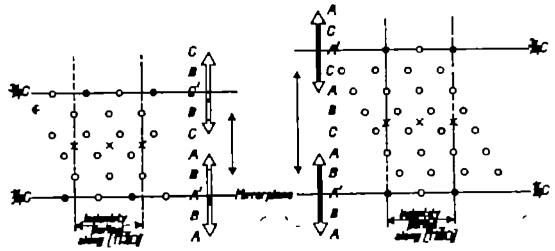
2 Ba	on	2(*b*)		
2 Fe	,,	2(*d*)		
4 Fe	,,	4(*f*)	$z = 75°$	
4 Fe	,,	4(*e*)	$z = 20°$	
4 Fe	,,	4(*f*)	$z = \overline{26{\cdot}8}°$	
4 Fe	,,	4(*f*)	$z = 33{\cdot}5°$	
6 Fe	,,	6(*g*)		
12 Fe	,,	12(*k*)	$z \sim \overline{54}°$	$x \sim 60°$

Space group $C6/mmc$
2 formula units per cell

6 O	in	6(*h*)		$x \sim 180°$
12 O	,,	12(*k*)	$z = 64{\cdot}5°$	$x \sim 60°$
4 O	,,	4(*f*)	$z = \overline{64{\cdot}5}°$	
12 O	,,	12(*k*)	$z = 40°$	$x \sim 180°$
4 O	,,	4(*e*)	$z = \overline{40}°$	
12 O	,,	12(*h*)	$z = \overline{13}°$	$x \sim 60°$
4 O	,,	4(*f*)	$z = 13°$	

The magnetoplumbite structure can be described as consisting of spinel-like blocks, with the thickness of four oxygen layers, linked together by layers in which one oxygen has been replaced by barium. The linking layer is hexagonally packed with respect to its neighbouring layers. Moreover, it contains an iron atom surrounded by five oxygen atoms in a trigonal dipyramid.

The new structure described here is built along the same lines. The spinel block has not four but six oxygen layers, the Ba/Fe ratio now being 1/18.



BaFe$_{12}$O$_{19}$ — Two formula units per cell

BaFe$_{18}$O$_{27}$(16Fe^{3+},2Fe^{2+}) — Two formula units per cell

⇔ Hexagonal close-packed layers

◀—▶ Cubic close-packed layers

○, Oxygen ; ●, barium ; ×, centre of symmetry

A detailed discussion of the structure determination will be published elsewhere.

The accompanying drawings show the relation between the two structures mentioned. They represent sections through the 0001 and 11$\bar{2}$0 axes. All iron atoms are omitted; they are distributed regularly among the cavities in the close packing of oxygen and barium.

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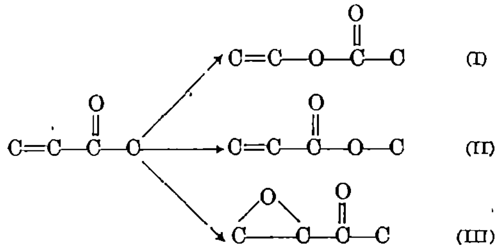
[1] Went, J. J., Rathenau, G. W., Gorter, E. W., and van Oosterhout, G. W., *Philips Tech. Rev.*, B, 194 (1951–52), *Phys. Rev.*, 86, No. 3, 424 (1952).

[2] Adelskold, V., *Ark. Kemi, Mineral. Geol.*, 12A, No. 20 (1938).

[3] Wijn, H. P. J., see preceding communication.

Peroxidation of Unsaturated Ketones

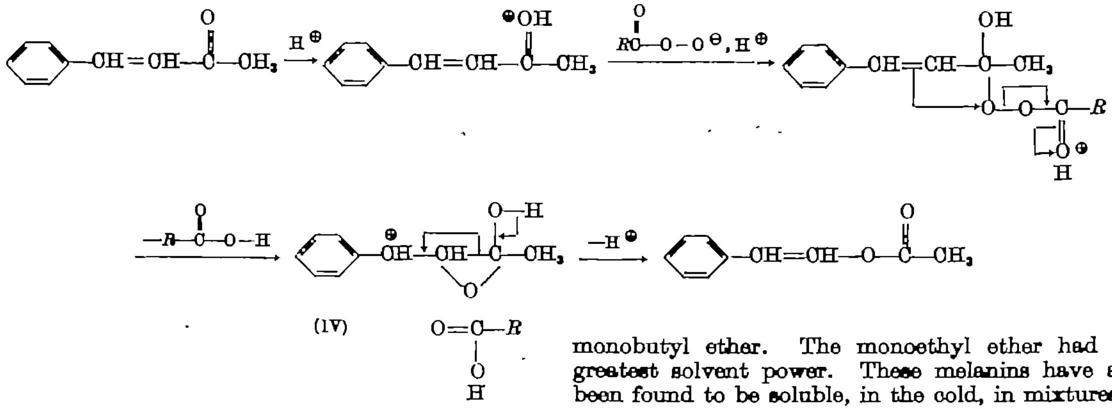
Two recent reviews of peroxidation of organic compounds[1,2] cite the fact that α,β-unsaturated ketones are oxidized by peracids to enol esters. *A priori*, however, one might expect one or more of three possible products and their hydrolysates.



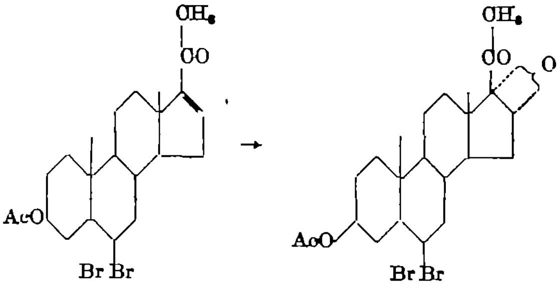
Thus, I and II would result from an attack of peracid at the carbonyl carbon followed by rearrangement according to the mechanism proposed by Criegee[3], Friess[4], and Doering[5], while III would be the consequence of an attack at the β-carbon of the conjugated system.

With the exception of a few peroxidation reactions in the terpene field, only three main examples[6–8] of this process appear in the literature, and in all three cases the starting compounds possess a phenyl group in the β-position. On applying the accepted mechanism[3–5] to this system (for example, benzalacetone), it becomes apparent that the transition state involves a mesomeric benzyl carbonium ion (IV) if the electron-rich carbon–carbon double bond is permitted to participate in breaking the peroxide linkage. Since (IV) constitutes a low-energy state, it would be expected that the above transition requires less activation energy than either the migration of the methyl group (to yield II) or an original attack of the peracid molecule on the β-carbon (to yield III). Thus, it might be predicted that any α,β-unsaturated carbonyl system containing a substituent in the β-position, which has the power of stabilizing a carbonium ion there, would yield an enol ester or lactone on peracid oxidation. Furthermore, systems not having this property might be expected to yield the same, and/or α,β-unsaturated esters or lactones and/or α,β-epoxy-ketones.

Julian's perbenzoic acid oxidation[9] of 5,6-dibromo-16-pregnen-3β-ol-20-one acetate (V) to the 16,17-oxido compound (VI) lends some credence to the above argument. Likewise, preliminary experi-



ments of an extensive research of the peracid oxidation of unsaturated ketones in these laboratories have yielded similar results; for example, an α-phenyl-α,β-unsaturated ketone reacted with peracetic acid giving a mixture consisting mainly of compounds II and III. It is hoped to report on the outcome of these investigations in due course.



(V) (VI)

Helpful discussions on the above problem with Prof. G. Stork are gratefully acknowledged.

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[1] Swern, *Chem. Rev.*, **45**, 1 (1949).
[2] Criegee, *Fortschr. Chem. Forsch.*, **1**, 508 (1950).
[3] Criegee, *Ann.*, **560**, 127 (1948).
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[5] Doering and Speers, *J. Amer. Chem. Soc.*, **72**, 5515 (1950).
[6] Boeseken and Kremer, *Rec. trav. chim.*, **50**, 827 (1931).
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Solubility of Melanins

IN further attempts to find a solvent for melanin which would be of use in histological work, the following substances have been found to dissolve, in the cold, the pigments extracted from the ink sac of *Sepia officinalis* and melanoma tissue, and those prepared from adrenaline and 3,4-dihydroxyphenylalanine (dopa): ethylene glycol monomethyl ether, ethylene glycol monoethyl ether, and ethylene glycol monobutyl ether. The monoethyl ether had the greatest solvent power. These melanins have also been found to be soluble, in the cold, in mixtures of ethyl lactate and benzyl alcohol, the best proportions being 6 of the former to 4 of the latter (by volume). In all these solvents the solubilities of sepia, melanoma and adrenaline melanins were, so far as could be determined from what must be regarded as impure specimens, of the same order, but the melanin from 3,4-dihydroxyphenylalanine was much less soluble than the others. However, these solvents failed to dissolve the melanin in sections of melanoma tissue, even with the aid of heat. The method used for extracting the sepia and melanoma melanins was: (1) solution in 10 per cent aqueous sodium hydroxide, (2) filtration and precipitation of the melanin by dilute hydrochloric acid, (3) removal of extraneous fatty substances by extraction with ethyl alcohol, chloroform and benzene, (4) repetition of (1) and (2). This extraction procedure was also applied to melanins from 3,4-dihydroxyphenylalanine and adrenaline, but in spite of this uniformity of treatment the former product was still the least soluble of the four types of pigment.

Millott and Jacobson[1] have recently directed attention to the variations in the solubility of melanin as described by different workers in this field. In the case of sepia and melanoma melanins, as compared with that from 3,4-dihydroxyphenylalanine, these differences in solubility may well be due to combination of the pigment with other intracellular substances, probably proteins. (Preliminary experiments have suggested that sepia melanin has a molecule approximately twice the size of that from 3,4-dihydroxyphenylalanine[2].) This does not explain the difference in solubility between 3,4-dihydroxyphenylalanine and adrenaline melanins; but this may be due to the persistence of the methyl group, attached to the indole nitrogen, in the adrenaline product[3].

Two conclusions appeared to be justified: (1) removal of melanin from the ink sac of *Sepia officinalis* and melanoma tissue by the method described above altered its chemical composition; and (2) these melanins, after taking into consideration this effect of extraction, are not identical with that derived from 3,4-dihydroxyphenylalanine.

The work has been carried out with the aid of a grant from the Government Grant Committee of the Royal Society.

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[1] Millott, N., and Jacobson, F. W., *J. Invest. Dermat.*, **18**, 91 (1952).
[2] Lea, A. J., (unpublished data).
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Action of X-Rays on Aqueous Solutions of Perchloric Acid

IN the study of the radiation chemistry of metal ions in solution, it may seem desirable to use perchloric acid solutions because it is generally assumed that perchlorate ions show relatively little tendency to complex formation.

However, as was found recently[1], perchlorate in aqueous solutions is decomposed by the action of X-rays into chlorate and oxygen. Fig. 1 shows that the amount of chlorate formed in the irradiation of aqueous solutions of perchloric acid by X-rays (200 kV.) is directly proportional to the concentration of the perchloric acid. While the addition of ceric salts to the solution does not influence the formation of chlorate (see Fig. 1), if ferrous salts are present in the solution, chloride is formed in an amount which is equivalent to the chlorate formed in the absence of ferrous salt, under otherwise similar conditions.

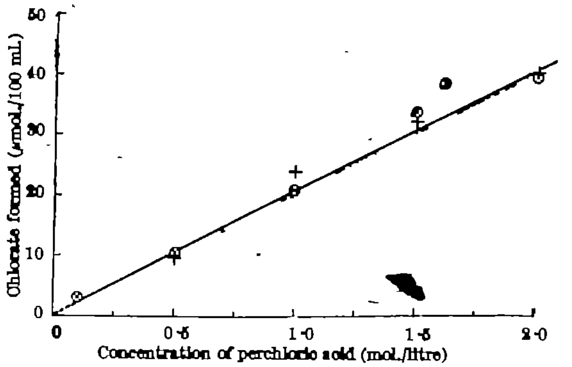

Fig. 1. Dependence of the formation of chlorate on the concentration of perchloric acid. Irradiation with X-rays (200 kV.) at constant dose of 2×10^5 e.u., in the presence of air. (1 e.u. ≡ 93 ergs/ml.) ○, aqueous perchloric acid, +, aqueous perchloric acid in the presence of ceric perchlorate ($3{\cdot}17 \times 10^{-4}$ *M*)

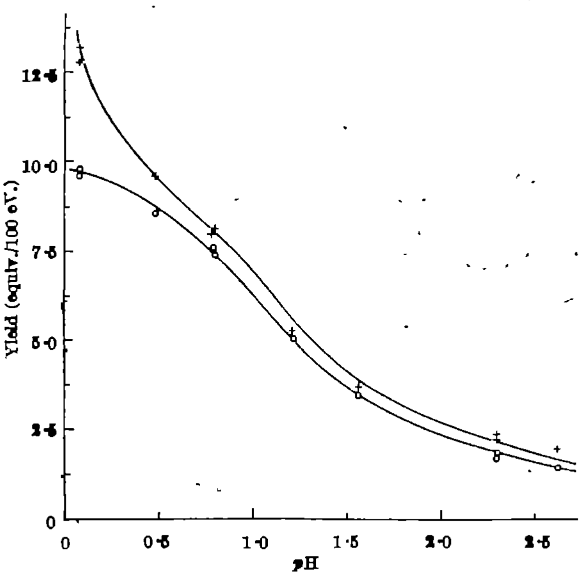

Fig. 2. Dependence of the yield of ferric salt (+) and of hydrogen (○) formed in the irradiation of ferrous perchlorate (0·01 *M*) in evacuated solutions at different concentrations of perchloric acid (as indicated by the *p*H). X-rays (200 kV.); constant dose of about $8{\cdot}70 \times 10^5$ e.u.

Fig. 2 shows some of the results obtained in the system ferrous perchlorate – perchloric acid. In this case, particularly at the higher perchloric acid concentrations, the results do not show the normal features of the radiation chemistry of the ferrous–ferric system[1]. Whereas in the irradiation of ferrous sulphate in sulphuric acid solutions, *in vacuo*, the amount of hydrogen gas formed is equivalent to the amount of ferric salt produced[1], this is no longer true in perchloric acid solutions where, under similar conditions, less than the equivalent amount of hydrogen is produced.

The general conclusions which can be drawn from these results are again in agreement with the assumption that the energy absorbed by the water leads to the net decomposition: $H_2O \xrightarrow{\sim\sim} H + OH$, resulting in the formation of hydrogen atoms and hydroxyl radicals[2], which, however, under the conditions in question, seem to be unable to react with the perchlorate.

As pointed out above, the amount of chlorate formed is directly proportional to the concentration of the perchlorate. This would be in agreement with the assumption that its formation is due to a 'direct' effect, that is, to the radiation energy which is absorbed by the perchlorate itself. It is conceivable that this mechanism involves the formation of an unstable intermediate leading to the formation of chlorate (which is not influenced by ceric salts) and which in the presence of ferrous salts is further reduced to chloride.

A full account will be published elsewhere.

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[1] Rigg, T., Stein, G., and Weiss, J., *Proc. Roy. Soc.*, A, **211**, 375 (1952).

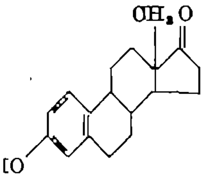
[2] Weiss, J., *Nature*, **153**, 74 (1944).

A New Route to Œstrone

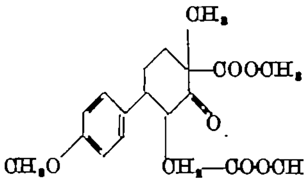
IN a recent paper, Johnson and Christiansen[1] have reported a new total synthesis of œstrone (I) from the keto-diester (II).

For a number of years we have been engaged in the study of the Friedel–Craft reaction with the view of preparing compounds of type II. We have already reported[2] the synthesis of 4-methyl-4-carbethoxy-(*p*-methoxyphenyl)-cyclohexan-3-one (IV) by Friedel–Craft condensation between anisole and 4-methyl-4-carbethoxycyclohexene-3-one (III). In the present communication, the study of the condensation of methyl 4-methyl-4-carbomethoxycyclohexene-3-one-2-acetate (V, $\lambda_{max.}$ 235 mμ, log ε 3·8) with anisole is reported. The reaction was carried out in the cold with a solution of (V) in anisole in a slow stream of dry hydrogen chloride and in the presence of anhydrous aluminium chloride. The condensation product, obtained as a glass, was hydrolysed and decarboxylated in 80 per cent yield to give a mixture of two isomers of 4-methyl-(*p*-methoxyphenyl)-cyclohexan-3-one-2-acetic acid (VI, *A* and *B*, melting points 208° and 135°) in the ratio 1 : 7, respectively. The isomer *B* was also obtained by Johnson and Christiansen by the hydrolysis of their keto-diester II (private communication). A direct comparison of the mixed melting point of our isomer *B*, melting point 135° with an authentic specimen, kindly supplied by Dr. W. S. Johnson, showed no depression. The recent successful conversion of (II) to œstrone (I) makes further work in this line unnecessary.

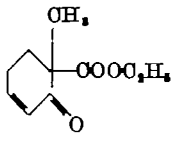
The unsaturated keto-ester (V) was prepared by the following method. Methyl hexane-1,2,6-tri-



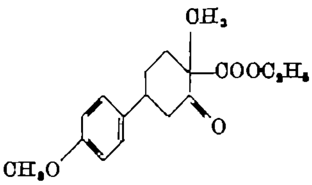
(I)



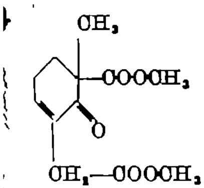
(II)



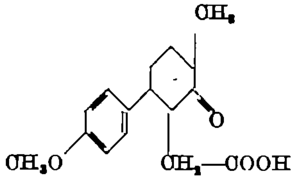
(III)



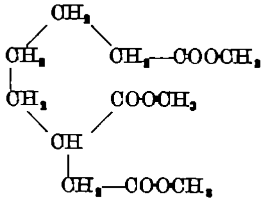
(IV)



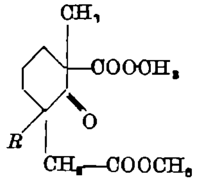
(V)



(VIA, m.p. 208°
VIB, m.p. 185°)



(VII)



carboxylate (VII), prepared from ethyl 2-carbethoxycyclohexanone-2-acetate[3], was cyclized in benzene solution with sodium dust in an atmosphere of nitrogen, and the resulting sodio derivative was directly treated with an excess of methyl iodide to furnish the methylated β-keto-ester (VIII, *R* = H; $n_{D}^{29°}$, 1·4649) in 88 per cent yield. This ester reacted smoothly with a molar quantity of bromine in carbon tetrachloride solution to give the solid bromo compound (VIII, *R* = Br; melting point 94–95°) in 80 per cent yield. The latter on dehydrobromination by treatment with dimethylaniline gave methyl 4-carbomethoxycyclohexene-3-one-2-acetate (V, $n_{D}^{29°}$, 1·5141) in 75 per cent yield.

In view of the good yield in each step of the above preparation, the present method for the preparation of the key intermediate II, in the synthesis of œstrone (I), appears to be an attractive one.

Our thanks are due to Dr. D. K. Banerjee, professor of organic chemistry, College of Engineering and Technology, Bengal, for his suggestions, and to Dr. William S. Johnson, of the University of Wisconsin, for supplying an authentic specimen of VI, *B*.

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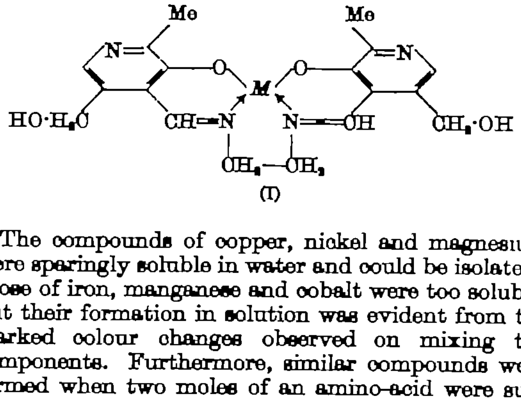
Pyridoxal Derivatives in Transamination

IN living systems a transfer of amino groups occurs between certain amino-acids and keto-acids. This important reversible process, known as 'transamination'[1], effects a link between carbohydrate and protein metabolism, and the responsible enzymes, the transaminases, are activated by pyridoxal[2] or pyridoxamine phosphates[3]. The proposed mechanisms of the reaction involve participation of a Schiff base between amino- and keto-acids[4] or between amino-acids and pyridoxal phosphate[5]. Prototropic rearrangement followed by hydrolysis gives, respectively, the keto- and amino-acids or the keto-acid and pyridoxamine phosphate, the latter then undergoing a reverse reaction with a different keto-acid. A reversible, non-enzymic reaction between pyridoxal and amino-acids to give pyridoxamine and keto-acids, discovered by Snell[6], was shown recently to be catalysed by trace metals (copper, iron, aluminium)[7]. Interest in this chemical process lies mainly in its possible connexion with the biological one; therefore an explanation of the part played by metals in such reactions is clearly desirable.

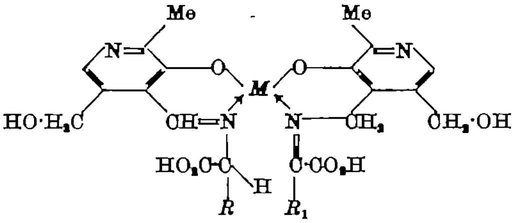
Pyridoxal is a typical phenolic aldehyde, resembling salicylaldehyde in many of its reactions. It has been found that this similarity can be extended to the formation of metallic complexes between pyridoxal, ethylenediamine and metal salts. These co-ordination compounds are analogous to those formed with salicylaldehyde[8] and have the probable structure (I).



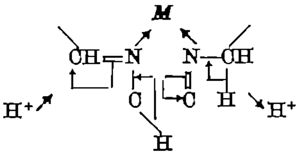
(I)

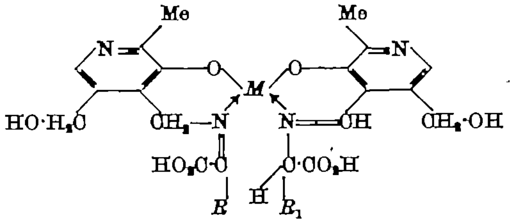
The compounds of copper, nickel and magnesium were sparingly soluble in water and could be isolated; those of iron, manganese and cobalt were too soluble, but their formation in solution was evident from the marked colour changes observed on mixing the components. Furthermore, similar compounds were formed when two moles of an amino-acid were substituted for the ethylenediamine. Pyridoxal formed green copper complexes with all the amino-acids examined (glycine, alanine, serine, lysine, *iso*leucine, valine, threonine, methionine). In most cases these were too soluble for isolation, but their formation was observed by the characteristic green solutions produced on mixing the components (in the absence of pyridoxal the typical deep-blue copper-amino-acid complexes were produced). The green colour persisted in acetic acid solution but was destroyed by mineral acids. The tyrosine compound was sufficiently insoluble for isolation (found C, 45·6; H, 5·0; N, 8·4; Cu, 14·5; $C_{34}H_{38}O_{10}N_4Cu_2 6H_2O$ requires C, 45·6; H, 4·9; N, 6·3; Cu, 14·3 per cent).

In view of the ready formation of such compounds, it is possible that, in a solution containing pyridoxal, pyridoxamine, an amino-acid and a keto-acid, mixed co-ordination compounds of the type (II) would be formed. The sharing of the lone electron pairs of the two nitrogen atoms with the metal would facilitate the release of protons from the α-position of the amino-acid residue, and from the methylene group adjacent to the aromatic ring in the pyridoxamine moiety. Electronic displacements might then occur as indicated, giving rise eventually to (III). Hydrolysis of (III) would complete the transamination. The process would be reversible and an equilibrium state attained.



(II)





(III)

In the non-enzymic reaction only two components, together with cations, were required; for example, pyridoxal and an amino-acid. However, the other components necessary for the formation of (II) could be formed to a small extent in the initial stages by spontaneous reaction.

The significance of these proposals in biological transamination is not yet clear. Cations are known to be essential for the proper functioning of many enzymes, but the transaminases have not yet been obtained sufficiently pure to ascertain their cation requirements. If a similar mechanism does operate, then it becomes possible to ascribe functions to most of the groups in the coenzymes. The aldehyde (or amino) and phenolic groups would be involved in the transamination proper, while the ring nitrogen and phosphate group (on the 5-hydroxymethyl) would participate in electrovalent linkage with a protein.

Thanks are due to Roche Products, Ltd., for a gift of pyridoxal.

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Production of Antibiotic Substances by the Roots of a Grass (*Trachypogon plumosus* (H. B. K.) Nees) and of *Pentanisia variabilis* (E. Mey.) Harv. (Rubiaceæ)

DURING the course of a study of the rate of nitrification in soils taken from plant communities representing various stages of the secondary grassland succession on the Transvaal Highveld, it was found that soils taken from the *Trachypogon plumosus* grassland climax community showed a consistent lag in the production of nitrate.

The experimental methods were as follows. (1) Soils were moistened and incubated for several weeks; the flasks were weighed initially, and reweighed from time to time, the loss of weight being made up with distilled water. These soils were then analysed for nitrate-nitrogen and ammonium-nitrogen. (2) Soil columns were perfused with distilled water using the Lees and Quastel perfusion technique. The perfusate was analysed for nitrate-nitrogen and ammonium-nitrogen from time to time. (3) Whole plants with their surrounding soil cores were placed in large pots. The aerial parts were removed completely, leaving an undisturbed soil and root system in the pots. Rain-water that percolated down through the soil cores was collected and analysed for nitrate-nitrogen and ammonium-nitrogen. Botanical analyses were carried out on the soil surfaces of the pots from time to time as plant growth regenerated.

It was found that, in the pots containing the *Trachypogon plumosus* root and soil, (*a*) little or no nitrate was produced; (*b*) the regeneration of plant growth was practically negligible.

It was thought from these observations that the roots of *Trachypogon plumosus* were secreting antibiotic substances which were inhibiting the activity of nitrifying organisms, and also seemed to be inhibiting the germination of weed seeds, and the growth of weed seedlings.

Roots of *Trachypogon plumosus* were collected, washed free of all soil particles and an extract was made with distilled water. This extract was tested by the agar cup method on plates seeded with *Escherichia coli*, *Bacillus subtilis*, *Staphylococcus aureus* (Oxford strain) and *Streptococcus hæmolyticus* (Richard strain). Very clear, wide zones of inhibition were displayed on all plates. So far as we know, this is the first instance where grass roots have been shown to exhibit antibiotic properties.

The possibility of other plants in this community containing antibiotic substances arose, and several grasses and non-grasses were treated accordingly. Three other non-grass plants were found to show antibiotic activity. Two of them displayed only slight activity against *E. coli* and *B. subtilis*, but *Pentanisia variabilis* (Rubiaceæ) showed very marked activity against *E. coli* and *B. subtilis*, and slight activity against *Staphylococcus aureus* and *Streptococcus hæmolyticus*.

An antibiotic assay of most of the important plants growing in the *Trachypogon plumosus* grassland climax community is at present being carried out. Further work on the antibiotic principle of *Trachypogon plumosus* and its effects on nitrifying organisms and weed seeds is proceeding.

I wish to acknowledge the advice and assistance given by Prof. N. P. Badenhuizen, Botany Department of the University of the Witwatersrand, Prof. J. J. Theron, Department of Agricultural Chemistry

of the University of Pretoria, and Dr. J. Murray, South African Institute for Medical Research.

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Microbiological Decomposition of Malto- and Lacto-bionate

Stodola and Lockwood[1], and Kluyver, De Ley and Rijven[2], demonstrated that several species of *Pseudomonas* are able to oxidize maltose and lactose to the corresponding malto- and lacto-bionic acid, by oxidation of the reducing group of the disaccharide, without breaking the oxygen bridge. Some strains of *Pseudomonas* consume the calcium salt of these acids slowly[2]. *Pseudomonas* is a common surface inhabitant of several natural waters, so it is likely that under these natural conditions these cells may convert maltose from polysaccharides (formation of lactose is improbable) into the corresponding acid. It seemed to be of interest to ascertain what kind of micro-organisms are endowed with the ability to consume maltobionate, with the view of getting an idea of the importance of this decomposition process in Nature. Lactobionate was included in view of a future study of the enzymatic mechanism of its breakdown.

Petri dishes, containing agar, with potassium, ammonium and magnesium sulphates, yeast extract, calcium carbonate and a calcium bionate, were inoculated with ditch- and river-water, stagnant water, soil, humus, dune-sand, etc., and incubated, usually at 25°–30° C., one set aerobically, another anaerobically. Growth in anaerobic conditions was scanty, and only a few colonies developed on bionates. On the other hand, there was a luxurious aerobic growth on bionates and a great variety of microflora developed. Of these, more than sixty strains have been isolated and investigated. These strains quickly consume malto- or lacto-bionate, or both, in a liquid culture medium when incubated for plentiful aeration in a shaking device in an incubator room at their optimal temperature. The consumption of bionates was determined by the titrimetric method of Kluyver, De Ley and Rijven[2]. The accompanying list indicates the bacteria found (nomenclature according to "Bergey", 6th edit. ; quantitative data will be published elsewhere) : *Escherichia freundii* or *intermedium* ; *Paracolobactrum aerogenoides* ; *Aerobacter aerogenes* ; *Aerobacter cloacae* ; *Serratia plymuthicum* ; *Alcaligenes faecalis* ; *Achromobacter* sp. ; *Flavobacterium* sp. ; *Corynebacterium simplex* and *helvolum* ; *Pseudomonas fluorescens* and sp. ; *Bacillus megatherium* and *circulans*. Several other bacteria, as yet unidentified, are able to consume malto- and/or lacto-bionate. Usually several different strains of the same micro-organism were isolated. *E. coli* strains are unable to consume maltobionate ; some decompose lactobionate slowly. Most of the above-mentioned strains decompose both bionates. Only maltobionate can be broken down under anaerobic conditions by some strains of *Aerobacter*. The following moulds decompose maltobionate : *Penicillium* sp. ; *Hormodendrum cladosporoides* ; *Aspergillus* sp. ; *Fusarium merismoides, avenaceum* and *oxysporum*. It is remarkable that no yeasts were detected.

Most of the bacteria grow well on the corresponding disaccharide. Some of the apparent exceptions are under investigation.

The following scheme of maltose decomposition in natural surface waters is proposed, this being additional to those already known .

$$\begin{tikzcd}[row sep=large] \text{Maltose} \arrow[d, "\textit{Pseudomonas}"] \\ \text{Maltobionate} \arrow[d, "\substack{\text{obligate aerobic micro-organisms}\\ \text{Enterobacteriaceae}}"] \\ \text{Glucose and gluconate} \end{tikzcd}$$

or

unidentified pathway.

The large number of strains observed suggests that this pathway for the metabolism of maltose may be quite important in Nature.

A full account of these and related results will be published elsewhere. We also hope to publish a preliminary investigation of the enzymatic mechanism in the near future. We are indebted to Sandoz, Ltd. (Switzerland), for a generous gift of lactobionate.

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Deoxyribonucleic Acid Content of Haploid and Diploid *Aspergillus* Conidia

In 1948, Boivin, Vendrely and Vendrely[1] suggested that the somatic nuclei of a vertebrate species may contain a fixed amount of deoxyribonucleic acid that is double the amount present in the germ cells. Since then, a considerable volume of evidence has been obtained to support this view[2,3]. Some apparent exceptions, such as rat liver, have been found, but these can be explained by the presence of nuclei with different degrees of 'ploidy'. The evidence is consistent with the view that in resting nuclei a specific amount of deoxyribonucleic acid is associated with each set of chromosomes[4].

In vertebrate tissues it is difficult to make sure that a tissue has a population of nuclei homogeneous in respect of the number of chromosome sets. Therefore we have thought it of use to investigate the deoxyribonucleic acid content of conidia of diploid and haploid strains of *Aspergillus nidulans*[5]. These conidia are uninucleate ; genetic and cytological evidence shows that in different strains the nuclei are either diploid or haploid, and in the conidia the nuclei are all uniformly in one stage, presumably the resting stage. The volumes of the diploid and haploid conidia are[5,6] in the ratio of 2 : 1.

Two haploid strains were used : the wild type (+, green conidia) and a mutant strain (w_3) with white conidia[7]. Two diploid strains heterozygous for known markers were prepared[8] : one with green conidia (w_3 lys/ad_3 y) and the other with white conidia (28-*a*). The latter strain was obtained through somatic recombination[5,8] from a green diploid (w_3 $paba_1$ bi_1/ad_3 y). Cultures were grown on a minimal agar medium containing glucose and mineral salts. The conidia were harvested in saline containing 0·1 per cent calzolene oil and were counted in a hæmocytometer. They were precipitated with 0·5 vol. 30 per cent trichloroacetic acid and extracted successively with 10 per cent trichloroacetic acid (twice), acetone, ethanol, hot ethanol : chloroform 3 : 1, hot ethanol : ether 3 : 1 (twice) and ether. The dry powder obtained was extracted[9] with 5 per cent trichloroacetic acid at 90° for 15 min., and the deoxypentose in the extract was estimated by the diphenylamine method[10] with incubation at 37° for 18 hr. The results are expressed in terms of deoxyribonucleic acid phosphorus, the method having been calibrated with purified thymus deoxyribonucleic acid.

Strain	Deoxyribonucleic acid phosphorus (10^{-14} gm. per 10^{8} conidia)
Green haploid	4·04
Green diploid	9·39
White haploid	4·22
White diploid	7·75

Within the limits of the methods, these figures are consistent with a deoxyribonucleic acid ratio of 1 : 2 for the conidia from haploid and diploid strains.

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Efficiency of Growth in *Mytilus edulis* and Two Gastropod Veligers

GROWTH efficiencies have been studied extensively in domestic animals and in some common laboratory animals[1]. Little is known, however, of the utilization of energy in the growth of lower animals. I have been able to show that marine invertebrates may have high growth efficiencies. Efficiency calculations were based on growth-rate and oxygen uptake in *Mytilus edulis* of different ages, and in veligers of two marine gastropods, *Littorina littorea* and *Nassa reticulata*. Rates of growth were calculated from average increases in length in Nature during known intervals of time. Data published by Thorson[2] were used in calculating growth-rates of veligers of *Littorina* and *Nassa* (from the Isefjord, Denmark) and of young metamorphosed *Mytilus* (from the Sound). I myself measured the growth of *Mytilus* veligers (from Isefjord). Data on growth of *Mytilus* during later stages were obtained from the Pacific off La Jolla, California, where Coe[3] measured the average increment in length of different age- and size-groups during August–November while maximum growth is taking place. Lengths were first converted into total nitrogen content using the relationship found by Zeuthen[4] (and unpublished results of Dr. Zeuthen). Then total organic matter was computed, assuming a nitrogen content of 8 per cent of the dry organic matter. Rates of oxygen uptake were obtained from Zeuthen[4]. The oxygen values were converted into organic matter by assuming that 1·2 litres of oxygen is equivalent to 1 gm. of organic matter.

	Length (mm.)	Nitrogen content (γ-nitrogen)	Daily increase in organic matter (per cent)	Daily combustion of organic matter (per cent)	Gross efficiency of growth (per cent)
Mytilus edulis veliger	0·09–0·26	0·003–0·07	11·2	4·2	73
Mytilus edulis metamorphosed	0·35–6·0	0·2–100	14·4	2·8	84
	11·0–22·8	580–2,900	5·7	1·8	76
	21·0–32·1	2,500–7,000	3·4	1·5	69
	31·0–40·9	6,500–12,000	2·0	1·3	61
	40·9–49·0	12,000–18,500	1·4	1·2	54
	51·0–56·9	21,000–27,000	0·8	1·0	44
	61·0–63·8	32,000–36,000	0·4	1·0	29
	90·0–90·8	82,000–84,000	0·1	0·8	11
Littorina littorea veliger	0·20–0·38	0·02–0·22	9·0	5·4	62
Nassa reticulata veliger	0·30–0·56	0·13–0·63	9·3	5·4	63

From the accompanying table it is seen that the efficiency of growth is of the same order in veligers of *Mytilus*, *Littorina* and *Nassa*. Furthermore, the efficiency of growth in *Mytilus* does not significantly change on metamorphosis. Owing to the heterogeneity of the material the increase in efficiency indicated in the table is probably not significant. A pronounced decrease in efficiency starts at a length of about 30 mm., when the growth-rate drops to about 2 per cent daily. Harvey[5] calculated that the efficiency of growth in the marine copepod *Calanus finmarchicus* was about 70 per cent. The growth efficiencies in *Calanus*, *Littorina*, *Nassa* and *Mytilus*, up to a length of about 50 mm., fall close to the values found in embryos. The gross efficiencies of growth of embryos for the hen, frog, fish and silkworm are 62, 51, 59 and 65 per cent, respectively (Brody[1], pp. 43–44). Maximum efficiencies of postnatal growth are generally found to be lower than in these marine invertebrates ; for example, 20–40 per cent in pig, trout and cockroach[6].

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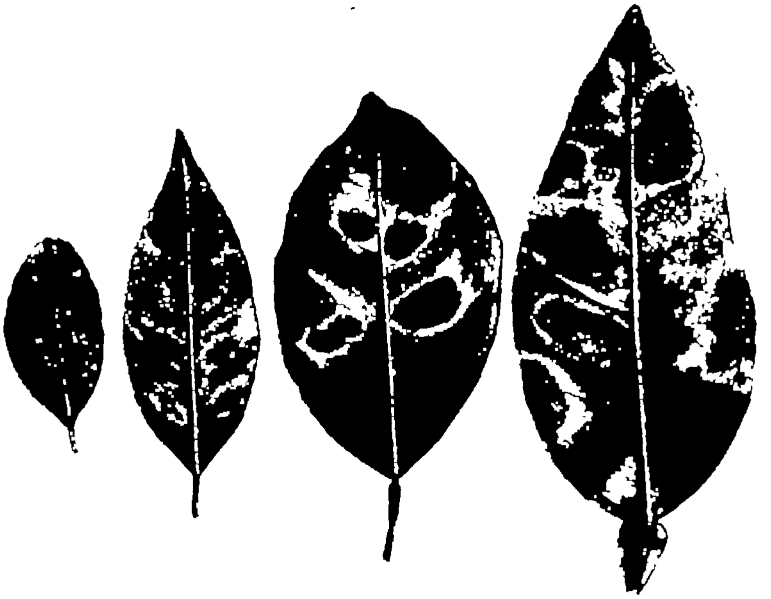
Molybdenum Deficiency in Florida Citrus

INVESTIGATIONS at this Station have disclosed that molybdenum deficiency is found in citrus trees throughout the citrus-growing area of Florida. The symptom of this deficiency has been called yellow spot since it was first described by Floyd[1] in 1908. Yellow spot has also been reported in citrus on the Isle of Pines[2]. Repeated studies[3] failed to demonstrate that it was due to an infectious fungus, bacterium or virus. It is known to occur on practically all kinds of citrus ; but the rootstock greatly affects the extent



Molybdenum deficiency of citrus leaves. Left to right leaves from Temple orange, tangerine, orange and grapefruit

to which the tree is injured. Trees on grapefruit rootstock are much more seriously affected than are trees on other rootstocks. This is one of the reasons why grapefruit has not been widely used as a rootstock in Florida.

Molybdenum deficiency in citrus appears first as water-soaked areas in leaves in the early spring. In the summer, these areas develop into large interveinal yellow spots with gum on the lower leaf surfaces (see photograph). Badly affected leaves eventually drop, and in extreme deficiency the trees become almost completely defoliated during the winter.

Molybdenum foliage sprays caused the yellow spot leaves to become green within three to four weeks after application. Some response was obtained when as little as 0·1 gm. of sodium molybdate was applied per tree. The lowest amount which gave a satisfactory response was 0·1 ounce per tree applied as a spray in 10 gallons of water. Equivalent amounts of ammonium molybdate have been equally as effective as the sodium salt. When 1 gallon of a solution containing 1 gm. sodium molybdate was injected under pressure into the trunk of a yellow spot tree, using an apparatus similar to that described by Southwick[4], the leaves became completely green within ten days.

The amount of molybdenum required by citrus is very small. Vanselow and Datta[5] in greenhouse studies found that molybdenum deficiency showed up in lemon trees in which the dried leaves analysed spectrographically contained 0·02–0·03 p.p.m. molybdenum. Chemical analyses made at this Station showed that the molybdenum content of yellow spot leaves from grapefruit and orange trees varied from 0·03 to 0·08 p.p.m. The molybdenum content of leaves from nearby green trees was found to be slightly higher in each instance. Samples of leaves taken from two yellow spot trees three months after soil applications of 1 gm. and 1 ounce of sodium molybdate were made showed the leaves contained 0·05 and 0·08 p.p.m. of molybdenum respectively. There was no noticeable greening of the leaves six months after the soil application.

Molybdenum sprayed on trees did not appear to be readily translocated. When the lower halves of grapefruit trees were sprayed with 1 ounce of sodium molybdate, leaves that were covered with the spray became green whereas those in the tops of the trees remained yellow and eventually dropped.

The total molybdenum content of Florida citrus soils has been found to be very low, ranging from 0·20 to 0·40 p.p.m. Water extractions were made on a large group of Florida soils and the amount of soluble molybdenum was found to be less than 0·001 p.p.m.

Studies[6] have shown that the amount of molybdenum taken up by plants increases with increasing *p*H of the soil. Grapefruit trees in plots at the Citrus Experiment Station growing on soil having a *p*H of 4·2 were severely affected with yellow spot, which caused almost complete defoliation of the trees. Chemical analysis of the leaves indicated they contained 0·03 p.p.m. molybdenum. Trees were green on adjacent plots where the soil had been limed to *p*H 5·6. The molybdenum content of leaves from these plots was found to be 0·06 p.p.m.

This is believed to be the first time that symptoms on trees growing in soil have been identified as due to molybdenum deficiency.

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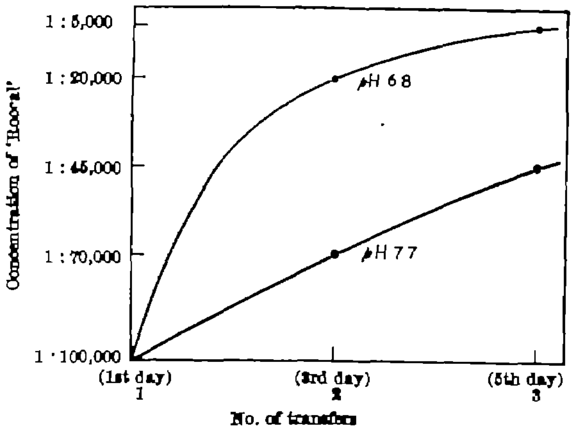
Factors Governing the Adaptation of Bacteria against Quaternaries

CHAPLIN has shown[1] that, contrary to a view current until then[2], it is possible to increase the resistance of certain Gram-negative bacteria to some quaternaries such as the cationic detergent 'Roccal' (alkyldimethylbenzyl ammonium chloride).

Using a sensitive strain of *Serratia marcescens* (obtained through the courtesy of Dr. C. E. Chaplin), we were able also to grow cultures resistant to higher concentrations of 'Roccal'. The experiments involved three direct transfers, namely, from a 1 : 100,000 dilution of 'Roccal' in nutrient broth containing 0·5 per cent 'Trypton' and of 'Peptone Difco', to one of 1 : 20,000 and then to one of 1 : 5,000; the *p*H of the media was found to be ~ 6·8 but varied slightly with the amount of 'Roccal' used. However, the bacteria adapted in this way did not survive when transferred to a nutrient broth containing



'Roccal' of a concentration of 1 : 5,000 at a pH of 7·4, but they survived at this pH in the absence of the quaternary.

When the above experiments were repeated under slightly alkaline environmental conditions (pH 7·7), the same dependence upon pH was found, because we were able to increase the resistance through three direct transfers from 1 : 100,000 to only 1 : 45,000, corresponding to a 2·2-fold higher concentration of 'Roccal' instead of the 20-fold reached when the pH was on the acid side; since we were mainly interested in the dependence on pH and not in the extent of the adaptation possible, we did not consider it necessary to carry out a greater number of transfers. In both experiments there is a maximum concentration for each transfer above which there is no survival. These concentrations are those used in our experiments and shown in the graph.

The results indicate that the adaptation is dependent on the pH of the medium, just as the bactericidal activity is. The bactericidal activity of a cationic compound is known to be enhanced by a rise in pH and to be diminished by a lowering of pH[3]. The rule has been shown to govern the affinity of a cationic compound for wool, and formed part of a general relationship found to hold between the bactericidal activity of a compound and its affinity for wool[4].

Quaternaries have a higher bactericidal activity against Gram-positive bacteria than against Gram-negative[2,5] bacteria. We have shown that such compounds, as exemplified by 'Bradosol' (phenoxyethyldimethyldodecyl ammonium bromide), have a higher affinity for a degraded wool, which we have taken to simulate the behaviour of Gram-positive bacteria, than for intact wool, the model for Gram-negative bacteria[6]. We conclude from this that the bactericidal activity of a substance is largely dependent on its affinity for that part of the bacteria (presumably cytoplasmic membrane) the behaviour of which is simulated by wool. It follows from this hypothesis that any factor which alters the affinity of a bactericidal agent for bacteria will affect the bactericidal activity in the same direction[7]. On this basis the results of our adaptation experiments become readily understandable. Since a rise in pH will increase the affinity of cationic substances, the bactericidal activity will increase, and it will require, therefore, a lower concentration of the cationic substance to produce the same effect as shown in the graph and further supported by the results in the accompanying table.

BACTERICIDAL ACTIVITY OF 'ROCCAL' AGAINST *S. marcescens* AFTER 24-HR. CONTACT IN NUTRIENT BROTH, AT DIFFERENT pH'S

Concentration of 'Roccal' in nutrient broth	pH 6·8	pH 7·4	pH 7 8
1 : 325,000	–	–	–
1 : 250,000	–	–	–
1 : 175,000	–	–	–
1 : 100,000	–	–	+
1 : 70,000	–	+	+
1 : 45,000	+	+	+
1 : 20,000	+	+	+
1 : 10,000	+	+	+
1 : 5,000	+	+	+

+, indicates activity*; –, indicates absence of activity.

* A reinoculation into fresh media was made to confirm that we were dealing really with a bactericidal action and not a bacteriostatic one.

A similar explanation can be used to show why Chaplin[1] was unable to render a Gram-positive organism resistant to quaternaries. Such compounds have a much higher affinity for Gram-positive than for Gram-negative bacteria, and therefore a much lower concentration of the compound would be required to enable the production of a resistant strain. In all probability, under the conditions of Chaplin's experiments, the concentration was always too high.

We acknowledge the gift of 'Roccal', supplied by Winthrop-Stearn, Inc., Windsor, Ontario.

R. FISCHER
P. LAROSE

National Research Council,
Ottawa. April 1.

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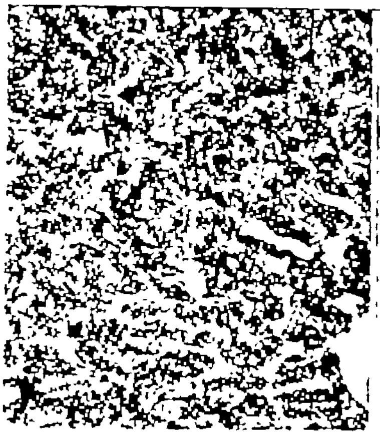
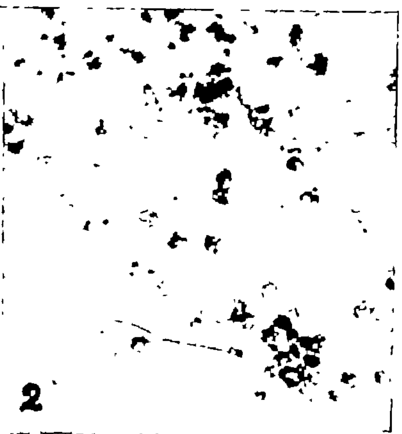
Distribution of Dextran in the Tissues of Rabbits

THE increasing use of dextran solutions as plasma substitutes has made the problem of the fate in the organism of the injected polysaccharide a very important question. Several studies on this problem have been carried out by means of chemical and serological methods of determination of dextran in extracts of tissues[1], and a few histological investigations are recorded in the literature. The methods used in these studies are, however, inadequate, as they do not allow any conclusions to be drawn as to the nature of the deposits found in the tissues after injection of dextran.

It has been demonstrated by several investigators that a considerable part (about 25 per cent) of the dextran injected is excreted through the kidneys within a few hours. Others have suggested that a portion is eliminated by the intestinal tract[2]. But what becomes of the remaining dextran that slowly disappears from the blood without being detected either in the urine or in the faeces? Some authors postulate a breakdown of the polysaccharide to glucose units, which are metabolized in the body[3]. The localization of such processes is undetermined. A transient accumulation of dextran outside the vessels may be suggested, and the presence of dextran has been demonstrated in lymph nodes and spleen by the use of chemical and serological methods.





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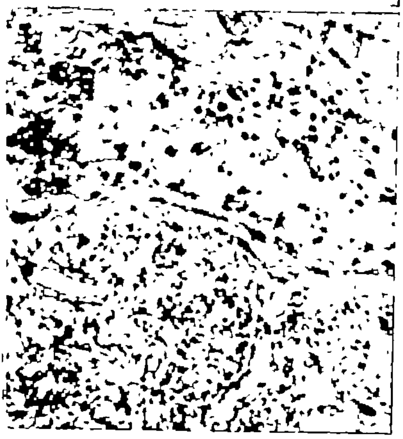

Fig. 1. Dextran inclusions in liver cells and Kupffer cells 48 hr. after injection of 'Macrodex'. Modified *PAS* reaction

Fig. 2. Polymorphonuclear leucocytes loaded with dextran 4 hr. after injection of 'Macrodex'. Modified *PAS* reaction

Fig. 3. Bone marrow with reticular cells loaded with dextran granules, 96 hr. after injection of 'Macrodex' intravenously. Modified *PAS* reaction

Fig. 4. Lymph node containing many macrophages filled up with dextran, 48 hr after administration of 'Macrodex' intravenously Modified *PAS* reaction

In order to follow the distribution of injected dextran ('Macrodex', Pharmacia) in various organs and tissues in rabbits, a series of histochemical investigations was started late in 1950. The determinations were based on the use of the periodic acid – leucofuchsin method. In order to assure a certain specificity to the reaction against dextran, the procedure described by Hotchkiss was somewhat modified. Furthermore, adjacent sections were treated with other oxidizing agents (chromic acid and permanganate), and with iodine and azur *A*. Thus it was possible to distinguish dextran from other polysaccharides in the sections. Detailed descriptions of the methods used are to be published elsewhere.

The present communication gives a short summary of the results of a series of histochemical investigations on 104 rabbits given 6 per cent 'Macrodex' parenterally in doses of 20 ml./kgm. body-weight. The organs and tissues of the animals were studied at intervals varying from 15 min. to 80 days after the administration of dextran. Liver, kidneys, spleen, lymph nodes, bone marrow, blood leucocytes, stomach, small intestine, thymus, adrenals, omentum and skin were examined.

Kidneys. The passage of the low-molecular part of the 'Macrodex' through the glomerulus and nephron during the first few hours after injection was well demonstrated in the sections. A small, transient deposition of dextran granules in the cells of the convoluted (proximal and distal) tubules was noted within the first twelve hours. No traces of dextran were visible in the tubular epithelium 48 hr. after administration.

Liver. The uptake of dextran by the liver cells was visible about 24 hr. after injection of 'Macrodex'. Some of the livers studied were deprived of most of their ordinary glycogen content by starving the animals for 24 hr. before autopsy. The dextran granules deposited in the liver cells were of uniform size, and scattered over the whole area of the cell without forming any floccules like glycogen (Fig. 1). Dextran inclusions were visible up to three days after administration. No dextran was observed in the bile ducts.

Blood leucocytes. An accumulation of dextran occurs very rapidly in the polymorphonuclear leucocytes. Within 15 min. of intraperitoneal or intravenous injection of 'Macrodex', a great many granulocytes were seen to be packed with dextran granules. The number of leucocytes with dextran inclusions was at a maximum 3–4 hr. after administration. At this time such cells are seen everywhere in the small vessels and in loose connective tissue (Fig. 2). In the spleen, dextran-loaded leucocytes are retained for several days. The histochemical properties of the dextran granules in the leucocytes differ from those observed with dextran *in vitro*. This may be due to a change in the chemical structure of the substance due to some enzymatic attack on the dextran molecule.

Reticulo-endothelial system. The spleen, lymph nodes, bone marrow and the Kupffer cells of the liver were studied as being important parts of the reticulo-endothelial system. The uptake of dextran by reticulo-endothelial cells was similar in all the organs and tissues studied. A moderate amount of the polysaccharide was visible within the cells about 12 hr. after intravenous injection of 'Macrodex'. The accumulation of dextran increased and showed a definite peak 48–96 hr. after administration. Especially in the bone marrow and lymph nodes, a great number of reticular cells and macrophages completely filled with dextran granules was visible (Figs. 3 and 4). Twelve days later, it was still possible to see a moderate number of dextran-loaded reticulo-endothelial cells in the bone marrow and lymph nodes. Thirty days after the injection of 'Macrodex', the reticulo-endothelial cells did not differ from those in the controls.

These observations suggest that the liver cells, the polymorphonuclear leucocytes, and the reticulo-endothelial cells, all of which are known to be enzymatically very active, play a part in breaking down dextran into units that can be utilized by the body or which can be easily eliminated from the organism. An interesting problem in this connexion is the effect of the accumulated dextran on the various physiological properties of the reticulo-endothelial system. Work on this subject is in progress in our laboratories.

Detailed reports on the results briefly outlined here will appear elsewhere.

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April 10.

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Airborne Dispersal of *Phytophthora palmivora*, causing Black-Pod Disease of *Theobroma cacao*

AT the 1951 Cocoa Conference, Mr. G. F. Bowman, chief of the American Cacao Research Centre, Turrialba[1], referred to work by Salazar[2] which shows that the sporangia of *P. palmivora* are almost certainly not airborne, except in drops of water. Contrary evidence was not apparently produced at the Conference; therefore it is desirable to direct attention to certain observations in Nigeria which indicate that *P. palmivora* sporangia may be airborne and that infection apparently results thereby. In this respect, the species in question would appear to be comparable with *P. infestans* in temperate regions, the airborne dispersion of which has been discussed by Gregory[3] and by Van der Plank[4]. It seems necessary to postulate long-distance dispersal to explain the epidemiology of black-pod disease. Observations have therefore been made to test this hypothesis, and also to determine whether free moisture is essential for take-off and dispersal of sporangia in Nigeria.

Sporangia have been observed on 'Vaselined' disks of 'Cellophane' (3 mm. diameter), mounted on pins above the surface of an infected pod. The arrangement was generally such that the disk was facing the sporangia and parallel with the pod surface. The distance between the disk and the pod varied from approximately 5 mm. to about 20 mm. Six or more disks per pod were exposed for 12-hr. periods (7 a.m.–7 p.m. and 7 p.m.–7 a.m.). The maximum mean number of sporangia found per disk was 2·3, but generally the mean number was less than one per disk. Sporangia were caught on disks when free moisture was apparently absent during the exposure period. It should be noted in this connexion that Ashby[5] stated regarding *P. palmivora* in culture that "the sporangia when mature fall away from the sporangiophores by natural abscission . . .". This observation lends support to the experiments now described, which indicate that take-off of sporangia can occur without the assistance of water.

It is possible that Salazar's[2] failure to catch sporangia on plates may have been due to the relative inefficiency of large 'traps', which has been established by Gregory[3]. Small disks have been used in Nigeria because they are likely to be relatively efficient under the conditions of low wind velocity ($\frac{1}{4}$–1 m.p.h.), which prevail locally[7]. Having established the possibility of air dispersion of sporangia, it is necessary to ascertain whether the occurrence of the disease is in conformity with this finding.

Van der Plank[4] has described a procedure which is suitable for the examination of black-pod disease distribution in cacao fields, by observing the number of doublets (pairs of affected trees) in sequences of trees. In this connexion, it is convenient to describe a tree as 'diseased' when it carries one or more affected pods, as opposed to a 'healthy tree' carrying only healthy pods. Results from observations made in the same field on two occasions are summarized below.

Table 1. INCIDENCE OF DOUBLETS OF DISEASED TREES IN A CACAO FIELD

Date	No. of trees observed (healthy + diseased)	No. of diseased trees	No of doublets		Difference (observed − expected)	Standard error ±
			Observed	Expected		
29/5/50	451	55	7	6·6	0·4	2·57
10/7/50	303	244	207	195·7	11·3	13·99

Table 1 shows that the numbers of doublets observed exceed the numbers to be expected if diseased trees were distributed at random, but the differences are not significant, because they are less than their respective standard errors. Therefore such grouping as occurs, and which may be due to spread from neighbour to neighbour, could occur by chance ($P > 0·05$).

Further evidence of random dispersal has been obtained from observations on the spread of disease from a source consisting of a diseased tree with black-pods heaped around its base. The trees under observation were inspected every other day, and black-pods were recorded, removed and added to the heap.

Table 2. SPREAD OF BLACK-POD DISEASE FROM A SOURCE OF INFECTION

Distance from source (m.)	0–10	11–20	21–30	31–40	41–50	51–60	61–70	71–80	81–90
Diseased trees (per cent of total trees)	33	35	37	25	22	23	13	24	29
No. of diseased pods (per 100 trees)	69	85	98	45	48	34	23	43	44

There are indications of a decreasing gradient of infection from 0–70 m.; but from 71–90 m. there would appear to be an opposing gradient which may have been due to extraneous infection coming from some source beyond the observation area. The heap of pods occupied a space about 8 ft. in diameter, therefore it could not be properly considered as a point-source, which may partly account for the 'flatness' of the gradient in the interval 0–30 m. The results suggest random distribution from a central source, because an approximation to a straight line is obtained when the logarithm of the percentage of healthy trees is plotted against the number of diseased pods[6]. In connexion with the possible origins of extraneous infection, it is worth mentioning that there is no direct evidence under local conditions for the natural production of *P. palmivora* sporangia from alternative hosts or on parts of the living cacao tree except the pods. Sporangia have been observed on chupons (vertical stems) following artificial inoculation.

It has been shown that there is evidence for horizontal dispersion of black-pod disease in a random manner, such as would be expected for an airborne disease. There is also evidence for vertical spread in such a way that healthy pods become infected from diseased pods several feet below. It is probable that sporangia are commonly dispersed from infected pods in splash droplets, but there is evidence that take-off can occur in 'dry' air; it appears that sporangia may be airborne over considerable distances.

Phytophthora palmivora can readily infect healthy pods through wounds; hence there is a possibility that some pod infection may be associated with insect damage. Most of the pod damage by insects in Nigeria is ascribed to *Helopeltis* sp., but casual observations indicate that it is only exceptionally that black-pod infection is associated with such insect punctures.

Black-pod disease studies are continuing and detailed results will be published elsewhere. I am greatly indebted to Dr. P. H. Gregory, Rothamsted Experimental Station, for his advice and suggestions adopted in the preparation of this communication, which is published with the permission of Mr. A. G. Beattie, Inspector-General of Agriculture, Nigeria.

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April 16.

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Gilbert of Colchester and Wingfield House

DR. WILLIAM GILBERT, who wrote the celebrated treatise, "De Magnete", and who was physician to Queen Elizabeth I and president of the College of Physicians, lived and worked in London in a "capital messuage or mansion" called Wingfield House. There, in a bachelor establishment, he gathered about himself a group of students of the new learning and developed the scientific method of inductive reasoning, his "new sort of philosophising", which he applied to experiments on magnetism and static electricity.

Wingfield House was in St. Peter's Hill, in the parish of St. Peter, Paul's Wharf. So much is apparent from published records and has already been noticed in accounts of Gilbert's life. It seems worth while to identify this interesting site more closely, however, for it was in Wingfield House that the seed of modern science in England germinated and bore its first fruit.

The earliest known reference to Wingfield House is in an indenture executed in 1519[1]. It is not clear how or when the house came into Gilbert's possession, though the fact that his stepmother was a Wingfield provides a clue. However, the successive ownership of the property after Gilbert's death in 1603 can be traced through his will[2] and through various deeds of conveyance[3,4] until the time of the Great Fire of 1666, when the house was destroyed. Collation of entries in the manuscript survey of building sites in London after the Great Fire[5] with Ogilby and Morgan's map of London published in 1677 shows that Wingfield House stood opposite the northern end of the College of Arms, almost exactly in the middle of the east side of the remnant of St. Peter's Hill that runs between Knightrider Street and Queen Victoria Street.

It appears from the deeds that the front of the house was 36 ft. wide, and that the site extended back about 100 ft. Some years after Gilbert died, part of Wingfield House was sold to "the Master, Wardens and Cominalty of the Mystery or Art of Upholders"—that is, the livery company of Upholders or Upholsterers. The indenture[4] that defines the partition of the property describes the house at some length. There was a paved yard near the middle of the site between a fore part and a rear part of the building, the two parts being connected by the kitchen, which presumably flanked the yard. There was probably also another yard or garden at the back.

The eastern side of St. Peter's Hill was devastated again during the Second World War. The remains of a wall that can be seen running east from the street may well mark the northern boundary of the site of Wingfield House.

G. F. GAINSBOROUGH

13 Avenue Gardens,
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Middlesex.

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[1] Hustings Roll, 238 (91).

[2] Prerogative Court of Canterbury, Bolein 109.

[3] Hustings Rolls, 342 (20) and 349 (52).

[4] Close Roll, C54/3341, mem. 1.

[5] Survey by Mills, P., and Oliver, J., Vol. 1, fol. 85 (b); Vol. 2, fol. 19 (a), Vol. 4, fol. 131 (a).

Cooling Bath for Cytological Investigations

THE disadvantage of liquid air[1] as a cooling bath for the rapid quenching necessary in freezing and drying for cytological purposes was recognized by Hoerr[2] as the formation of a vapour coat of low thermal conductivity around the specimen. He introduced isopentane for this purpose as a liquid of high boiling point which did not vaporize around the piece of tissue. Isopentane cannot be cooled below its melting point, – 160° C., and near this temperature is a thick liquid which cannot be stirred efficiently. In a search for a better bath liquid it has been found that propane has several advantages. It can be cooled to – 190° C. and is still very fluid near its melting point. It is easily obtainable as 'Propagas' (B.O.C.)[3]. Both isopentane and propane have to be cooled with liquid nitrogen, because of the fire and explosion hazard with liquid air or oxygen.

With the increasing use of freezing and drying by histologists and cytologists, it is of interest to report that a non-inflammable and non-toxic cooling bath can be made by condensing dichloro-difluoromethane in a tube cooled by liquid air. This material is easily obtained as 'Arcton 6' (I.C.I.) and has a melting point of – 158° C. It is denser than either of the hydrocarbons, and the pieces of tissue float on the surface after quenching, allowing easy recovery from the bath. The possible use of such a bath was discussed at the Bristol meeting of the cytochemistry commission of the International Society of Cell Biology in July 1951.

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June 27.

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[1] Gersh, I., *Anat. Rec.* (U.S.A.), 53, 309 (1932).

[2] Hoerr, N. L., *Anat. Rec.* (U.S.A.), 65, 293 (1936).

[3] Bell, L. G. E., 'Int. Rev. Cytology", 1 (New York); "Freezing and Drying" (Inst. of Biology, London).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, October 27

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Impact of Television on Sound Broadcasting" (to be opened by Mr. G. Parr).

Chemical Society, Oxford Section (in the Physical Chemistry Laboratory, South Parks Road, Oxford), at 8.15 p.m.—Prof. Alexander Haddow: "Carcinogenesis" (Alembic Club Lecture) (All Fellows are invited.)

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Capt. John Giaever and Mr. G. de Q. Robin "International Expedition to Antarctica".

Tuesday, October 28

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Colin Smith: "Renan and Science".*

Iron and Steel Institute (joint meeting with the British Iron and Steel Research Association, at 4 Grosvenor Gardens, London, S.W.1), at 2 p.m.—Discussion on "The Corrosion of Steel under Phosphate Coatings and Protective Finishes".

Chadwick Public Lecture (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 2.30 p.m.—Sir Martin Roseveare: "The School and the Health of the Community".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. Bernard W. Bradford: "Physical Chemistry in the Chemical Industry". (Further Lecture on November 4.)

Society of Instrument Technology (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. D. O. Walter: "The Design of Sliding Contact Assemblies in Instrument Applications".

Tuesday, October 28—Wednesday, October 29

Institute of Fuel (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 10 a.m. each day.—Conference on "A Special Study of Ash and Clinker in Industry".

Wednesday, October 29

Physical Society (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Presentation of the Planck Medal to Prof. P. A. M. Dirac by Prof. M. von Laue.

Royal Statistical Society, Research Section (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. F. J. Anscombe: "Sequential Estimation".

Institution of Electrical Engineers, Supply Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. M. Cook: Chairman's Address.

Thursday, October 30

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Miss Pauline Whitby: "Animal Food".*

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Harold Spencer Jones, F.R.S.: "The Masses of the Sun, Planets and Stars". (Further Lectures on November 6 and 13.)

Royal Aeronautical Society (at 4 Hamilton Place, London, W.1), at 7 p.m.—Dr. E. W. Still: "Temperature Control for Pressure Cabin Jet Aircraft".

Friday, October 31

Royal Meteorological Society, Scottish Centre (in the Department of Natural Philosophy, The University, Drummond Street, Edinburgh), at 5 p.m.—Prof. P. A. Sheppard: "Atmospheric Turbulence and the General Circulation".

Bedson Club (in Lecture Theatre I, Chemistry Building, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. C. W. Davies: "Ion Association" (87th Bedson Lecture).

Manchester Statistical Society, Industrial Group (at the Portico Library, Mosley Street, Manchester), at 6 p.m.—Mr. R. F. H. Banister: "What Management Expects of Statisticians".

North-East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Westgate Road, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. Claude Seippel: "From Stodola to Modern Turbine Engineering" (Parsons Memorial Lecture).

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the University Chemical Society, in the Chemical Laboratory, Pembroke Street, Cambridge), at 8.15 p.m.—Dr. T. C. J. Ovenston: "By-Ways in Absorption Spectrophotometry".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. Morris W. Travers, F.R.S.: "Sir William Ramsay".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant (Grade B) in Biology—The Principal, Acton Technical College, High Street, Acton, London, W.3 (November 1).

Research Assistant at the Plastic Surgery Centre, for work in connexion with the application of radioactive isotopes to clinical research—The Group Secretary, Odstock Hospital, Salisbury (November 1).

Teachers of Mathematics and Physics, Iraqi Ministry of Education, Baghdad—The Director, Personnel Department, British Council, 65 Davies Street, London, W.1, quoting subject and 'Baghdad' (November 1).

Assistant Lecturer in Electrical Engineering—The Registrar, College of Technology, Manchester 1 (November 3).

Chemist (Scientific Officer grade) (with suitable good honours degree and, preferably, some research experience) for research on the proteins and enzymes of milk—The Secretary, National Institute for Research in Dairying, Shinfield, Reading (November 8).

Plant Pathologists (with a four-year degree in botany, agricultural botany or agriculture, with at least one year's specialization in plant pathology), Southern Rhodesia Government—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (November 8).

Research Assistant (qualified in social anthropology or sociology and statistics) to engage in a community research project—The Registrar, The University, Leeds 2 (November 8).

Scientist (with a good honours degree in natural science (physics, chemistry or mathematics) preferably with experience in the study of dust and other industrial environmental problems) on the staff of the Director of Scientific Control at London headquarters, to co-ordinate and supervise environmental studies which are to be carried out at 20 or more selected collieries during the next 10 years as part of a field research on pneumoconiosis—The National Coal Board, Establishment (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting TT/544 (November 10).

Textile Scientist (Senior Research Officer or Research Officer grade) in the Physics and Engineering Unit of the Wool Textile Research Laboratory, Sydney, to develop a programme of research into the physical properties of fibre assemblies or into the physical principles of textile processes—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 4010 (November 15).

Chair of Pharmacology at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 17).

Senior Lecturer in Botany (Plant Physiology) at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 1).

Lecturer in Civil Engineering at the University of Queensland—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 15).

Lecturer in Zoology at the University of Hong Kong—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 3).

Rutherford Scholarship for research in any branch of the natural sciences—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (February 15).

Assistant (with a degree in botany or natural science and some training in plant pathology) to the Chief Officer, and a Research Assistant (with a degree in botany or natural science), in the Official Seed Testing Station for England and Wales—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Assistant Lecturer in Chemistry—The Acting Registrar, University College, Exeter.

Geologist for service in the Antarctic with the Falkland Islands Dependencies Survey—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.33272.E.

Head of the Department of Chemical Technology, Indian Institute of Science, Bangalore—The Ministry of Labour and National Service (A.S.12), Almack House, 26 King Street, London, S.W.1, quoting A.12/1.31.E.

Librarian-Information Officer (with a science degree and, preferably, a working knowledge of French or German)—The Director, Fruit and Vegetable Canning and Quick Freezing Research Association, Campden, Glos.

Physical Chemist (Scientific Officer or Senior Scientific Officer grade) at a Ministry of Supply research establishment in South-West England, to lead a small group working upon a variety of research problems in physical chemistry—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.669/52A.

Research Assistant in the Department of Aeronautical Engineering, to aid and initiate researches in the study of noise from aircraft and jets—The Registrar, The University, Southampton.

Scientific Officer or Senior Scientific Officer, for an investigation on the soundness of iron castings—The British Cast Iron Research Association, Alvechurch, Birmingham.

Senior Plant Pathologist (with a good honours degree and considerable postgraduate research experience of virus diseases of trees and, if possible, of handling insect vectors) at the West African Cocoa Research Institute, Gold Coast—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting Ref. No. 63/86/01.

Senior Scientific Officer for chemical and technical investigations of plant and animal products, and assistance in preparation of memoranda, reports and replies to inquiries regarding their production, preparation and marketing (Ref. F. 666/52A), and a Scientific Officer to assist in the duties outlined above (Ref. F. 667/52A), at the Colonial Products Advisory Bureau (Plant and Animal), London, S.W.7—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

University Graduate or Postgraduate in Electrical or Mechanical Engineering, Physics or Mathematics (with at least three years experience in the application and use of gyroscopes in navigational instruments and the development of low wander rate gyros)—The National Research Council of Canada, Africa House, Kingsway, London, W.C.2, quoting Ref. No. 2908.

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ACADEMIC FREEDOM IN THE MODERN STATE

THE appearance after an interval of two years of a new review of the activities of the Rockefeller Foundation[*] would in any event be of considerable interest, and especially as in this survey Mr. Chester Barnard attempts to re-assess the objectives of the Foundation and its position in the world. He is not content merely to describe the reorientation of the Foundation's activities and its new objectives, but also endeavours to relate them to the general needs and problems of our time. This analysis is of the more interest in view of some comments on the position of such voluntary bodies which are made in the seventh report from the Nuffield Foundation[†], published almost simultaneously. Together the two reports give an encouraging picture both of the way in which such voluntary bodies are able to foster creative work and also of their indispensability if human society is to remain healthy and flexible in an age when research itself is increasingly dependent on public, or rather State, support.

Mr. Barnard points out that the resources of the Rockefeller Foundation are limited indeed in the face of the myriad wants of mankind, and because of this disparity the Foundation can select for support only those wants which represent critical needs and which provide opportunities for service in fields that are at the very basis of human well-being. In discharge of that heavy responsibility of selecting the most appropriate projects, the trustees and officers of the Foundation are entitled to draw some encouragement from the results which have flowed from some almost trifling grants. Mr. Barnard refers to the way in which the Montreal Neurological Institute, to which the Foundation has already appropriated nearly one and a half million dollars, has arisen from a grant of 2,784 dollars made twenty-five years ago to Dr. W. Penfield for a fellowship in neurosurgical research at McGill University.

Mr. Barnard uses this grant to illustrate the potency of the comparatively small grants—at least when measured against the resources of the State—which independent and voluntary organizations can make for research. Nevertheless, he emphasizes that the principle of adequacy is the correct yardstick to apply in any decision regarding the magnitude of a grant, and his discussion of this point vividly recalls some remarks of Sir Henry Tizard in his Messel Memorial Lecture. This illustration is even more significant, however, in its demonstration of the value of the voluntary organization with its freedom to experiment in fields where it would be difficult for the State to commit its own resources. The Rockefeller Foundation, as Mr. Barnard sees it, must work, irrespective of the magnitude of the project which is to be undertaken or of the size of the grant which is to finance it, with small groups, such as university departments, laboratory teams and individuals, who are both technically competent and intellectually free.

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[*] The Rockefeller Foundation: a Review for 1950 and 1951. By Chester I. Barnard. Pp. 126. (New York: Rockefeller Foundation, 1952.)

[†] Nuffield Foundation. Report for the Year ending 31 March 1952. Pp. 162. (London: Nuffield Foundation. 1952.)

From this point of view Mr. Barnard shows concern at the increase of restraints on individual and group freedoms imposed in the interests of national security. The code of morals prevalent in Western society, in his view, rests on the twin pillars of the freedom and the responsibility of the individual. Recognizing the necessity for security and the difficulties of attaining it, he discusses what adjustment can be made that will preserve the life of the mind without endangering national security.

Mr. Barnard thinks that the sense of responsibility to institutional and public interest within the academic fraternity in the United States is not, on the whole, as mature as is desirable. With some qualification, that is possibly true of academic circles in Great Britain also, and it will be remembered that Prof. A. V. Hill made a similar comment in his presidential address to the British Association. Nevertheless, free discussion in the academic world is of increasing importance when so many activities in other fields are largely and necessarily subject to formal co-ordination and to central direction.

The Rockefeller Foundation, Mr. Barnard points out, endorses the view that only the free mind is capable of really productive intellectual work, either in research or in teaching, and that the man or woman who has an ideological axe to grind is conspicuously less successful as a contributor of knowledge than one who is free of such a restriction. The two personal criteria by which the Foundation judges eligibility for grants and fellowships are technical competence and integrity as a scholar. The first requisite for intellectual integrity is an open mind; once a man becomes a partisan in his search, and accepts the dictation of external authority as to the interpretation of the phenomena he observes, he ceases to be a scholar.

That still needs saying, and Mr. Barnard's further contention that those who sacrifice their freedom to a party line thereby disqualify themselves for research, and automatically exclude themselves from the immunities granted by society to the scholar in exchange for his dedication of himself to the search for truth, points the way towards a solution of the problem of freedom and loyalty and responsibility. The view taken by Mr. Barnard is, in fact, thoroughly realistic. Strongly as he argues that freedom to inquire, to observe, to theorize, to exchange ideas and experiences and to criticize, is essential to fundamental research and for creative work of any kind, he recognizes too that in some areas of research, where national security is involved, the traditional liberty of the scholar is subject to restriction in the interests of the nation and society. It cannot be granted as an inalienable right, and the scientific man who wishes to work in such areas must accept the restriction as an unavoidable evil. If he feels that he cannot fulfil his responsibility in research unless he can communicate his findings freely with other scholars and share their discoveries, a man of science should withdraw and work in another field where such secrecy considerations are not over-riding. He can claim no right to set his own judgment as to the necessity of free communication above the judgment of those who may be no less concerned with scientific advance but who are responsible also for maintaining national security. Moreover, to withdraw, as Prof. Hill very clearly indicated, is probably the surest way of emphasizing to the nation and to society the high cost of secrecy measures, and the way in which such measures impede both scientific discovery and technical development.

In this review, Mr. Barnard sounds a warning that has been given before in the Rockefeller Foundation reports; but while it is clear that the Foundation would be seriously concerned at any considerable extension of secrecy areas, the purpose of the present warning may equally be to give notice of the Foundation's concern with intellectual integrity, and its desire to foster a keener sense of public responsibility on the part of the scientific men and other scholars. The issue of academic freedom is also raised by the Nuffield Foundation in its seventh report, but from a rather different point of view. Although the fears expressed in its previous report of a sudden setback to the development of university work in Britain through a contraction of government spending have not been realized, the Foundation is still somewhat exercised as to the possible effects the increasing dependence of the universities upon public money may have on the traditional independence of academic work and the freedom of universities to manage their own affairs.

Some three-quarters of the total income of the universities of Britain will presently be derived from government sources, and while for the moment the universities will only have to face such restrictions on their activities as may be imposed by rising costs, the Nuffield Foundation is somewhat concerned at a passage in the Fifth Report of the Select Committee on Estimates for the Session 1951–52. That report, which subjected to careful analysis the grant-in-aid of universities and colleges from the point of view of public accountability, provided a striking indication of the effectiveness of the University Grants Committee system. The Select Committee was satisfied that the arrangement successfully harmonized academic freedom with proper control over the expenditure of public funds, and at the same time urged the desirability of securing the maximum contribution from private benefaction and local support.

It is on this question of further revenue from private gifts and endowments that the Nuffield Foundation is critical. The Select Committee noted that there was evidence of the same antipathy on the part of universities towards ear-marking by private benefactors as towards ear-marking by the Exchequer. Private benefactions, indeed, are apt to be even more restrictive than State ear-marked grants, and 54 per cent of total endowments are given for particular purposes. The Estimates Committee made no comment on this point; but the Nuffield Foundation takes up strongly the plea that private benefactions should not be tied by the donors to the creation of some particular facilities or the promotion of special projects.

Universities naturally prefer to be left unfettered in deciding the best use for such private donations, so that they can experiment with new developments or test out novel ideas; and the Foundation is fully mindful of the needs and circumstances of universities as centres of teaching at the highest level and of most of the research which advances knowledge. In previous reports, the Foundation has stressed the importance to-day of the comparatively much smaller but alternative resources which private funds can offer in support of activities so speculative as research. In the present report, the Foundation makes a spirited defence of its practice of making grants to universities for particular rather than for general purposes.

In doing so, the Nuffield Foundation could have drawn upon the experience of the Rockefeller Foundation as well as on its own. Both bodies, in seeking to use their endowments to foster those advances in knowledge from which human welfare stands ultimately to gain, have been concerned primarily with the exceptional men upon whom those advances depend. Both have made their grants more for special individuals than for special projects, and the Nuffield Foundation can claim with reason that it has been privileged on occasion, by enlarging the resources available at a university, without imposing restrictive conditions, to enlarge also the freedom both of the exceptional individual and of his institution. The object of any Nuffield Foundation grant is simply to give the individual able worker the means for carrying forward experiment and knowledge in the way which, because it suits him, is likely best to serve his subject.

The example cited by the Foundation in this report to demonstrate the decisive value of private benefactions for a specific purpose is the personal grant from Lord Nuffield in 1942 and grants from the Nuffield Provincial Hospitals Trust in 1943, which prevented the dispersion of Sir Howard Florey's team of research workers on penicillin. The instance cited by Mr. Barnard of the fellowship for neurological research equally establishes the value of the specific grant; and on the evidence of these two reports alone there can be no doubt as to the contribution to scientific advance which the voluntary association can make by means of its grants and endowments for specific purposes.

Implicit in both these reports is the belief in wise and responsible selection of individuals and projects. No objection has been raised to the acceptance of ear-marked grants or endowments from bodies of the standing of the Nuffield Foundation or the Rockefeller Foundation, with their established tradition of wise selection and public responsibility. It can equally be agreed that the fellowship schemes like those of Imperial Chemical Industries, Ltd., where full freedom of choice is allowed within whole scientific disciplines, are also a means for encouraging the emergence of the exceptional investigator. It would be unwise, however, to assume that every private benefactor will possess either the same tolerance or keen sense of public responsibility. Save where the repute and standing of the benefactor in these respects are beyond dispute, the universities are wise to prefer the uncommitted grant or endowment. Bodies like the Nuffield Foundation and the Rockefeller Foundation have an essential part to play in encouraging the development of backward or neglected fields. Great Britain could ill spare the effort which the Nuffield Foundation, for example, proposes to make during the next five years to encourage fundamental research in the United Kingdom in the biological and sociological fields, and to utilize special opportunities in other fields of medicine and science, as well as in old people's welfare and in the finance of biological and other research in the Commonwealth, particularly in the utilization of local resources.

But the Nuffield Foundation is well qualified to discuss the opportunities which exist or can be created for work of high standard in such fields. Its choice, in the ultimate resort, is made on the quality of the individual and is guided by lively contacts with academic thought and practice. The real issue for us to-day is to secure the continuance of such independent bodies, and provide the conditions by which such voluntary effort can continue to maintain the growing points and opportunities for experiment in society to which the State itself—directly or indirectly—can with difficulty, if at all, commit itself. Perhaps the most encouraging feature of the present report from the Nuffield Foundation is the indication it affords of the way the Foundation finds it possible to work, formally and informally, in co-operation not only with the universities but also with the major departments of State and the official research organizations, and to bring to the common task the flexibility, initiative and independence which mark the voluntary body.

FREEZING AND DRYING

Freezing and Drying

Report of a Symposium held in June 1951. Pp. 206. (London: Institute of Biology, 1952.) 15s.

THIS report contains all the papers read at a symposium at the Institute of Biology which was held in London during June 1951. In addition to the papers, the whole of the discussion which followed them has been included. The complete compendium is a most valuable contribution to this rapidly expanding subject.

The principle of freeze-drying is, of course, dependent upon the fact that frozen water has a significant vapour pressure, and even at − 20° C. this is equal to about 0·9441 mm. of mercury. Consequently, in a vacuum of a lower pressure than this, the frozen water will pass directly into vapour (that is, it will sublime) and can be removed from the system. Progressive removal of the water vapour so formed will eventually cause the drying of the tissue. Biological fluids and tissues kept at these low temperatures remain virtually inactive. Autolytic reactions do not take place, growth of micro-organisms is prevented and proteins are not denatured. Moreover, most enzyme activity of tissues and fluids frozen-dried in this way is maintained. The advantages of freeze-drying were, of course, made use of during the Second World War, when the production of large quantities of dried blood-plasma and penicillin were made possible by its use. A glance at the list of papers read at the symposium and recorded in this volume demonstrates the range of activities to which this technique is now applied.

First, there is a series of four papers on what can best be described as large-scale freeze-drying—that is, treatment of antibiotics and foodstuffs—by this method, and also discussions on methods of freeze-drying. A second section deals with effects of freeze-drying on the viability of cells and tissues. Here we have papers on mammalian skin, tumour tissues, spermatozoa, red blood cells and endocrine tissue.

A third section records the effects of freeze-drying on bacteria and viruses, and a fourth discusses the problems of tissue fixation by freezing and drying and its significance in histochemical and cytological studies. This latter problem was, in fact, first investigated by Altmann as long ago as 1890, but was neglected until it was more fully investigated and improved in the early 1930's by Isadore Gersh in the course of his studies for the degree of Ph.D. at the University of Chicago; Dr. Gersh himself read the opening paper in this section.

It can be seen that there are few biological activities—commercial, bacteriological, cytological, etc.—which are not affected by the development and further application of this new technique. This volume should therefore have a wide and ready sale.

As a record of the first symposium held by the newly formed Institute of Biology, the book augurs well for the future of the Institute's activities.

GEOFFREY H. BOURNE

HORMONES IN PLANTS AND INVERTEBRATES

The Action of Hormones in Plants and Invertebrates

Edited by Kenneth V. Thimann. (Reprinted, with additions and supplementary bibliographies, from 'The Hormones', Vol. 1.) Pp. viii+228. (New York: Academic Press, Inc., 1952.) 5.80 dollars.

THIS volume consists of four essays on the hormones of plants, insects and crustaceans, gathered together under one cover in the hope that their proximity might lead to the same sort of unification as has occurred in mammalian endocrinology. One is left with the impression that the realization of unity has been somewhat less than the anticipation. Although each of the essays possesses considerable intrinsic value to workers in the particular field discussed, there seems to be relatively little carry-over between the various groups. In fact, one is led to wonder whether the study of hormones has as yet been so significant a unifying force in biology as the editor believes. Aside from the universal occurrence of hormonal mechanisms of correlation and control in complicated organisms, one can think of no major generalizations to make. If other basic similarities do, in fact, exist, they need to be pointed out, for they are well hidden.

The four essays are "Plant Growth Hormones" and "Other Plant Hormones" by Prof. Kenneth V. Thimann of Harvard University, "Hormones in Insects" by Berta Scharrer of the University of Colorado, and "Hormones in Crustaceans" by Prof. Frank A. Brown, jun., of Northwestern University. They have been reprinted from Vol. 1 of "The Hormones" (1949), together with some additions to the text and supplementary bibliographies to bring them up to date as of late 1951. It is hoped that such supplementation will make complete revision unnecessary for some years to come.

Prof. Thimann's article on plant growth hormones is a skilful condensation and modernization of the kind of material originally presented in Went and Thimann's "Phytohormones". The result is a brief coherent survey of the state of our knowledge of the chemistry and physiology of the auxins up to five years ago. Because of the extremely rapid advances which are now being made in this field, parts of the auxin story are somewhat out of date, and the inclusion of the recent bibliography does not quite remedy the situation.

The chapter on "Other Plant Hormones" is especially welcome, since it summarizes much material not before integrated. One may find here authoritative discussions of the wound hormone, flower-forming hormones, vitamins which act as plant hormones, leaf growth-factors, calines and the hormones of fungi. Since relatively little important work has been done in these fields in the years since the article was originally written, it is as complete and up-to-date a review as one could hope to find.

The comparatively young field of invertebrate endocrinology has very recently produced a spate of interesting discoveries on hormonal regulatory effects in insects and crustaceans. Most of these hormones have been shown to exist by purely physiological and surgical means, and in only one instance, the formation of eye pigments in *Drosophila* and *Ephestia*, has the chemical nature of the hormone been definitely ascertained. Nevertheless, these studies hold great promise for an eventual rationalization of the complex problems of growth and morphogenesis, especially in the insects.

Dr. Scharrer discusses insect hormones under the following headings: (*a*) hormones controlling postembryonic development, (*b*) sex hormones, (*c*) hormones affecting pigmentation, and (*d*) "gene hormones", that is, hormones directly involved in the expression of a particular gene. Although distinct differences are shown to exist among various orders of the insects, it seems clear that in all groups there are hormones controlling larval growth, pupation and moulting. It also seems clear that an 'anti-differentiation factor' (the juvenile hormone of Wigglesworth) is present. In this respect, one can see a broad analogy with plants, in which there appears to be a growth versus sexual differentiation control by the interplay of auxin and florigen. The corpora allata, the centres of synthesis of the juvenility factor, may thus be regarded as analogous with the stem tip, in which the major share of auxin synthesis occurs; and the neuroglandular intercerebralis–cardiacum complex, which produces the growth and differentiation hormone, with the leaves which produce florigen. It would be interesting to know whether the production of the growth and development hormone in insects is as sensitive to environmental control as is the synthesis of florigen in plants.

In the Crustacea, discussed by Prof. Brown, no single hormone has yet been obtained in a pure state, but many are known to exist. As in the insects, they control colour-change, moulting and growth, sexual processes, and certain aspects of growth, development and metabolism. Some of these hormones have been hypothesized almost exclusively on the basis of observation, as in the effects of parasitic castration on secondary sexual characteristics. With others, especially hormones involving colour changes, a sound experimental basis for their existence has been laid. The account of the hormonal control of chromatophores by the sinus gland and central nervous organs is especially exciting.

The study of hormones in plants and invertebrates, which began less than thirty years ago, has already wrought a revolution in our understanding of the physiology of these types of organisms, and the increasing tempo of research augurs well for its future. This volume is a valuable chronicle of progress in a vigorously growing field, and it is hoped that it may aid in achieving the unity in biology to which Prof. Thimann dedicates it.

ARTHUR W. GALSTON

THE FULMAR POPULATION

The Fulmar

By James Fisher. (New Naturalist Series.) Pp. xv + 496 + 52 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1952.) 35*s.* net.

THE nucleus for the present work was the British Trust for Ornithology Inquiry into "The Breeding, Distribution, History and Population of the Fulmar (*Fulmarus glacialis*) in the British Isles", conducted by the author and George Waterston (*J. Animal Ecol.*, 10, 204; 1941). In the published paper the spread of the fulmar from one colony in 1874 to 269 colonies in 1939 was considered by the authors to be "due to a biological change which is not understood". As a plankton-eating arctic species the fulmar should have been retreating northwards with the shrinking of the ice-cap and the amelioration of the climate of the northern hemisphere—but, in fact, it was moving south at a great rate. They wrote: "Correlations may exist between the spread of the fulmar and its food, but it will be a Herculean task to discover them".

A simple solution was, however, discovered by Marchant and myself on our visit of nine days at Rockall in June 1948, when we became convinced that the fulmar's increase was related to the availability of the tons of fish offal which are thrown into the sea each hour of each day all the year round by the great fleets of deep-sea trawlers of the maritime nations of Western Europe. We saw up to five thousand fulmars at one moment devouring this offal, which was hosed over the side of the trawler after the gutting of each trawl-load of about a ton of fish every four hours day and night. As it is now known that the larger petrels are capable of long fasts and of flying great distances there is no reason why most of these fulmars at Rockall (or at any other trawling bank) should not be breeding birds from the nearest colonies between two and four hundred miles away. At least fifty thousand fulmars were present on the Rockall Bank during June 1948 (they could not have all been non-breeders), which is $2\frac{1}{2}$ per cent of Fisher's estimated world population of one million pairs of Atlantic fulmars. Once it had tasted offal in this form the individual fulmar would be likely to attend trawlers regularly and even become quite dependent on this (at present) unfailing and abundant food supply. Hence the rapid colonization by nesting sites along the Iceland–British Isles seaboard within a few hundred miles of the trawling grounds. Making use of this hypothesis, the author has investigated the northern fisheries as far back as the height of the whaling period of the seventeenth century. Whale-flensing provided an abundant, though only seasonal, supply of offal for the scavenging fulmar. His analysis shows a significant correlation: a slight increase in the number of fulmar colonies during two hundred years of whaling, a rapid increase with sixty years of deep-sea trawling; the increases taking place near the sites of these fisheries.

A short review cannot do justice to the excellence of this large monograph. Fisher shows how much of the breeding biology is yet unknown; the incubation period has not been accurately measured; and a theory of intermittent breeding is discredited. Field ornithologists especially will welcome his lucid presentation of the history of the distribution and increase of this remarkable petrel, gathered as it has been from the reading of more than 2,400 references. Disappointingly, none of these is listed in the monograph; but we are promised the bibliography later.

R. M. LOCKLEY

NEW LIGHT ON ALCHEMY

The Alchemists

Founders of Modern Chemistry. By Dr. F. Sherwood Taylor. Pp. x + 246. (London: William Heinemann, Ltd., 1951.) 12*s.* 6*d.* net.

DR. F. SHERWOOD TAYLOR'S book appeared very appositely just at the time of the recent exhibition of alchemical books at the Science Museum, South Kensington. It is apposite in another way also, for the modern trend in history pays much more attention than ever before to the growth of ideas, and it is from this point of view that Dr. Sherwood Taylor surveys his subject. The literature of alchemy is formidable, not only for sheer bulk but also for its complexity and often deliberate obscurity; many of its students have sooner or later become discouraged by vain attempts to thread their way through the labyrinth, and have indeed doubted whether, if it could be threaded, there would be anything worth discovering at the centre. One may, of course, investigate the alchemical *corpus* solely in order to assess the matter-of-fact chemical knowledge contained in it; but even this is not easy on account of the enigmatic nomenclature so generally favoured by the alchemists. Genuine practical chemistry is, however, only one facet of the alchemical crystal: the sparkle comes mainly from the numerous facets of doctrine. What Dr. Sherwood Taylor has set out to do, and what, in fact, he has succeeded in doing very well, is to examine alchemical doctrine to see if any coherence and continuity can be detected in it. He has the advantage of being a chemist versed not only in chemistry but also in theology, philosophy, and mysticism, and has thus been able to follow clues imperceptible to one less well equipped.

What emerges from this careful and original study is that, in spite of its paraphernalia of alembics, cucurbits, pelicans, and furnaces, alchemy was essentially a religious philosophy aimed at the unification of all Nature in a single scheme under Divine guidance: there is a causal chain of descent from God to matter. As the author points out, this is compatible with Christian theology, but it is equally compatible with Muslim theology; allowing for Muslim disbelief in the Trinity and in the divinity of Christ, it is possible to trace quite clearly the continuity of alchemical philosophy from the Brethren of Purity to Thomas Vaughan.

Dr. Sherwood Taylor makes the further point that, owing to its religious basis, alchemy would have no truck with black magic. This is an interesting suggestion, and it is to be hoped that the author will expand it in a further book or paper; the dividing line between alchemists and magicians was surely not always very well defined.

While I have directed attention to what seem to me to be the important contributions to alchemical studies made in the book, it should be added that the main story is a beautifully written and well illustrated account of alchemy from the earliest times: quite the best account yet given in such compass. It will interest all who are curious about man's interpretations of Nature and its relations to the Deity, and, if it be the history of an error, the error was one extremely tenacious of life. It is, indeed, not dead even in this twentieth century. I remember seeing a practising alchemist of the old school, Al-Hajj Abdul-Muhyi Arab (once Mufti of the Shah Jehan Mosque at Woking), absorbedly bending over a heated ladle which was always going to, but never did, deliver a golden stream of transmuted lead.

E. J. HOLMYARD

PHYSICAL CONCEPTS, NEW AND OLD

The Scientific Adventure

Essays in the History and Philosophy of Science. By Prof. Herbert Dingle. Pp. ix+372. (London: Sir Isaac Pitman and Sons, Ltd., 1952.) 30s. net.

THE author of this collection of essays and lectures presides over one of the most interesting and progressive academic 'schools' in Great Britain—that of the history and philosophy of science in the University of London. Thus it is appropriate that he should divide his book into two sections, one historical and one philosophical. As he is at pains to point out, however, he is more specifically in his element when concerned with the latter than with the former. Nevertheless, of the past he has much of consequence to say.

Although composed for a wide variety of occasions, there is a certain thread of continuity running through these pages, a strand of astronomy, astrophysics and cosmology deftly intertwined with their associated epistemological correlates. Amidst much of importance, there should be little difficulty in recognizing that Chapters 1, 9 and 19 (the last) are outstanding in their respective fields. To these, therefore, in general, this review will be restricted. But before getting to grips, one notices how true to type they are. The first, being frankly historical, leaves us to draw—as indeed we must—the conclusions based upon several centuries of scientific endeavour. The other two are quite different in that they propound questions possibly unanswerable. This seems perfectly legitimate, and in full accord with the traditional duty of a philosopher, especially since many an ordinary person (if such exists) would scarcely dream that such problems were stuff for thought at all, let alone disciplined inquiry. It is the merit of these papers that, through reading them, attention is inevitably directed to the presence of several formidable philosophical hurdles confronting the individual and society. There may be little inclination to try to jump them, but to know that they are there is salutary.

Chapter 1 describes what are in effect two life-lines, one that of the logical development of scientific knowledge, the other the actual. Naturally, at certain points they intersect. Broadly, however, the factual course is strewn with minor deviations which lead nowhere, whereas the chart of formal progress is dead straight. Prof. Dingle points the moral clearly. The logical *Lebenslauf* is the lot of the student, if only for the reason that to wander aside into history might touch off some sparks of interest, and thus endanger his effective working hours. As things are, it is only rarely that he has any chance of appreciating how major discoveries and inventions came about; he is constrained largely to pool them in order to get some kind of tidy conspectus. Experience, however, goes far to condemn this tendency, because it is crystal-clear that the capacity for original work of the highest order is more often than not found in those who have deliberately studied the past and pondered over its message.

Turning now to Chapter 9, this deals with "the philosophical viewpoint of the scientist". The emphasis is upon two anomalies, to which the author has devoted a great deal of thought. One is the subject–object relation. The other concerns time. The solution offered is to regard the subject "as inevitably stationed at the present", whereas the object is to recede into the past. Following upon this, reason is seen not to be objective "in the act of thought", whereas experience is found to be placed in time.

Towards the end of this chapter comes the link which seems to join it without constraint to Chapter 19. This is the problem of ethics. We are faced with the Kantian co-equals, 'practical reason' and 'pure reason'; and, sure enough, back we are driven to the categorical imperative. This the author fails to find coercive, and, philosophically speaking, the majority of mankind will agree with him. But, once again, nothing can be done about it.

From here, the reader may well survey the last contribution as from a point of vantage. Its subject is "science and religion". Even to anyone a little wearied of such a theme, it must appear as exceedingly well conceived. Perhaps the reason for this is because Prof. Dingle refuses to get bogged down in the *minutiæ* of what will always, on this side Jordan, be essentially subjective and personal experiences. Yet—and here is the strength of this particular presentation—they are none the less real for that.

Time was, and perhaps to some degree still is, when philosophy was the accredited handmaid of theology, and proud to share a palace with the queen of the sciences. This ancillary relationship has since become somewhat difficult. It is not wholly a question of 'abdication'; events have made it less easy for 'the Crown' to keep clear of, and to sit above, the stresses and strains of contemporary life. But these are matters only discernible maybe upon another plane of discourse, namely, that on which we shall know, even as we are known.

F. I. G. RAWLINS

Quantum Mechanics of Particles and Wave Fields

By Prof. Arthur March. Pp. x+292. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 44s. net.

PROF. A. MARCH'S book is a very welcome addition to the literature of modern developments in the quantum theory of particles and wave fields. The changes in centres of interest in this subject are well indicated by the fact that one-half of this book is devoted to the subject of relativistic wave equations, and to the quantization of wave fields. The earlier chapters give a good introduction to the earlier developments in quantum theory, including, of course, Schrödinger's wave equation and the principles of matrix mechanics. The later chapters are peculiarly interesting and suggestive, as they deal with the central problems of quantum electrodynamics.

There is a curious passage on p. 179 which seems, at least on the surface, to be at variance with the usual interpretation of Dirac's wave equation. Prof. March writes: "It is important to realize the physical significance of the wave equation (248) [that is, Dirac's wave equation]. It has been emphasized already that this equation no longer permits an interpretation in the sense of non-relativistic quantum mechanics. As long as it is not quantized, it has no relation whatever with particles, but controls the behaviour of a field that is not purely symbolic but actually represents a physical reality. This is clear from the fact that, according to (249), (251), and (253), the field possesses charge, energy, and momentum, and thus it can be measured relative to these observables. It is only a question, then, as to whether wave fields corresponding to the assumed equation really exist, a question that must be answered in the affirmative". This interpretation is so unusual that Prof. March might well have referred to the fact that most writers, including Dirac himself, regard the relativistic wave equation as referring to the behaviour of an individual particle.

G. TEMPLE

The Lipids

Their Chemistry and Biochemistry. By Prof. Harry J. Deuel, Jr. Vol. 1: Chemistry. Pp. xxiv+982. (New York and London: Interscience Publishers, Inc., 1951.) 18.50 dollars.

THE term lipid has been interpreted in its fullest sense, and the author discusses not only the simple lipids (fats and waxes, 405 pages) but also the compound lipids (phosphatides and cerebrosides, 102 pages) and the derived lipids (carotenoids, 160 pages, and vitamins A, D, E and K, 194 pages). The author does not claim to be an authority in all these fields, though it is suggested, in the preface, that this will make the book less involved and therefore more understandable to non-specialist readers.

For so large a book, the number of mistakes is small, though some have been noted. For example, the formulæ on p. 168 (1 : 2-benzylidene glycerol), 428 (choline chloride) and 602 (azafrinone) are in error. It is stated (p. 88) that linolenic and elæostearic acids are the only octadecatrienoic acids known; but octadec-6 : 9 : 12-trienoic acid, reported to occur in *Œnothera biennis* seed oil, is a member of this series. The statement (p. 242) concerning the low iodine value of linolenic acid seems doubtful, while the section on atmospheric oxidation of unsaturated fatty acids and their natural derivatives is somewhat inadequate, making no reference to the important new developments reported in this field by many workers during the past decade.

Despite these errors and omissions, the general style of the book is pleasing, and I have read it with profit and enjoyment. References are copious, and the indexes (121 pages) appear to be very complete. The book is most useful to the reader in those parts of the field in which he is not a specialist.

F. D. GUNSTONE

A Basic Course in the Theory and Practice of Quantitative Chemical Analysis

By Prof. George L. Clark, Prof. Leonard K. Nash and Prof. Robert B. Fischer. Pp. xxi+448. (Philadelphia and London: W. B. Saunders Co., 1949.) 21s.

QUANTITATIVE analysis is one of the fundamental branches of the science of chemistry, and the proper instruction of the beginner in the broad essential aspects of the subject is invaluable to him in whichever field he may eventually specialize. This book, written by three authors with considerable experience in the teaching of analytical chemistry, forms an excellent introductory course for students.

Part 1 deals with gravimetric analysis, and Part 2 with volumetric analysis, the method of presentation in each case being a logical combination of theory and practice. Three representative determinations have been treated with unusual care and completeness in order to lead the inexperienced student to the proper critical approach to the subject, the later methods being dealt with in somewhat less detail. Part 3 describes briefly the modern instrumental methods of analysis. Many of the chapters are followed by review questions and problems which serve to test the reader's grasp of the subject-matter. Part 4 consists of ten short appendixes, including those on essential mathematics for quantitative analysis, standardization of weights and statistical treatment of experimental data.

The book is well written and well produced, but, from the British reader's point of view, the use of such terms as "precipitimetry" and "complexometry" is to be deplored.

A Text-Book of Practical Organic Chemistry, Including Qualitative Organic Analysis

By Dr. Arthur I. Vogel. Second edition. Pp. xxiii+1033. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1951.) 50s. net.

THE issue of a second edition of this laboratory manual only three years after the publication of the first edition (see *Nature*, 161, 995; 1948) is evidence of the popularity which it has deservedly achieved. The new edition is, in fact, little more than a reprint. For the most part the pagination corresponds with that of the first edition; but it is stated that the opportunity has been taken to correct various minor errors and to incorporate some suggestions made to the author. The appendix is enlarged by the inclusion of examples of new preparative methods in common use. These are the formation of some acetylenic compounds by liquid ammonia reactions; the use of N-bromosuccinimide, the Huang–Minlon modification of the Wolff Kishner reaction; reductions with lithium aluminium hydride; cyanoethylation; and the use of organo lithium compounds. These are welcome additions. There is no doubt that this book has established itself as a medium of instruction in practical organic chemistry.

J. W. COOK

METEORITES AND COSMIC RAYS

By Dr. S. F. SINGER

Office of Naval Research, U.S. Embassy, London

THE extensive measurements of Paneth and his collaborators[1] of the uranium, thorium and helium content of iron meteorites have established a method for determining the time elapsed since their solidification. The widely varying 'ages' obtained by this method have led Bauer[2] and also Huntley[3] to suggest that cosmic rays may provide an additional source of helium and therefore affect these determinations. Certain of Bauer's more detailed conclusions have been criticized[4]; but it seems very likely that the ages quoted[1] represent upper limits. (Underlying all of this work is the assumption, for which there is experimental support[5], that the diffusion of helium, and therefore its loss, is negligible at ordinary temperatures due to the structure of iron meteorites.)

The problem of helium production by cosmic rays has therefore been re-examined[6]. (1) By taking into account the important contributions of cosmic-ray secondaries and other factors, one obtains a lower limit for the rate of helium production which is more than an order of magnitude greater than Bauer's value. One also comes to a conclusion different from Bauer's about its variation with depth in the meteorite. These calculations can be checked by related experiments; a calibration may also be obtained from self-consistent age measurements on a single meteorite. (2) A method is developed here for separating experimentally the helium contribution by cosmic rays and by radioactivity; it is based on the fact that cosmic rays are able to produce substantial amounts of helium-3 either directly or through tritium, whereas the radiogenic helium consists entirely of helium-4.

The results of such studies on the total amount of radiogenic and cosmic-ray helium can then be applied to give a correction to the age determinations of meteorites and to other cosmological problems[6].

Production of Helium

A number of processes are known by which the cosmic radiation can produce helium in meteorites (strictly speaking, 'meteoroids'). The most important contribution comes from the excitation of iron nuclei by fast cosmic-ray particles, and the subsequent evaporation of helium-4 and helium-3 nuclei, and of tritium nuclei which decay into stable helium-3. Other processes of lesser importance contribute to the helium production, namely: (1) primary helium nuclei stopping in the meteorite; (2) helium fragments from the break-up of heavy primary nuclei; and (3) heavy unstable nuclei ejected in cosmic-ray induced disintegrations ('stars') which break up into α-particles[7].

These events differ in some respects from those occurring in the atmosphere. The effect of the higher atomic weight of the meteorite will be to change the characteristics of the 'average' star[8], while due to the much higher density of the meteorite most π-mesons (themselves produced in nuclear encounters) will interact before decaying into non-interacting μ-mesons, and thus carry the helium production process to greater depths. (On the other hand, the effects of low-energy neutrons which produce tritium in the atmosphere[9] can be neglected here.)

The rate of production of helium-3 and helium-4 in iron has been calculated in two essentially different ways; they lead to concordant results. One method uses a cosmic-ray flux figure extrapolated from measurements on the primary radiation, empirical interaction cross-sections, and results of evaporation theory[10]. The other more empirical approach combines certain features of evaporation theory with a statistical study based on about 12,000 cosmic-ray stars, obtained by the University of Bristol group in high-altitude exposures.

Not only the primary radiation, but also lower-energy secondaries (protons, neutrons and π-mesons) are effective in producing stars. For this reason the amount of helium produced reaches a rather flat maximum some distance from the surface of the meteorite, and falls off rapidly with distance only after a depth of about 25 cm. The results given here apply for the case of an infinitely large meteorite having a nearly plane boundary. (In practice, this would correspond to a 'pre-atmospheric' diameter rather greater than one metre.) For meteorites of small size or odd shape, these results can be used, together with a suitable numerical calculation to take proper account of the solid-angle factor.

The final numerical value for the rate of helium production (by a flux of cosmic rays corresponding to the present-day value in the vicinity of the earth's orbit) in the region 2–15 cm. from the surface of an iron meteorite is $(5 \pm 1\cdot5) \times 10^{-14}$ c.c. of helium at N.T.P. per gm. of meteorite material per year. Of this amount ~ 30 per cent is calculated to end up in the form of helium-3.

The errors given are estimated ones and based on the present state of knowledge of cosmic-ray processes. In any event, it is thought unlikely for the rate of production to be appreciably lower, since all known cosmic-ray effects are believed to be taken into account. It should be pointed out also that the fraction of helium in the form of helium-3 decreases slowly with decreasing mean energy of the star, and hence with increasing depth in the meteorite.

These estimated errors are not likely to be reduced appreciably by further refinement of the calculations. A more promising approach, particularly with regard to the ratio of helium-3 to helium-4, comes from the experimental side, where one can attempt to simulate in the laboratory the exposure of meteorites to cosmic rays. As a first step in this direction, Dr. W. Barkas has kindly exposed a stainless steel target in the Berkeley 340-MeV. proton synchrocyclotron; this sample is now being analysed at the University of Durham. It is hoped to continue this approach by exposing a suitable sample in a bevatron, which produces protons in the cosmic-ray energy region. Independently, an experimental check on certain features of the evaporation theory and its application to an iron nucleus can be obtained by analysing by means of a magnetic field and nuclear emulsions the evaporation products of stars produced by cyclotron protons[11]. Following a different line of attack, nuclear G-2 and G-5 emulsions loaded with thin iron filaments have been obtained through the courtesy of Prof. G. P. S. Occhialini (Brussels) and Mr. C. Waller (Ilford, Ltd.). These have been exposed to the cosmic radiation at mountain altitudes.

Age Correction

Making the proper correction to the meteorite age requires the subtraction of cosmic-ray helium from the helium sample extracted from the meteorite. (A typical sample would amount to $\sim 10^{-6}$ c.c. helium per gm. of meteorite.) It is necessary first to measure the amount of helium-3 in the sample. After subtracting the helium-3 plus the proper amount of cosmic-ray helium-4 (calculated from the ratio above), one is left presumably only with radiogenic helium-4. The age can then be calculated by conventional methods[1].

The helium isotope ratio in the sample can probably be determined with modern mass-spectrometric equipment[12]. For very small samples, however, a radiochemical procedure based on Coon's method[13] may also be of value. Helium-3 is known to have an extremely large absorption cross-section (about 5,000 barns) for thermal neutrons. The (*n,p*) reaction occurring produces tritium, which is β-unstable and is transformed back into helium-3 with a half-life of 12 years. Exposure of a helium sample containing only 10^{-6} c.c. of helium-3 in a nuclear pile for a few days would give sufficient tritium to produce a measurable activity. It is proposed to determine the helium-3 content of the meteorite sample by comparing this activity with those from calibrated samples (enriched with helium-3) exposed under identical conditions. (Even smaller amounts of helium-3 could be detected by the use of special triton counters[14].)

In view of the fact that a unique age should result from a series of corrected age determinations obtained from different parts of the same meteorite, it may be possible to obtain a consistency check of the numerical result given in this article for the cosmic-ray helium isotope ratio and a calibration of the variation of this isotope ratio with depth in the meteorite.

Meteorites as Integrating Cosmic-Ray Meters

Some additional applications of the cosmic-ray helium method to problems of cosmological interest are pointed out here. These remarks must be viewed with some reserve, because of the many uncertainties about the physical history of meteorites. (For example, the helium gas may have diffused through the meteorite and have escaped if the latter was exposed to high temperatures.) Essentially one wants to provide an experimental test for the following assumptions: (1) the meteorite has been exposed directly to the primary cosmic rays from the time of solidification to the time of chemical analysis (that is, over the whole time interval during which radiogenic helium was allowed to accumulate); (2) this primary cosmic-ray intensity experienced by the meteorite corresponds to the flux in the vicinity of the earth; and (3) the average intensity over the life-time of the meteorite corresponds to the present-day intensity.

(1) By making use of the fact that cosmic rays produce helium in meteorites, one can develop the concept of considering a meteorite as an integrating cosmic-ray meter which gives one the time and space integral of the cosmic-ray flux it encounters over its path and life-time. From the corrected age of the meteorite and the amount of cosmic-ray helium, an empirical rate of helium production by cosmic rays can be determined and compared with the rate calculated on the basis of the assumptions just stated. It may then be possible to gain information about the cosmic-ray intensity in prehistoric times; or the intensity in the region where the meteorite spent the major part of its existence. A low value of cosmic-ray intensity obtained in this way may also be interpreted by assuming that the meteorite did not become exposed to cosmic rays until some time after its solidification, or that it landed on the earth during prehistoric times.

(2) By virtue of the fact that (in very large meteorites) the production of helium by cosmic rays is a 'surface effect' as opposed to the volume effect of radioactivity, one may hope to learn more about the physical processes undergone by the meteorite in its creation and in its travel through space. In particular, by determining its loss of mass in its traversal of the earth's atmosphere, it may be possible to establish an experimental test for the theory[15] of astroballistic heat transfer of a meteorite.

Full details of the present work will appear in *Geochimica et Cosmochimica Acta*. Experimental work on the possibility that helium-3 exists in meteorites is now in progress.

I want to express my thanks to Prof. F. A. Paneth for his interest in this work and for many stimulating discussions, also to U. Camerini, D. H. Perkins and S. Sørensen for valuable comments.

[Aug. 15.

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Dr. S. F. Singer has kindly shown me the preceding paper. It may interest readers that in a recent article[1] containing various experimental results—obtained partly in collaboration with the Clarendon Laboratory in Oxford—figures are given for the helium-3 content of five iron meteorites. They are in very good agreement with Dr. Singer's theoretical deductions, as can be seen from the accompanying table.

Name of meteorite	Helium content in 10^{-6} c.c./gm.	Helium-3/helium-4 (%)
Mount Ayliff	36·8	31·5
Carbo	22·0	28·0
Toluca (Durham)	18·9	29·7
Bethany Amalia (Krantz)	3·4	27·8
Bethany (Harvard)	0·36	17·8

For a discussion of these results in connexion with the question of the age of meteorites, the article referred to above in *Geochimica et Cosmochimica Acta* should be consulted.

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Sept. 3.

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ADVANCES IN THERMODYNAMICS

THE first of the laws of thermodynamics discovered was the second, by Carnot in 1824, when he described the cycle known after him and stated 'Carnot's theorem' that the work done in any reversible cycle operating between two temperatures is proportional to the heat supplied at the higher temperature and to the difference of temperatures. This was put into symbolic form by another engineer, Clapeyron, in 1834. Let a quantity of heat q fall through a temperature difference $\delta\theta$ in a reversible cycle and let the work w be done in the cycle, then:

$$w = Cq\,\delta\theta,$$

where C is a function of the higher temperature θ only. The work is $\Delta V \mathrm{d}p$, where ΔV is the volume change at the higher temperature and $\mathrm{d}p$ is the difference of pressures at the higher and lower temperatures; hence:

$$\mathrm{d}p/\mathrm{d}\theta = Cq/\Delta V. \tag{1}$$

Both Carnot and Clapeyron adopted the prevailing 'caloric' theory of heat, according to which heat is a material fluid (q equals a constant), and explained the production of work by the 'fall' of caloric through a temperature difference, just as work is obtained from a weight falling between two levels in a gravitational field. 'Energetics' later postulated that every form of energy is a product of two factors, quantity (for example, caloric for Carnot) and intensity (for example, temperature).

The first law of thermodynamics followed about 1849 with the work of Joule, and required that the heat absorbed in the cycle is not indestructible (as Carnot himself had suspected) but part appears as work. William Thomson (later Lord Kelvin) had shown that the original Clapeyron equation (1) gives correctly the effect of pressure on the melting point of ice, and that it could give an 'absolute' definition of temperature. We could say now that if heat, like work, is a form of energy, $\mathrm{d}p\Delta V$ and q have the same dimensions, and hence C in (1) must be the reciprocal of a linear function of temperature, $a + b\theta$; and by assigning suitable values to a and b, an absolute temperature scale, including the zero and the size of the degree, can be obtained. This was done by Thomson in 1850, after he had shown that Clapeyron's equation is still true when some heat disappears. In fact, in (1) only the heat taken in is concerned. In 1850 Thomson and Clausius, independently, stated the second law in its modern form; but Thomson did more. In 1855 he noticed that (1) can be written in the form:

$$\mathrm{d}w = q.\mathrm{d}T/T, \text{ or } (\mathrm{d}w/\mathrm{d}T) = q/T, \tag{2}$$

and since:

$$q = \Delta E + w, \tag{3}$$

where ΔE is the energy increase of the system in the finite change at the higher temperature in the cycle and w is the work done:

$$\mathrm{d}w/\mathrm{d}T = (\Delta E + w)/T. \tag{4}$$

In these equations, T is the absolute temperature reckoned from zero, in the way suggested by Thomson. Equation 4, which combines both laws of thermodynamics, has received various names, a favourite being the 'Gibbs–Helmholtz equation'. It was never stated or used by Gibbs, and was published by Helmholtz only in 1882. Nernst used it in the form:

$$A - U = T(\mathrm{d}A/\mathrm{d}T), \tag{5}$$

where $A = w$, $-U = \Delta E$.

In 1879, Thomson introduced the name 'motivity' for the part of the energy of a system available for conversion into work. The motivity at constant temperature was renamed 'free energy' by Helmholtz in 1882, and he gave it the symbol F. Hence:

$$w_T = -\Delta F, \tag{6}$$

and from (4):

$$\mathrm{d}\Delta F/\mathrm{d}T = (\Delta F - \Delta E)/T. \tag{7}$$

Thomson showed that his equation 4 applies to various kinds of work, and that it embodies a general law. He also stated that in all actual (irreversible) processes there is a diminution of free energy, which he called a "dissipation of energy".

In 1876, Massieu used the free energy F and another function of state:

$$G = F + pV, \tag{8}$$

such that in isothermal changes at constant pressure, $-\Delta G = -\Delta F - p\Delta V$ is the work done minus the external work (not, as beginners are apt to think, the work done at constant pressure). These functions were much used by Gibbs in 1876, who wrote $F = \psi$, $G = \zeta$, without giving names to either. It is shown above that the name 'Helmholtz free energy' for F is a misnomer.

A useful subsidiary function, the chemical potential μ, first used by Maxwell in 1874 but extensively applied by Gibbs, may be defined as:

$$\mu = \mathrm{d}F/\mathrm{d}m, \tag{9}$$

where $\mathrm{d}m$ is a quantity of a component introduced under specified conditions. This makes the energy equation for a multi-component system take the form:

$$\mathrm{d}E = \Sigma X \mathrm{d}x, \tag{9a}$$

and by Lagrangian transformations many useful subsidiary equations, including those in $\mathrm{d}G$, are at once obtainable. In the absence of radiant energy such a form may usually be specified.

With the work of Thomson and Clausius outlined above, classical thermodynamics may be said to have reached maturity. Thomson in 1898 showed, in fact, that all the fundamental equations may be stated in terms of E and F, defined as above. In 1864, however, Clausius introduced another derived function S, which he called the entropy. This is quite useful and is given by (2) as:

$$S = \mathrm{d}w/\mathrm{d}T = -\mathrm{d}F/\mathrm{d}T, \tag{10}$$

and hence from (4) by:

$$\mathrm{d}S = \delta q/T \tag{10a}$$

in reversible processes. It is seen that F and G are expressible in the forms:

$$F = E - TS;\ G = E - TS + pV. \tag{11}$$

Since F decreases in irreversible changes, S increases; in equilibrium F is a minimum at constant volume and temperature and S is a maximum at constant energy. S cannot claim to be more fundamental than F, and was introduced rather late, when most of the derived equations of thermodynamics were familiar.

The first applications of thermodynamics to chemistry go back to Horstmann, who, from 1869, used it in studies of dissociation. The most important pioneering work in this field, however, is that of van't Hoff in 1885. He not only carried over the equations for ideal gaseous systems to ideal solutions, but also gave equations for the work done in reversible chemical changes in such systems, and the change of equilibrium constant with temperature. Van't Hoff made use of cyclic processes, in which selectively permeable membranes are employed to separate the constituents of mixtures. All subsequent developments of chemical thermodynamics show the influence of van't Hoff's work.

Thomsen in 1854 and Berthelot in 1864 had suggested that, in chemical changes :

$$w = - \Delta E ;$$

and although this is seen to lack general validity from the point of view of equation 4, it is found experimentally to be approximately true in so many cases that some relation between ΔE and w, or alternatively between E and F, not contained in the two laws of classical thermodynamics, may be suspected. Such an approach, on the basis of experiment, is apt in many cases to disclose new laws, and is abundantly more fruitful than arguments based on symbolic equations. It was Nernst in 1906 who disclosed this new relation, called after him the 'Nernst heat theorem'; since it has limitations, the name 'third law of thermodynamics' sometimes used for it is unsuitable. The theorem states that in reactions between pure solids :

$$\mathrm{d}w/\mathrm{d}T = 0 \text{ when } T \rightarrow 0, \qquad (12)$$

when (4) shows that $\Delta E = - q_v$ is equal to w. Equations 3 and 10*a* then show that :

$$\Delta S = 0 \text{ when } T \rightarrow 0. \qquad (13)$$

A special case, in which S for every reacting solid is zero when $T \rightarrow 0$:

$$S = 0 \text{ when } T \rightarrow 0, \qquad (13a)$$

was proposed by Planck in 1911. Even if this is not true, we have no means of finding the absolute entropies at $T = 0$, and (13) shows that they are irrelevant in calculations; hence Planck's form is now always used. It at once enables S for any material to be calculated for any state (solid, liquid, or gaseous) from specific heats only, by integration from $T = 0$, when all specific heats are seen from (13*a*) to be zero. From S and known values of ΔE, the values of ΔF may be calculated. When these are known, the equilibrium constants of chemical reactions may be found by an equation deduced by van't Hoff in 1885, which, with suitable standard states, may be written in the form :

$$- \Delta G = RT \ln K \qquad (14)$$

for ideal gases or ideal solutions, where $\ln K$ is the natural logarithm of the equilibrium constant. A whole field of chemical thermodynamics is thus opened out.

A useful subsidiary function introduced by G. N. Lewis in 1907 enables (14) to be carried over to non-ideal systems. Instead of using the concentrations in K, it is possible to introduce quantities called activities which are functions of concentration, $a = fc$, where f is an activity coefficient. Lewis derived his equation by cyclic processes, which have always proved attractive to discoverers of new principles in thermodynamics, but the most convenient form is :

$$\mathrm{d}\mu = RT \ln a, \qquad (15)$$

where μ is the chemical potential. From (15) the equations of Lewis's scheme may be derived.

In the latest, modern, phase of thermodynamics, Thomson was also a pioneer. Both he and Maxwell clearly realized about 1870 that, when the atomic constitution of matter is brought into the picture, the second law of thermodynamics loses its general validity, since processes involving individual molecules which violate it, without disagreeing with the first law, can be imagined. The second law is true for systems composed of very large numbers of molecules, which behave like large populations and for which predictions based on statistical principles or probabilities can be used. Thus it is true only in a statistical sense. The development of this idea by Boltzmann and Planck led to a new science, statistical mechanics, which supplements the classical second law and limits the range of validity of the Nernst heat theorem. In this region, alternative types of statistics apply. Maxwell–Boltzmann statistics, based on classical mechanics, applies with close approximation in most cases, though probably never exactly, while in systems subject to laws governing quantum, as contrasted with continuous, energy changes, new types of statistics are used. One of these, due to Bose and Einstein, gives Planck's radiation formula. At present, the close relation of thermodynamics to statistical mechanics makes it desirable to deal with both in a text-book on thermodynamics, although statistical mechanics has many applications outside that subject.

All the equations of thermodynamics apply only to reversible processes. All real processes are more or less irreversible, and will be represented by inequalities, conformable with the condition that the free energy will be decreasing, or the entropy increasing, more than for a reversible change. A locomotive drawing a train at high speed with the regulator valve fully open is wasting much energy in friction, which is greater the higher the speed. In running up a gradient, the speed drops and, since there is less friction, the efficiency increases. The maximum efficiency is reached when the gradient is so stiff that the train is on the point of stopping, and all reversible processes, which are successions of equilibrium states, take place infinitely slowly, since they never really take place at all. Time has no place in classical thermodynamics.

Some reversible changes are, by their nature, always accompanied by irreversible ones. In his treatment of thermoelectricity, Thomson assumed that the reversible Peltier and Thomson effects could be treated independently of the irreversible Joule effect of heat production due to resistance, and similar assumptions have been made elsewhere. Since the results agree with experiment, they must be justified. It is only quite recently, however, that an attempt has been made to systematize such procedures in the case of steady states, when as much heat is entering an element of the system as is leaving it in the same time. The irreversible generation of entropy in the system due to the flow of heat is then known. One approach seeks to combine equations 9*a* and 10*a*, X being a generalized force and x being replaced by a rate of flow in steady states. A linear relation is assumed (which will not be true in some cases) and the general form is a tensor, which may be symmetric. If it is assumed that a temperature exists in every volume element, an equation giving the rate of generation of entropy as the sum of the products of the generalized forces and generalized flow-rates, divided by the temperature, is obtained. The subject is important, and a promising start has been made, which has proved useful in several fields. This is the newest phase of thermodynamics.

The books referred to below* deal with the applications of thermodynamics in chemistry; but that by Denbigh is of wider interest. They are all good and useful and can all be warmly recommended. Allard's book is very clear and interesting, starting at the beginning and deducing the equations from the fundamental laws. It has a fairly long section on the phase rule, which seems out of place, a good section on statistical mechanics, and a clear account of such parts of wave mechanics as are needed in this. The treatment is modern and the mathematics has been presented in an understandable form. It is a book very suitable for students.

The books by Rossini and Paul are based on the Lewis system; fugacity is rather fully dealt with by Rossini but only in passing by Paul. Both books attempt to start at the beginning. Rossini makes heavy weather of free energy by approaching it from entropy, and has more than a page in finding what is equivalent to equation 6 above, at the same time making it clear that ΔG is only part of the free energy change, a point not always evident in American books. Rossini's definitions are careful and clear, but it is not obvious why he should bring in atomic energy in such detail, since thermodynamics does not deal with nuclear changes. In both books the symbol F is used for G, and it is called free energy, which is confusing. Rossini, as might be expected, lays particular emphasis on experimental data, and his accounts of the calculation and use of thermodynamic quantities are admirable. He has not much to say of irreversible processes. Paul gives the usual treatment based on Clausius, which is not very clear; he could with advantage have reconsidered this topic, since he obviously has the capacity for understanding difficult subjects and making them clear to students. Both Rossini and Paul deal with the Debye–Hückel theory of strong electrolytes, but only Rossini deduces the equations. Both books deal with statistical mechanics, Paul's account being more readable and likely to be more intelligible to beginners. Both have problems, and Paul's gives answers. A section at the end of Rossini's book deals with the applications to such technical problems as fractionation, which should be useful to young chemists entering industry and called upon to put their knowledge into practice. In short, the books by Paul and Rossini are sound treatises written on American lines and bringing Lewis and Randall up to date.

Denbigh's book, I think, is not quite successful. It deals in a limited space with a rather difficult subject. It makes several re-starts on the same topic, which leaves the impression of a certain breathlessness, the i and k subscripts on pp. 27–29 are confusingly jumbled, and some of the statements, such as the one on p. 61 that both energy and entropy in thermodynamics are simply mathematical quantities, are rather startling. The real meaning of the heat of transport is not made very clear at the start, and the introduction of time into thermodynamics is not justified; the procedure of converting an equation into a kinetic equation by dividing by dt (p. 46) requires more justification, and the statement that de Donder's treatment of thermodynamics is better than Lewis and Randall's (p. 45) would not be approved by Allard, who shows in his book (p. 198) that it has some undesirable features; and is also clear (p. 72) that the application of the principle of increase of entropy to a 'universe' is meaningless unless the universe is defined as a thermodynamic system, which is not done by those using the idea.

The subject of thermodynamics has developed very much in recent years, and much of this has come about by reason of its applications in chemistry. The chemist needs to know what is contained in such books as the above, and it would do the physicist and engineer no harm to know it either. The method of treatment suitable in the study of heat engines is less applicable in chemistry, and the special methods used in that science have amplified the scope of the subject and have also provided a bridge between classical thermodynamics and statistical mechanics which has led to many valuable interchanges of material from the two sciences. The study of irreversible changes still remains undeveloped and difficult; but the material summarized in Denbigh's book shows that progress is being made in this field, and we may hope that before long many new fields of application will have been developed. Let those who think that thermodynamics is a closed subject reflect.

J. R. PARTINGTON

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* Éléments de thermodynamique chimique. Par Georges Allard. (Bibliothèque d'Éducation par la Science.) Pp. 472. (Paris: Albin Michel, 1951.) 1880 francs.

Chemical Thermodynamics. By Prof. Frederic D. Rossini. Pp. xix+514. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1950.) 48s. net.

Principles of Chemical Thermodynamics. By Prof. Martin A. Paul. (International Chemical Series.) Pp. viii+740. (London: McGraw-Hill Publishing Co., Ltd., 1951.) 64s.

The Thermodynamics of the Steady State. By Dr. K. G. Denbigh. (Methuen's Monographs on Chemical Subjects.) Pp. vii+103. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1951.) 6s. 6d. net.

MOISTURE RELATIONS AND FIBRE PROCESSING

DURING the morning of September 9 at the recent meeting in Belfast of the British Association, Section A (Physics) held a session on the moisture relations of textile fibres, which consisted of two papers, one by Mr. J. A. Matthew, head of the Spinning Department of the Linen Industry Research Association, entitled "Moisture Absorption by Fibres and its Effect on Fibre Properties", and the other by Dr. A. B. D. Cassie, director of research at the Wool Industries Research Association, entitled "Moisture Relations and Clothing Comfort".

Mr. Matthew dealt with three main aspects of the problem. He discussed the relation between the amount of water absorbed by textile fibres and the atmospheric temperature and relative humidity, and also the effect of the absorbed water upon the physical properties of the fibre. He then gave some practical examples of the effect of humidity on the efficiency of the processing of flax fibres and yarn during spinning and weaving.

If fibre, yarn or cloth is stored in an atmosphere maintained at a constant temperature and relative humidity, the moisture content of the material, expressed as a percentage of the oven-dry weight, gradually attains a steady value called the 'equilibrium regain'. The equilibrium regain of all textile fibres and their products depends primarily on the relative humidity and temperature of the air, but other factors, including the previous history of the material, also have their effect. If the material is wetted out and then allowed to reach its equilibrium regain at a constant temperature and at a series of progressively decreasing relative humidities, the regain values lie on a sigmoid desorption curve when plotted against the relative humidity. When the process is continued with ascending humidities, the regain values lie on a second sigmoid absorption curve which lies below the desorption isotherm curve, except at very low and very high humidities. A similar hysteresis effect occurs when absorption takes place as a result of increasing the humidity after partial desorption or when desorption occurs after partial absorption. Hysteresis also occurs when the material is brought to equilibrium in an atmosphere of constant humidity at temperatures which are progressively increased and afterwards decreased.

These effects are shown by the following materials : cotton, flax, hemp, jute, etc. ; wood, silk and hairs ; fibres manufactured by the regeneration of cellulose ; and some other materials such as wool and starch. For all these materials the absorption and desorption isotherms are very similar in shape, so that the ratio of the equilibrium regain of one material to that of another is very nearly the same at all humidities.

A few manufactured fibres such as cellulose acetate, nylon and 'Terylene' do not behave in this way. There is no point of inflexion in the curve at low humidities, the regain is quite small at all normal humidities, and there is very little difference between the absorption and desorption isotherms.

The equilibrium regain at given atmospheric conditions differs from one type of fibre to another. For example, at 65 per cent relative humidity and 65° F. (18·3° C.) average values are as follows : wool 14 per cent, viscose rayon 13 per cent, green flax 11 per cent, silk 9·5 per cent, raw cotton 8 per cent ; but with all natural fibres the equilibrium regains of different lots differ according to their origin and treatment.

The physical and mechanical properties of textile fibres depend upon the humidity of the air to which they have been exposed, and Mr. Matthew went on to deal with these effects in detail. The strength of fibres and of the yarns and cloth manufactured from them depends upon the humidity of the atmosphere in which they have been conditioned. Vegetable fibres usually increase in strength with increase in relative humidity, whereas the reverse is the case with artificial and protein fibres ; for example, linen yarns increase 25 per cent in strength when the humidity is increased from 50 to 90 per cent, whereas viscose rayon loses 40 per cent of its strength under similar conditions. The moduli of elasticity and rigidity of fibres decrease with increasing relative humidity. The frictional properties of textile fibres and yarns increase rapidly with increase in humidity ; but in most cases there is a reduction in the friction when a free film of water is present. The electrical properties of fibres and their products vary considerably with the regain. The conductivity of fibres is extremely low at low regains but increases very rapidly with increasing regain, while the dielectric constant remains fairly constant at low regains but thereafter increases rapidly with increase in regain. The variation in the electrical properties with regain forms the basis of electrical moisture meters ; and, although the accuracy of these instruments is limited by differences between the behaviour of different batches of the material and a separate calibration is required for each type of fibre, the rapidity with which these instruments can be used more than offsets these disadvantages.

The absorption of water vapour by flax and other textile fibres and the consequent effects on their physical properties affect textile technology in many ways. After pointing out the need for control of the relative humidity in checking the weight per unit length of the yarn or the weight per unit area of the cloth, and the strength of the product, Mr. Matthew gave some examples taken from the spinning and weaving of linen, in which the atmospheric humidity has an important effect upon the efficiency of processing. In preparing flax fibre for spinning, the material passes through a number of frames on which it is drawn out by pairs of rollers rotating at different speeds. Fibre is liable to collect or 'lick-up' on these rollers, and when this happens the machine must be stopped for cleaning and so production is lost. 'Lick-up' can be considerably reduced by maintaining the flax at a suitable regain. In dry spinning, productivity is limited by breakages of the yarn, and the rate at which these breakages occur is much reduced by increasing the relative humidity. Similarly, in weaving, stoppages due to breakages of the warp yarn are reduced when the operation is carried out at a high temperature and humidity. Such atmospheric conditions, however, cause fatigue and discomfort to the workers, with a consequent reduction of output, so that in practice a compromise must be sought between the conditions which are most suitable for processing and those which are comfortable for the workers.

Dr. Cassie dealt with the thermal properties of clothing and showed how the interaction of the fibres with the water vapour in the atmosphere contributes in no small degree to the comfort of clothing by liberating heat when the wearer passes from a warm dry atmosphere to a cold damp one. Considering the thermal insulation, Dr. Cassie said that still air is the best insulator known to man, and fabrics make use of this property. The thermal conductivity of fabrics increases with their bulk density, and any increase in the amount of solid material of a fabric leads to a loss of heat insulation. Worsted fabrics contain about 60 per cent air, and the very large total surface area of the fibres—about 2,000 sq. ft./lb. of wool—exerts a very effective drag on the air, which is thus maintained at rest within the fabric and provides excellent heat insulation.

The large surface of the fibres brings them into close contact with the surrounding atmosphere and enables them to interact with the water vapour. Recent research has shown that in such conditions the time required for water to diffuse from the surface to the centre of a fibre is always negligible compared with the time required for the diffusion of water vapour and the transfer of heat through the air entrapped by the fibres. Fibres can react rapidly with heat and water vapour provided that they are presented to the fibre as quickly as required. On the other hand, at normal atmospheric conditions such as 65° F. and 60 per cent relative humidity, each c.c. of wool contains eighteen thousand times as much water as does the same volume of air, and this enormous difference between the water content of wool and air makes the approach to equilibrium slow when there is a relatively large bulk of wool.

The absorption of water vapour by fibres is accompanied by a large evolution of heat, and Dr. Cassie gave as an example the amount of heat liberated by a man's clothes when he goes out of doors from a well-ventilated and -heated room on a typical winter day in Britain. Assuming that the clothes contain five pounds of wool and that they are in equilibrium with the conditions indoors (namely, 65° F. and

45 per cent relative humidity), they will absorb one pound of water when taken outside and allowed to re-condition at 40° F. (4·4° C.) and 95 per cent relative humidity. In so doing they will liberate 1,200 B.Th.U. of heat. This amount of heat will provide excellent protection against the chill of a sudden temperature change provided that it is liberated at a suitable rate, and Dr. Cassie proceeded to show that the conditions within a fabric are such as to ensure that this heat is liberated at the optimum rate for protection against a sudden change of temperature.

The fibres are always in equilibrium with the air immediately surrounding them because absorption and desorption of water take place very rapidly; but the amount of water vapour absorbed from the air is so small compared with the water content of the fibres that their regain is virtually unchanged. The temperature of the air issuing from a mass of wool is therefore determined by the condition imposed by the fibres, namely, that the relative humidity must remain unchanged. The heat obtained by condensing enough water vapour from any given volume of air to maintain a constant relative humidity when its temperature is decreased by 1 deg. C. is roughly equal to the heat required to raise the temperature of the air in the given volume by 1 deg. C. Thus, if the temperature of the air coming into contact with the textile is reduced by 10 deg. C. without change in the water vapour pressure, the air after passing through the textile will only be reduced by 5 deg. C., enough water having been condensed from the air by the textile to raise its temperature by 5 deg. C. This thermostatic effect of textiles is maintained over considerable periods because, fortunately, the diffusion constants for heat and for water vapour are almost the same, being 0·21 cm.^{2}/sec. and 0·25 cm.^{2}/sec., respectively. Thus the temperature and water vapour gradients are correctly maintained for securing the maximum effect in reducing the chill produced by a decrease in temperature.

The results of experiments designed to test the accuracy of these theoretical conclusions were then described by Dr. Cassie, who showed that excellent quantitative agreement has been obtained between the theoretical and actual results. The effect was studied of increasing the temperature of the air, passing through a mass of fibre, from 20° to 35° C. without change of vapour pressure, and it was found that the change in temperature of the emerging air was halted at 26° C. The subsequent rate of increase in temperature was small, being least of all for wool and increasing in the order, wool, flax, silk and cotton. This corresponds to the order of the regains of the fibre, and, as predicted by the theory, the protection afforded by the fibres increases with the slope of the regain – relative humidity curves.

Finally, Dr. Cassie pointed out that a similar large thermostatic effect can result from textile furnishings. The increase in regain of a carpet when a room is left unheated results in the liberation of as much heat as would be given off by a 1-kW. electric fire burning for 1½–2½ hr., the heat being liberated over a period of several days.

In the discussion which followed these two papers, Dr. R. W. Powell described experiments made at H.M. Norfolk Flax Establishment on the moisture relations of the growing flax plant, and pointed out that the normal date of pulling flax corresponds to the time at which the whole plant has a uniform moisture content. He mentioned experiments made on the heating up of stacks of flax straw and also described how the humidification of dry flax straw before scutching increases the yield of flax fibre.

Miss M. V. Griffiths asked whether the airing of domestic linen is really necessary, as a large amount of electricity is being consumed in modern houses for this purpose. Should the air movement be increased during drying in an airing cupboard or could a more efficient drying cupboard be designed? In reply, Mr. Matthew said that he regarded airing as a safety measure; linens stored in a folded condition in drawers would have little access to free air and so would not dry if they were put away damp. The rate of drying increases with increasing air velocity and temperature; usually the most economical method is to use some heat and a definite but not necessarily very large air velocity, on well exposed material. Dr. Cassie said that it is necessary for underwear to be dried to a low regain; measurements have shown that, in the absence of perspiration, the air between the skin and underclothing has a relative humidity of only about 20 per cent, and underclothing should therefore be conditioned to this relative humidity by airing. J. L. SPENCER-SMITH

AFFORESTATION OF MOORLAND

At the meeting of the British Association in Belfast, Section K* (Forestry) devoted a session during the morning of September 8 to the consideration of sylvicultural problems resulting from recent large-scale planting on moorland soils. The need for a considerable extension of the forest area in Britain —a need admitted by men of all shades of opinion— has led to the formation of large plantations on heathland and moorland mainly in the upland regions. The current annual planting programme, in State forests alone, of approximately sixty thousand acres requires the use of large areas of these types of land, and work has been going on actively since 1919 in such diverse conditions as those afforded, for example, by the Yorkshire moors, the peat-covered Border country, the upland heaths of north-east Scotland, of Wales and of south-west England, and the blanket bog of the north-west of England. In forming their plantations, foresters had little to guide them at first except the existence of one or two relatively small plantations, the history of which had been recorded. They have had to hammer out their own technique. The need for carefully conducted experimental work was early recognized, and the large number of experiments carried out in the west and in the north, covering a wide range of subjects, such as choice of species, methods of planting, ploughing, drainage and the use of fertilizers, has had a marked influence on the course of events.

J. M. B. Brown (Forest Research Station, Alice Holt), in a paper on "The Role of Indicator Plants in Moorland Afforestation", discussed the use of the natural flora of moorlands and heathlands as a guide in the selection of tree species for planting. The vegetation on the ground before planting has been extensively used during the past thirty years for determining what land is plantable and what is unplantable and for allocating tree species to the various sites. Interpreted with discretion, the natural flora may give useful information by indicating which species of tree appears to be suitable to the local conditions of soil and climate. In Great Britain, however, there is, even now, comparatively little evidence which helps to correlate the performance of trees throughout their life-time with the vegetation at the time of planting. The difficulties of the problem have been greatly increased by the use of exotic conifers in moorland afforestation, for many of these trees have been widely used only during the past thirty years and some of them have scarcely been studied ecologically in their native habitats. The natural vegetation may also suggest the kind of difficulty to be expected in establishing trees on the site and the degree to which individual species will be susceptible to these difficulties. Here, there is much more experience which may safely be relied on, but the occasional inconsistencies which occur emphasize the need for caution in making broad generalizations. The character of the vegetation has been little used as a guide in deciding which types of moorland should be ploughed before planting, as the use of the plough has now become general. Nevertheless, an examination of the plant community present before ploughing will usually tell what is likely to succeed it after ploughing and how rapidly the changes will take place. This is important in assessing the competition which the young trees will have to face.

Trees which will ultimately give a good account of themselves on moorland may be very difficult and costly to establish; on the other hand, trees which are comparatively easy to establish may not prove adapted to conditions in later life. Both the long-term and the short-term aspects must be kept in view.

The classification of moorlands for afforestation should not be based wholly on the occurrence of a few familiar and easily recognized dominant plants, which, because of their wide tolerance, may be apt to mislead. Regard must also be paid to the less-conspicuous associates, to notable absentees, to the height, luxuriance and health of the dominants, and to evidence of disturbance by grazing, burning and peat-cutting.

"Recent Work on the Problems of Moorland Afforestation" was discussed in a paper by J. W. L. Zehetmayr (Research Branch, Forestry Commission, Edinburgh), who stated that one of the main functions of sylvicultural research at the present time is to increase the area of 'plantable' land by making it possible to afforest land which is at present classed as 'unplantable'. This may also have the effect of improving production on ground already regarded as suitable for planting. Experimental plantations, made at various times since 1921, have, in many cases, served as pilot schemes which have since been followed by extensive plantations on ground that was originally regarded as of doubtful value for forestry. In other instances, experimental plantations, though tolerably successful, have not yet inspired sufficient confidence for more widespread application of their results; examples of these may be found on deep basin peats and on thinner slope peats in the north-west of Scotland.

In the afforestation of peat, the first consideration is drainage, and drains are now invariably used to provide turves in which the young trees are set in planting. It was shown in early work that the more turf a plant has round about it, the better it grows. The provision of more turf for each plant led to more surface-draining by ditches, but so long as all the work had to be done by hand the economic limit was soon reached. Nowadays the draining plough is used to provide a continuous strip of upturned turf on which planting can be done. This has given satisfactory growth; but the system of equally sized drains, one alongside each row of plants, raises difficulties in subsequent maintenance, while the drains do not run sufficient water to clean themselves. One solution is to use two ploughs, a large plough such as the 'Cuthbertson' to make the main drains, and a lighter, shallower plough, like the 'Begg' or the 'Haddington', to provide material for turf-planting. The use of mechanical methods has decreased the quality of the work, as it is less easy with machines to site the main drains correctly. The Norwegian method of making very large deep drains at wider intervals and of using explosives in their formation is now receiving attention in Great Britain. It may have uses on land where ploughing is impossible.

Draining is not a problem on the heaths, most of which lie in the drier, eastern half of Britain; but ploughing, which is now the standard practice on these sites, leads to the disappearance of surface water which often lies long, while the rupture of the pan allows water to percolate through the soil so that no drains for removing water from the area are necessary. Ploughing has greatly improved the early growth of trees on heathland. The current method of ploughing is to cut a deep furrow every five feet with a heavy plough which breaks the pan and throws up a ridge of spoil. Other methods, such as complete ploughing to a less depth, and the use of a 'tine' plough, are being tried experimentally. An important advance is the introduction of the hydraulic-lift tractor, which greatly increases ease of manœuvring and allows the plough to be lifted over boulders and rock outcrops. On difficult sites it is usual to apply ground mineral phosphate or high-grade basic slag at the rate of 1½-2 oz. to each plant. Recent work by E. M. Crowther has shown that nitrogenous fertilizers improve the growth of newly planted trees on heathland.

On difficult or on marginal sites it is important to use the best 'strain' or 'race' of the tree which is selected for planting. One aspect of this was dealt with by J. A. B. Macdonald (Forestry Commission, Dumfries) in his paper on "The Place of *Pinus contorta* in British Sylviculture". This pine, a native of western North America, has come into prominence lately as a result of its success as a planted tree on poor peat and heathland sites. It has a wide range in North America, along the Pacific coast from Alaska to California, and inland into the Rocky Mountains. With such a range of altitude and latitude it naturally varies, the two extreme forms being recognized as the beach or shore pine, *P. contorta* Dougl. ex Loud, and the inland lodgepole pine, *P. contorta* var. *latifolia* Engelm. The former is a strong-growing coarsely branched tree, with dark green foliage, which throws a comparatively heavy shade; the latter has normally a straighter stem, finer and more open branches, and thinner, yellowish-green foliage. Sylviculturally they have rather different effects.

Various provenance trials of *Pinus contorta* have been planted in different parts of Great Britain, and preliminary assessments of the different plots show that coastal lots from Oregon and Washington grow fastest, while there is a suggestion that, if the whole range of the tree along the Pacific coast is considered, plants from the northern part of this range grow more slowly in Britain than plants from farther south.

With the inland forms, the opposite may prove to be the case. The longest branches appear to grow on trees from the most northerly Pacific coastal origins, while the shortest branches tend to grow on trees from inland regions in the south. Generally there are more branches per whorl on the coastal forms. The coastal trees have shorter needles, averaging 1½ in., while inland forms have needles averaging 2–2½ in. in length; the inland lodgepole pine does not hold its needles as long as the coastal form, on which needles are retained for three years or more. All the trees of coastal origin have completely, or almost completely, killed out the ground vegetation; but very little suppression has been effected by inland forms.

These papers were preceded by an account by James Macdonald (director of research and education, Forestry Commission) of recent developments in forestry nursery technique. The success of a large planting programme depends on a continuous supply of suitable planting stock, and thus the raising of plants in the nursery has always been regarded as of prime importance. Various difficulties have been encountered in running nurseries at high pressure for the provision of young trees, almost entirely coniferous; during the nineteen-thirties, for example, there was a serious diminution in the fertility of many nurseries. One approach to the solution of this problem was made by the late Dr. M. C. Rayner, who established at Wareham, in Dorset, a nursery which made an important break with established practice. Instead of using an agricultural soil, Dr. Rayner set to work on a piece of uncultivated heathland and, by shallow cultivation, subsoiling, and a liberal use of composts, produced successive crops of seedlings much larger than had ever been raised before. Her technique, with various modifications, was widely used elsewhere, and a considerable proportion of the seedlings produced to-day are grown in 'heathland' nurseries. These nurseries, when properly sited and managed, are remarkably free from weeds, and the saving in weeding costs is an important item to be set off against the expense of the other operations. This technique did not solve the problems of the ordinary forest nursery; it avoided them. They were approached, however, from another side; by means of partial soil sterilization, with steam, with formalin and with other chemicals, combined with appropriate fertilizer treatment, nursery soils which had been producing very poor seedlings began to yield plants as good as those in heathland nurseries, while there was also a substantial reduction in weeding. The complex of factors involved in this and in other nursery processes is being studied by a committee which was set up by the Forestry Commission in 1944, under the chairmanship of the late Prof. F. T. Brooks, and on which Drs. E. M. Crowther and A. B. Stewart are active members. It has been found possible to raise with fertilizers seedlings as good as those produced with the aid of compost or sterilization; it has also been established that many conifers, and particularly Sitka spruce, are highly sensitive to lime in the nursery and that some of the trouble in the established nurseries was due to injudicious liming. Because it is possible to raise seedlings which can be handled at the end of their first year, it has been possible to use many more two-year-old transplants in moorland afforestation. These are less costly than the three/four-year old plants formerly used.

The prospect of effective weed-control in seed-beds has been brightened by the use of mineral oils applied before the tree seedlings emerge, while other directions in which research is proceeding are in the use of overhead irrigation and in the attempt to raise two or three successive crops of seedlings in a season with the help of bottom heat.

NEWS and VIEWS

Physiology in the University of London: Prof. Geoffrey Harris

Prof. Geoffrey Harris, who has been appointed to the Fitzmary chair of physiology in the University of London, is known for his work on the control of the pituitary gland. This chair, of which he is the first holder, is named after Simon Fitzmary (1492), the founder of Bethlem Royal Hospital; it is attached to the Department of Neuro-Endocrinology of the Maudsley Hospital. Prof. Harris was first trained in anatomy and medicine in Cambridge, and, after qualifying at St. Mary's Hospital, London, became in 1940 demonstrator and later lecturer in anatomy at Cambridge; in 1948 he was appointed lecturer in the Department of Physiology. His research work has been on the anatomy and physiology of the pituitary gland and on the control of pituitary secretions by the nervous system. In his recent work he has modified the technique of implanted electrodes and placed small secondary coils under the scalp with an electrode placed in various sites near the supra optic nuclei. By using a primary coil surrounding the animal, he was able to produce endocrine effects on urine flow, oestrus, etc., without otherwise disturbing the animal. He has shown the existence of a hormonal link, carried by a system of portal vessels, between the nervous and secretory structures. The pituitary forms the main link by which external events affect the endocrine glands via the nervous system, and this clarification of how this is effected helps in our understanding of both. His work is characterized by great skill in difficult operative techniques and in masterly grip of the physiological and anatomical problems of his chosen field. Prof. Harris's many friends will be glad that in his new post he will be able to devote himself almost entirely to research in this rapidly developing field, in which he has done so much to clarify our ideas during the past fifteen years.

H. G. Smith (1852–1924): a Pioneer Australian Chemist

An interesting centenary has recently been observed in Sydney, marking the birth on July 26, 1852, of Henry George Smith, a pioneer worker on the chemistry of the Australian flora. Smith was born at Littlebourne, in Kent, and emigrated to Australia in 1883. He amplified his scanty scientific training while holding a humble post at the Sydney Technological Museum, and in 1891 published his first original paper, announcing the discovery of barytes in the Hawkesbury sandstones at Sydney. In 1895 he became mineralogist at the Museum. An ensuing paper on eucalyptus kinos and the occurrence of eudesmin, published in collaboration with J. H. Maiden, the botanist, heralded a long series of original contributions to the chemistry of Australian essential oils, exudations and other indigenous plant-products. In 1899 Smith became assistant curator and economic chemist in the Museum, and most of his work on the chemistry of the Australian flora was carried out in collaboration with R. T. Baker, curator and economic botanist in the Museum. Their *magnum opus*, "A Research on the Eucalypts, especially in regard to their Essential Oils", was published first in 1902 and again, in an extended form, in 1920.

Upon his official retirement in 1921, Smith became associated with the then recently founded Department of Organic Chemistry in the University of Sydney, where he pursued further work, partly in collaboration with Prof. John Read, on the chemistry of some of the substances, notably the eucalyptus ketone, piperitone, that he had isolated in earlier researches. Smith and Read had previously collaborated in an investigation of the so-called 'marine fibre' of *Posidonia australis*; the results of this lengthy research were issued in 1919 as one of the early publications of the Institute of Science and Industry of the Commonwealth of Australia. One of Smith's last investigations dealt with the possibilities of utilizing Australian wood fibres in paper-making. Altogether, Smith published more than a hundred original contributions to chemical science; sixty-two appeared in the *Proceedings of the Royal Society of New South Wales*, of which Smith was a modest but much-esteemed member. A meeting of the Sydney University Chemical Society held last August was devoted to terpene chemistry, with special tributes to Smith's life and work. Many of his original isolations, papers and photographs were displayed, and addresses were given by Prof. A. J. Birch, of the University of Sydney, and Mr. W. J. Dunstan, of the New South Wales University of Technology.

J. N. Langley, F.R.S. (1852–1925)

John Newport Langley, whose signature is writ large in the history of the sympathetic nervous system, was born at Newbury a century ago, on November 2, 1852. In his second year at Cambridge, his interest in biology and physiology was aroused by Michael Foster, and he obtained a first class in the Natural Sciences Tripos in 1874 and three years later an open fellowship at Trinity College. His early research on the action of pilocarpine on the frog's heart was followed by a meticulous study, taking fifteen years, of the process of secretion in the mammalian salivary gland, in the course of which he distinguished between the 'loaded' and the 'exhausted' states of the gland. Foster had been made professor of physiology in 1883, and Langley, on being appointed in the following year as university lecturer in histology, became his assistant, succeeding him in the chair in 1903. During 1890–1906, helped by Hugh Anderson and W. H. Gaskell, Langley threw a flood of light on the sympathetic nervous system, his researches being a landmark in the history of physiology. He defined the autonomic system as an efferent system in 1903, and in 1921 published a book on the subject. He was working on the mechanism of excitation of cells when the outbreak of the First World War caused him and his depleted staff to pursue investigations of greater national urgency, such as the trophic changes in muscle and nerve following injury. In 1894 Langley paid off the debt which had long burdened the *Journal of Physiology*, and continued as owner and editor until his death. He was elected to the Royal Society in 1883 and vice-president in 1904. He died of pneumonia on November 5, 1925.

Regional Scientific Advisers for Civil Defence

The organization of regional scientific advisers for civil defence in Great Britain, which has been set up by the Home Office, is now virtually complete. Many of the leading scientific men of the country have responded to the appeal of the Home Secretary and the Secretary of State for Scotland, and are giving their advice and assistance in this vital department of the country's defence organization. In each of the eleven regions into which England and Wales are divided for civil defence purposes, a group of these scientific men has been appointed, and similar appointments have been made in Scotland by the Scottish Home Department. It is understood that the Government of Northern Ireland will also shortly appoint scientific advisers. These scientific advisers serve in an honorary capacity in time of peace, and are accredited to the staff of the Chief Scientific Adviser of the Home Office, Whitehall, London, S.W.1. They also give their advice and assistance independently to the civil defence authorities in their own regions. An important step has thus been completed. In effect, a panel of scientific consultants has been formed so that the best scientific thought and experience can be applied both nationally and regionally to the problems of civil defence. At the present time the regional scientific groups are giving valuable assistance in the formation and training of the technical reconnaissance units of the Civil Defence Corps, the officers of which are required to have university qualifications or be members of the professional scientific institutions. The regional scientific advisers are arranging and supervising courses of scientific instruction for them at the universities in the regions, particularly in the physics of atom warfare and the chemistry of the war gases. The contacts between the advisers and the professional institutions are most advantageous; and the institutions themselves have already volunteered their help in directing the attention of their members in the regions to the need for qualified men and to the importance of offering their services.

The several regions, with their centres and senior and other scientific advisers, are as follows: *Northern Region* (*Newcastle upon Tyne*): Prof. W. E. Curtis, Prof. G. R. Clemo, Dr. G. H. Christie; *North Eastern Region* (*Leeds*): Prof. F. W. Spiers, Prof. W. Bradley, Prof. W. Sucksmith; *North Midland Region* (*Nottingham*): Prof. L. F. Bates, Dr. D. O. Jordan, Prof. L. Hunter; *Eastern Region* (*Cambridge*): Dr. B. C. Saunders, Mr. E. S. Shire, Dr. E. N. Fox; *London Region*: Sir Charles Ellis, Prof. W. V. Mayneord; *South Eastern Region* (*Tunbridge Wells*): Brigadier R. A. Bagnold, Prof. D. H. Hey, Dr. F. C. Champion; *Southern Region* (*Reading*): Dr. H. W. Thompson, Prof. R. W. Ditchburn, Prof. A. N. Black; *South Western Region* (*Bristol*): Prof. W. E. Garner, Prof. S. H. Piper; *Wales* (*Cardiff*): Prof. W. N. Thomas, Prof. F. Llewellyn Jones, Dr. S. T. Bowden; *Midland Region* (*Birmingham*): Prof. H. W. Melville, Prof. P. B. Moon, Prof. J. R. Squire; *North Western Region* (*Manchester*): Prof. E. R. H. Jones, Dr. G. D. Rochester, Prof. C. E. H. Bawn; *Scotland*: Sir Edward Appleton, Prof. N. Feather, Prof. J. W. Cook, Prof. R. V. Jones, Prof. D. H. Everett.

Oil Pollution of the Sea

A MEETING of the Permanent Committee on oil pollution which was set up in June 1952 was held at the House of Commons on October 23, under the chairmanship of the Earl of Ilchester. Representatives of the following organizations which constitute the Committee were present: Association of Sea Fisheries Committees of England and Wales, Council for the Preservation of Rural England, International Committee for Bird Preservation, Royal Society for the Protection of Birds, Universities Federation for Animal Welfare, County Councils Association, Association of Municipal Corporations, Urban District Councils Association, Rural District Councils Association and the General Council of British Shipping. It was decided that the official name should be the Co-ordinating and Advisory Committee on Oil Pollution of the Sea (*Secretary*: Miss Phyllis Barclay-Smith, International Committee for Bird Preservation (British Section), c/o British Museum (Natural History), Cromwell Road, London, S.W.7). The meeting expressed gratification at the setting up by the Minister of Transport of a Government committee to investigate the problem, and it was agreed to offer this committee every assistance and co-operation, particularly with regard to providing factual evidence. The urgency of the problem was again stressed and the serious situation with regard to the pollution of small harbours was emphasized.

The clerk of Truro Rural District Council reported the results of an experiment carried out on St. Agnes Beach, Cornwall, during June 1–September 8, 1952. During these hundred days the beach, which is a small one of 160 yards in length at highwater mark, was cleared of oil deposits, which were weighed. The results showed that more than fifty-seven hundredweights of waste oil were washed up during this period, that is, an average of more than 64 lb. per day.

Greenwich Mean Time

THE practice at the Royal Observatory, Greenwich, of dropping the Time Ball, the symbol of Greenwich time throughout the world, was resumed at 1 p.m. on October 26. The Time Ball is a dull red sphere, 5 ft. in diameter; it is part of the Wren Observatory building and was erected for the purpose of enabling masters of vessels proceeding down the Thames to adjust their chronometers. The Time Ball is raised half-way up a mast, on which it slides, at five minutes to one, hauled to the top at two minutes to one, and released electrically on the hour. It was the earliest means of making Greenwich mean time known to the public, but the system has now been superseded for all practical purposes by the six pips broadcast at fixed times by the B.B.C. and by the speaking clock operated by the G.P.O. The Ball was operated continuously from 1833, when first installed, until the Observatory was evacuated during the Second World War. Its operation was temporarily resumed at the start of the Festival of Britain, but it is now intended to continue dropping it as long as members of the Observatory staff remain at Greenwich. Instruments of purely historical interest, such as the Time Ball, will remain at Greenwich.

Meteorology and Agriculture

SIR ROBERT WATSON-WATT, in his presidential address in 1951 to the Royal Meteorological Society, suggested a number of steps which might be taken to match meteorology to man's needs. One was for the Society to set up 'Interest Groups' for such subjects as agriculture and horticulture, fishing, education, transport and engineering. This suggestion has led to the initiation by the Royal Meteorological Society of its first Interest Group, on meteorology and agriculture and horticulture, under the leadership of Dr. G. L. Hogben. This development will be marked on the occasion of the second annual dinner of the Society on November 27, to be held in London, when the guest of honour will be Sir James Scott Watson, chief scientific and agricultural adviser of the Ministry of Agriculture and Fisheries and director general of the National Agricultural Advisory Service. He will be supported by distinguished representatives of agricultural science and practice and of meteorology.

Seismic Refraction Shooting in the Atlantic

M. N. HILL and J. C. SWALLOW have developed a method of seismic refraction shooting at sea using hydrophones at a depth of 100 feet below the surface of the sea, connected with sono radio buoys at the surface. Depth-charges exploded at a depth of 900 ft. send compressional waves through the sea and the rocks of the sea-bed. These *P*-waves are received on the hydrophones, and the records are transmitted to the ship by signals from the sono-radio buoys. Thus only one ship is necessary for the work. Experiments to test the method and to explore the sea-bed were carried out by Hill and Swallow from the Ocean Weather Ship *Weather Explorer* during August 1949, while the ship was occupying her routine position for meteorological observations at lat. 53° 50′ N., long. 18° 40′ W. The results have been written up by Hill alone (*Phil. Trans. Roy. Soc.*, A, No. 890, 244, 561; June 17, 1952; 7*s*. 6*d*.). The depth of water in this area of the eastern Atlantic is approximately 2,400 m., and below this Hill and Swallow found, as the result of the experiments, unconsolidated sediments of thickness 1,900–3,000 m. The velocity of *P*-waves in the sediments varied from 1·5 km./sec., nearest the water, to a limiting value of 2·5 km./sec. at depth. Below the unconsolidated sediments they also deduced the presence of crystalline rock to a depth of 2·7–3·4 km., through which *P*-waves travelled at 5·0 km./sec. Below this, to an unknown depth, they deduced the presence of rock which transmitted *P*-waves at 6·3 km./sec.

Overseas Information and Broadcasting Services

REPLYING to a question in the House of Commons on October 22, Mr. H. A. Nutting, Under Secretary, Foreign Office, said that the following committee has been set up to inquire into the overseas information and broadcasting services: Lord Drogheda (chairman), Sir R. Bruce Lockhart, Mrs. Mary Stocks, Mr. J. W. Platt, Mr. Gervas Huxley, Mr. Donald McLachlan, Mr. Victor Feather, and Mr. Laurence Heyworth. The terms of reference are: "To assess the value, actual and potential, of the oversea information work of the Foreign Office, Commonwealth Relations Office, Colonial Office, Board o Trade, and Central Office of Information; the External Services of the British Broadcasting Corporation; and the work of the British Council; to advise upon the relative importance of different methods and services in different areas and circumstances; and to make recommendations for future policy".

The Night Sky in November

FULL moon occurs on Nov. 1d. 23h. 10m., U.T. and new moon on Nov. 17d. 12h. 56m. The following conjunctions with the moon take place: Nov. 2d. 15h., Jupiter 7° S.; Nov. 15d. 06h., Saturn 7° N.; Nov. 19d. 03h., Mercury 2° N.; Nov. 20d. 11h., Venus 1° N.; Nov. 22d. 05h., Mars 0·2° S.; Nov. 29d. 17h., Jupiter 7° S. Mercury, an evening star, is too close to the sun for favourable observation and is in inferior conjunction on November 30. Venus is a conspicuous object in the western sky, setting about 17h. 55m. during the first part of the month and at 18h. 20m. on the last day; its stellar magnitude is − 3·5, and more than three-fourths of its illuminated disk is visible. Mars sets at about 20h. 05m. throughout November, stellar magnitude 0·9; but as its south declination is considerable, it does not rise very high above the horizon. Jupiter is visible throughout the night, setting in the morning hours at 7h. 40m., 6h. 30m. and 5h. 20m. on November 1, 15 and 30, respectively, and is a conspicuous object, stellar magnitude − 2·4, in the constellation of Aries; on November 8 the planet is in opposition to the sun. Saturn is a morning star, its times of rising being 5h. 10m., 4h. 20m. and 3h. 20m. at the beginning, middle and end of the month, respectively, stellar magnitude 1, and is easily recognized a little north of Spica. Occultations of stars brighter than magnitude 6 are as follows (observations being assumed to be made at Greenwich): Nov. 4d. 0h. 23·1m., χ Taur. (*R*); Nov. 8d. 1h. 57·8m., μ Canc. (*R*); Nov. 23d. 19h. 22·9m., 42 Capr. (*D*); Nov. 30d. 17h. 28·5m., η Taur. (*D*); Nov. 30d. 18h. 21·7m., η Taur. (*R*). *R* and *D* refer to reappearance and disappearance, respectively. The Andromedids and Leonids are due about November 14 and 16, respectively, but these meteor showers are now very weak and comparatively few meteors from them have been seen in recent years.

Royal Society of Edinburgh: Officers for 1952–53

The following were elected officers and Members of Council of the Royal Society of Edinburgh at the annual statutory meeting held on October 27: *President*, Prof. James Kendall; *Vice-Presidents*, Prof. E. T. Copson, Prof. J. H. Gaddum, Sir Robert Muir, Prof. James Ritchie, Prof. R. C. Garry, Prof. W. M. Smart; *General Secretary*, Dr. J. E. Richey; *Secretaries to Ordinary Meetings*, Prof. J. Norman Davidson, Dr. John E. Mackenzie; *Treasurer*, A. W. Young; *Curator of Library and Museum*, Dr. Douglas Guthrie; *Councillors*, Prof. J. F. Allen, Prof. A. Murray Drennan, Dr. E. Wyllie Fenton, J. M. Ross, Prof. C. M. Yonge, Prof. Norman Feather, Sir Godfrey Thomson, Dr. D. P. Cuthbertson, Principal H. B. Nisbet, Prof. T. C. Phemister, Dr. J. B. Simpson, Prof. Meirion Thomas.

Announcements

Dr. W. G. Penney, O.B.E., F.R.S., chief superintendent of the Armament Research Department, who has been responsible for the design and testing of the British atom bomb, has been promoted to be knight commander of the Civil Division of the Order of the British Empire (K.B.E.).

Lord Radnor, who has been a member of the Forestry Commission since 1951, has been appointed chairman of the Commission in succession to the late Lord Robinson, who died on September 5.

The 119th meeting of the American Association for the Advancement of Science will be held in St. Louis, Mo., during December 26–31. Besides the individual sessions of the eighteen sections of the Association, more than forty societies affiliated or associated with the Association will be concurrently holding meetings. Further information can be obtained from the director of public information, Sidney S. Negus, Medical College of Virginia, Richmond, Va.

The British Scientific Instrument Research Association is holding open days at its laboratories at 'Sira', Southill, Elmstead Woods, Chislehurst, on November 5 and 6.

An exhibition of Spanish scientific books has been arranged at the Science Museum Library, London, S.W.7, and will be open to the public during November 6–20.

A World Congress of Medical Practitioners for the Study of the Actual Conditions of Life, which was to have been held in Montecatini during October 16–18 (see *Nature*, June 28, p. 1085), did not take place owing to the refusal of the Italian Government to authorize the meeting. The Congress authorities hope to hold it some time during the first half of 1953. Further information can be obtained from the secretary, Dr. C. Massenti, Corso Trieste 65, Rome.

An exhibition entitled "Training for Industry", showing the work of the City and Guilds of London Institute, will be on view at the Goldsmiths' Hall, Foster Lane, Cheapside, London, during November 4–14, and will be inspected on November 3 by H.R.H. the Duke of Edinburgh, president of the Institute. The exhibition has been arranged in connexion with the Institute's yearly meeting, and among the features to be seen will be models of scientific and engineering equipment, including a supersonic wind-tunnel, from the City and Guilds College, South Kensington; students' work in fine arts and crafts from the City and Guilds Art School, Kennington; and a pictorial presentation of the work of the Institute's Department of Technology which covers nearly two hundred subjects.

The Meldola Medal, which is the gift of the Society of Maccabæans and is normally awarded annually, is being offered for award early in 1953 to the chemist who, being a British subject and less than thirty years of age on December 31, 1952, shows the most promise, as indicated by his or her published chemical work brought to the notice of the Council of the Royal Institute of Chemistry before December 31. Communications should be addressed to the President, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1, the envelope being marked "Meldola Medal".

Sir George Beilby Memorial Fund awards, which are considered by administrators representing the Royal Institute of Chemistry, the Society of Chemical Industry and the Institute of Metals, are made at intervals to British scientific research workers, preference being given to investigations relating to the special interests of Sir George Beilby, including problems connected with fuel economy, chemical engineering and metallurgy. In general, the awards are granted to younger men and women for original work done over a period of years. Awards may be made early next year, and the administrators request that their attention be directed, not later than December 31, to outstanding work of the nature indicated. All communications should be addressed to the Convenor of the Administrators, Sir George Beilby Memorial Fund, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1.

PROBLEMS OF THE SMALL FARM

THE three papers covering the problems of the small farm, given at Belfast on September 8 to Section M (Agriculture) of the British Association, differed in scope so widely that it was difficult at first to see how they fitted together; but on examination, it was possible to see a pattern which at least indicated some of the problems facing small farmers in the United Kingdom, without providing a ready-made solution for them.

Mr. Ronald Ede, agricultural attaché for Denmark, described the agricultural system in Scandinavia and the Low Countries. This account was particularly interesting because, although the average size of farm holdings in these countries is well below that of Great Britain, it is an accepted fact that the farming efficiency is high, and high-quality farm produce is exported at competitive prices in the world market. The second speaker, Mr. A. Cromie, a farmer in Northern Ireland, described his own farm—a typical small one in a country where the average size of farm is small—and gave his views on the problems facing farmers such as himself. The importance of his paper lay in the fact that he is a very progressive farmer. Finally, Mr. W. H. Cashmore, director of the National Institute of Agricultural Engineering, Silsoe, related the problems of mechanization to the size and type of farm and suggested that attention to organization, careful selection of equipment and further work on farming techniques would play their parts in extending the benefits of mechanization to the smaller farms.

In describing Scandinavian agriculture, Mr. Ede stated that nearly all land is owned by the farmers, but there is rigid government control of the size of small-holdings. Although the minimum size is five acres, the average is less than forty acres, and the tendency during the past thirty years has been to reduce both the number of large and small farms, and so raise the number of farms of average size, amalgamation of farms being prohibited. The labour is mostly family labour, and the majority of farms run on a mortgage at a low rate of interest. A smallholder with £250–500 capital can borrow up to £3,200, and the average level of borrowing is about £1,300.

The standard of living on the Danish farm is low compared with that in Britain, and smallholders are not replacing themselves because of the difficulties of finance. Many of the sons of smallholders move into industrial employment, the keenest demand for small farms coming from the sons of the medium-sized farms.

There is no State advisory service in Denmark, but advice reaches the farmers through the Smallholders' Association. Mr. Ede did not mention anything of special note about the cropping, except that there is a marked increase in fodder beet and a steady rise in fruit growing. The larger farms tend to grow the cereals for feeding-stuffs, and on the smallholdings grassland predominates.

Some machines, particularly the special and expensive implements, are handled on a co-operative basis. The standard of machinery at the homestead for handling cattle-food is high. The main features of Danish smallholdings are: small acreage (by British standards), good buildings that are well equipped, and dependence on borrowed capital. Even in Denmark there is some concern about the level of borrowed money, and it is realized that a fall in world prices would cause difficulties. In the discussion on this paper the mortgage position was the main topic. The general opinion was that the amount borrowed was high and, while it might be sound policy to raise money for current expenditure, it was risky to use borrowed capital for such items as machinery and buildings.

Mr. Cromie's farm is 37½ acres, of which 29½ is arable, and he rents a further 34 acres. His cropping is varied and includes small acreages of fodder crops such as marrow stem kale, fodder beet and arable silage; he also grows cash crops such as potatoes, ryegrass and oats, for seed.

The livestock consists of twelve Friesian cows and their followers, five sows and all their progeny, plus thirty to forty extra pigs each year, and some poultry. It was obvious that his stocking and production was well above average. The following examples illustrate the planning to raise the total output: the tractor had been equipped to do all the work, to the total exclusion of horses, thereby making it possible to carry two more cows; an analysis of the soil from various parts of the farm had indicated deficiencies which, when corrected, made it possible to carry more stock with an appreciable increase in the milk yield; a proportion of the grassland is ploughed out and reseeded each year to keep up the quality of the grass; silage-making is practised to conserve grass; and an electric fence is used for strip or controlled grazing.

Mr. Cromie confirmed the view that the production per acre can be higher on a small farm than a larger one because of greater personal attention and supervision. He was convinced that the output could be increased by 100 per cent if the results of agricultural science could be put into practice. At the present time a good deal of scientific work does not reach the small farmer. Quite often, improved techniques required additional capital outlay, and Mr. Cromie stated that the greatest handicap to progress was the large amount of capital needed, especially for reconstruction of buildings.

Great interest was aroused by the statement that the standard of knowledge on the farm will have to be raised. In the discussion, Mr. Cromie explained that farmers are taking an increasing interest in the management of a farm and the application of scientific work, but that the farmer is often too tired at night to go to lectures, discussions, etc., after a long day of toil. He thought that there is need for greater effort in spreading knowledge of scientific and experimental work, and suggested that demonstration farms would help.

Mr. Cromie confirmed that a farmer and his wife can make a fair living from about thirty-five acres in Northern Ireland, but he himself was strongly in favour of extending the area farmed by a further thirty acres; this justifies the services of a hired man and makes possible an increase in livestock. He admitted that in practice the high rental of the extra land and the labour cost offset most, if not all, the extra income.

In the discussion it was suggested that specialization on a few crops might increase the overall output per acre, and the idea of installing a small grass-drier to provide concentrated food for the dairy cattle and for sale was put forward. The case against 100 per cent grassland on the small farm is that arable land helps to keep the farm clean, and provides some cash crops such as potatoes and seed corn as well as by-products for livestock.

Mr. Cromie is without mains electricity, which is essential for a highly mechanized dairy and many of the appliances which support a 100 per cent grassland farm. In considering how far the use of machinery could assist the small farm, Mr. Cashmore stated that as the size of farm decreases below two hundred acres there is a marked upward trend in the capital invested in machinery per acre. His paper dealt with farms in the 50–150 acres class, on the assumption that below this level some specialization in cropping was necessary and so was outside the scope of this paper.

An analysis of capital invested in machinery and annual cash returns indicates that the greater use of machinery raises the yield rather than replaces regular labour. The margin of profit from increased mechanization is slender and very dependent on sound organization and proper maintenance. Even in the 50–150 acres class, capital expenditure on machinery increases as the size of holding decreases, but is justified by the higher returns per acre due to personal supervision and attention to detail.

In discussing how far expenditure on machinery could be kept down, Mr. Cashmore quoted from field surveys and investigations to show that in a number of cases the main advantage of a specialized machine is that it enables men to work a long day without undue fatigue. For short periods there is a slightly higher demand for labour ; but the overall cost of the operation is no higher. On these grounds it could be argued that the small farm would gain nothing by purchasing these machines. The limitations of the co-operative use of machinery were stated ; but where suitable contractor service is not available, there are possibilities in local farmers' co-operative societies for the use of certain expensive equipment. This system is already being employed in England for cereal harvesting and grass drying, and might be extended to ditching, hedge cutting, dung loading, etc.

Considerable emphasis was placed on better techniques and improved organization, and investigations were quoted to show that the efficiency of organization has a greater effect on the cost of a process than the design of the equipment. Commenting on general design, Mr. Cashmore stated that the small farm does not require scaled-down tractors or implements except in the case of barn machinery, which can be designed to run automatically provided electricity is available and the buildings are in good order. Already satisfactory equipment for the small farm has been devised, examples being milking machines and platform grain driers. It is possible that many more modifications or new developments would be helpful, but these must be related to technique investigations.

The discussion supported these views and emphasized the need for detailed studies to reveal whether the various problems could be solved by improved techniques, improvisation or new machines. It was thought that on the small farms the field equipment would have to be kept as simple as possible, with marked development of machinery for handling cattle food at the homestead.

In conclusion, the problems facing the small farmers are : shortage of capital, lack of knowledge on scientific work, poor farm buildings, and, in some cases, the wrong machinery. All these problems are interrelated, and, provided the size of holding is not less than 50–75 acres for general farming, it is reasonable to expect progress in the future.

W. H. Cashmore

CHEMISTRY IN ABERDEEN

By Prof. R. M. Barrer

Chemistry was one of the first sciences to develop as a university study. In part for this reason, but still more because of its intrinsic interest and great practical value, the subject now attracts many students. University departments, often designed long ago to house smaller numbers, have in many centres become inadequate and outmoded. It is a feature of recent university development in Britain that serious efforts are being made to remedy this situation by rebuilding or by rehabilitating and extending existing chemistry departments. In Aberdeen, the University is now seeing the completion of a building first contemplated more than thirty years ago, and commenced in January 1949. The subject of chemistry has been removed from Marischal College, where it had been taught since the union of the two original Universities of Aberdeen in 1860, and has been rehoused on a site near the historic buildings of King's College. The new building was opened by Sir Robert Robinson on September 17. The newness of the department may render a brief description of the layout and facilities of interest to scientists and others concerned in the design of science departments.

The building has been constructed in the form of a cross. Four floors are devoted to chemistry, and a final floor to soil science and agricultural biochemistry, both subjects closely allied to chemistry and of considerable significance to the rich agricultural industry of Aberdeenshire. Each is under a separate head. All floors are served by a central staircase, and by subsidiary stairs at the end of the south wing. In addition, the building contains two lifts, of which one is designed for carrying goods and equipment. The building is a granite structure, the granite of several blending hues having been taken from six different quarries.

The lower ground floor of the building contains the main chemical and apparatus stores, mechanical, glassblowing and electronic workshops ; a refrigerated room operating at adjustable temperatures down to − 10° ; and the electron microscope. There is in addition some research accommodation on this floor. In the east wing of the ground floor is situated the large elementary chemistry laboratory, with two balance rooms, one at each end. Associated preparation and subsidiary store rooms run into the south wing, which also contains research and staff rooms and a lecture room. This room is served by a large preparation room which also serves the main lecture theatre in the west wing. The theatre is excellently appointed and holds about 220 students. In the north wing are the main entrance hall, and large cloakrooms. Additional cloakrooms are available on every floor.

The first floor houses in the east wing the inorganic teaching laboratory with associated preparation and balance rooms. There is also a room especially provided for electrochemical work, and an inorganic research laboratory. In the west wing is a large research laboratory, and in the north wing a laboratory specially designed for larger scale chemical and physico-chemical operations. There is fume extraction from this room, which can be general or else can be concentrated at any desired point. In the same wing are a departmental library and staff room and further research laboratories. The south

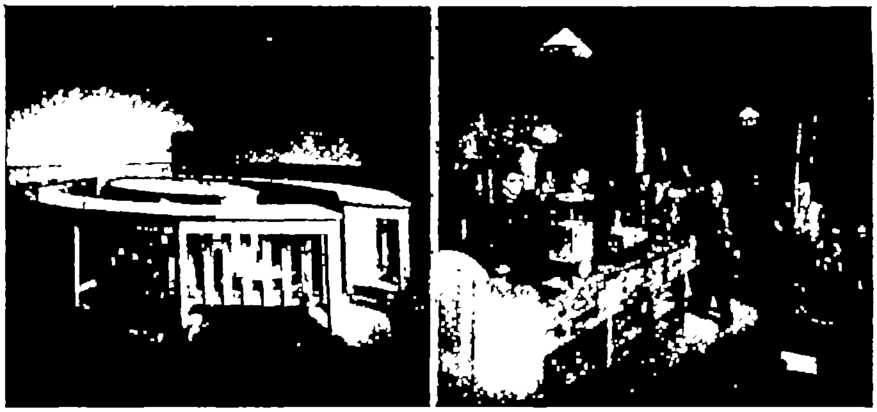

Fig 1 Chemical laboratories at Aberdeen (left) for medical students before 1896, (right) for science students about 1896

wing houses the main chemistry library, an X-ray room, staff rooms, the professor's research laboratory and a third lecture theatre. The second floor contains, in east and west wings respectively, the organic and physical chemistry laboratories, each with associated balance room, preparation room and subsidiary store room. The west wing also contains research laboratories and two well-equipped dark rooms, one for staff and the other for student use. The north wing contains five optical cubicles associated with the physical chemistry teaching laboratory, an electrical instrument store and two constant temperature research laboratories. The south wing contains a laboratory for microchemical analysis and six additional research laboratories. On the third floor of the building one moves into the domain of soil science and agricultural biochemistry. These subjects share a teaching laboratory and preparation and balance rooms in the north wing. Other accommodation provided includes staff rooms, workshop and store, research laboratories for staff and post-graduate students and an advanced teaching laboratory. An instrument room, optical cubicle, map room and museum, nitrogen room, dark room and tutorial room are also provided.

Teaching laboratories and lecture rooms are provided with plenum air as well as general air extraction. All research laboratories have high- and low-level extract from fume-cupboards. In the organic and inorganic laboratories, bench extract is also provided throughout. Research laboratories are designed with the view of maximum interconvertibility for use in any of the three branches of chemistry. Services include high-pressure air, and in some rooms vacuum, in addition to the usual gas, water and electricity supplies. Distilled water is piped from a central unit and also hydrogen sulphide. Many of the research laboratories contain, in addition to several sets of wall services, a complete set of services centrally placed at floor-level and accessible by removing a floor panel. All floors in research and teaching laboratories are sloped to drainage points so that water on floors is removed with minimum difficulty. Research laboratories are of several sizes capable of accommodating from one to four research workers.

Chemistry has advanced steadily within the University of Aberdeen, and the present big step forward emphasizes the high esteem in which the profession of chemistry is held. The first chair of chemistry in Scotland was occupied in Aberdeen in 1793 by George French, surgeon and chemist, although some instruction on the subject was given considerably earlier. While on one hand the cultural value of chemistry was acknowledged remarkably early within the Universities of Aberdeen, on the other

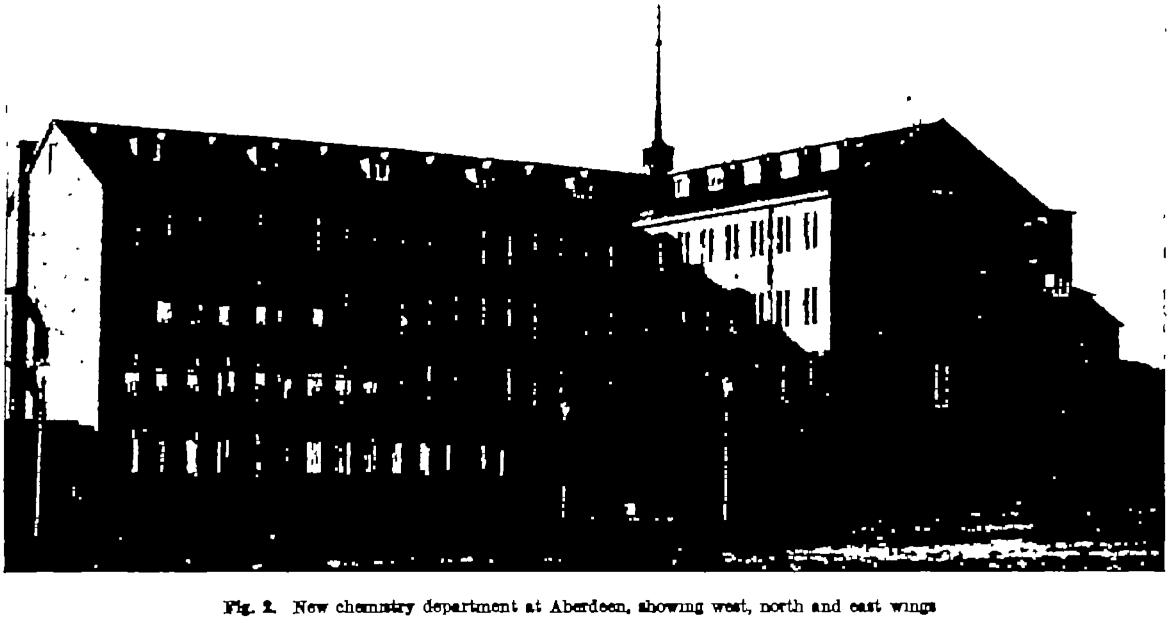

Fig. 2. New chemistry department at Aberdeen, showing west, north and east wings

hand, over all this earlier period no great efforts were spared for research. It was not until Carnelly (1888–90) and Japp (1890–1914) occupied the chair that it was considered particularly necessary for teachers of chemistry to try to extend the boundaries of the subject. Even with the growth of a new attitude, progress in research was not rapid. However, enthusiasm for original investigation was carefully fostered by later occupiers of the chair. There is now a vigorous research school, and the new building reflects the attitude that research as well as teaching is a vital part of any balanced university department. Three photographs are reproduced in this article which indicate the revolution in the provision made for chemistry over the past sixty years. The first photograph shows the chemical laboratory for medical students prior to 1896 and the second the chemical laboratory for science students at about the same time; both are reproduced by kind permission of Prof. A. Findlay, from his book "The Teaching of Chemistry in the Universities of Aberdeen" (Aberdeen University Studies, No. 112). The third photograph is of the west, north and east wings of the chemistry department of 1952. The subject is a forward-looking one where past triumphs are ever likely to be overshadowed by future achievements on a scale still more grand. Nevertheless, there is great interest in looking back and retracing paths, both scientific and personal, trodden by chemists of bygone generations. Such retrospect is bound to emphasize the mounting tempo of science, with all the responsibilities it brings.

THE UNIVERSITY OF CEYLON

By Sir IVOR JENNINGS, Q.C.

Vice-Chancellor

On October 6, the University of Ceylon moved 851 students, of whom exactly 300 were women, from Colombo to Peradeniya, near Kandy. They included all the students in oriental studies, arts and laws and the senior students in agriculture and veterinary science. The Faculties of Science and Engineering will move when their buildings are ready. The Medical School will remain in Colombo; but it is proposed to establish a second medical school in Peradeniya by 1960.

The 851 students include 27 Buddhist monks, who are housed in a University bungalow pending the erection of a monastery by the University Sangharama and Vihare Trust. The other 824 students are housed in five halls of residence. These halls are built on the principle of one student to each room; but since three halls—housing 490 students—will not be ready until 1953, there are usually two students in each room. The cost of residence is Rs. 630 (£46) per annum, and there are no tuition fees for Ceylonese students. Even so, about one-third of the students are subsidized, the University paying the whole or a part of the residence fee.

The present University Park contains 300 acres; but the land vested and to be vested in the University covers 3,000 acres. It includes a tea estate of 1,100 acres which is being converted under a ten-year plan into a timber estate. It also includes an experimental farm of 650 acres (of which 240 acres are cultivable) which is at present used as a School of Agriculture but will be transferred to the Faculty of Agriculture in 1953. This area of land stretches up the valley of the Mahaweli-Ganga for two miles, enclosing the headquarters of the Government Department of Agriculture and the Royal Botanic Gardens.

For seven years in the fourteenth century Peradeniya was the capital of the Sinhalese monarchy. When the capital was moved down the river to Kandy, Peradeniya became a royal garden. Under British rule a small portion (140 acres) became the Royal Botanic Gardens, while the remainder was put first under coffee and sugar and then under tea and rubber. The land receives both monsoons and therefore about 100 in. of rain a year. This creates a luxuriant tropical vegetation, which supports a remarkable fauna. Twenty-six varieties of birds have been identified from the Lodge, without using binoculars. Some ornamental trees were left by the superintendent of the tea estate; but planting was begun in 1942 and is continuing as areas are taken over under the landscape scheme. The climate is equable, for the buildings are between 1,600 and 1,700 ft. above sea-level.

This magnificent valley, framed by the great Hantane Ridge (4,500 ft.) from which the University draws its water supply, is one of the most beautiful university sites in the world. The layout was planned by Sir Patrick Abercrombie and Mr. Clifford Holliday, while the building plans were drawn by a Sinhalese architect, Mr. Shirley d'Alwis, who died of a heart attack two weeks before the students came into residence. Great care has been taken with the architecture of this central group, ancient Sinhalese motifs, mostly of the Polonnaruwa period (A.D. 1000–1200), being adapted to modern buildings. The long and narrow Senate Building, for example, is raised on granite pillars like the Brazen Palace at Anuradhapura, though the weight is carried by good English steel. The canopy of the University Theatre is supported by carved granite pillars, while the massive doors, made of Ceylon teak, are carved in Embekke style. There is, too, a huge 'moonstone', six feet in diameter, carved out of a solid block of granite in the style of the giant moonstone at Anuradhapura. In the Senate Building, Hilda Obeyesekera Hall and elsewhere much use has been made of lacquer-work carried out by Kandyan craftsmen, who have been at work for the past five or six years. On account of expense, however, most of the architectural detail has been carried out in concrete.

Though Kandy is only four miles away, it has been necessary for the University to organize many of its own services. Water is drawn from the University estates on Hantane; gas will have to be made on the site when the laboratories come into use; electricity is taken in bulk from the hydro-electric scheme and distributed by the University as licensed supplier through three transformer stations; a separate telephone exchange is being established under University control; a University Supply Organization has been established to purchase and distribute supplies through a University shopping centre (not yet erected); an electric laundry is being established; the University owns 135 houses and expects to own another three or four hundred; and a school will have to be provided when the technical staffs of the Faculties of Science and Engineering come into residence. In short, the University Park is much like a small 'company town'.

The residential system was adopted for Ceylon after a controversy which lasted fifteen years, in which much use was made of the Sadler Report on the University of Calcutta in 1919. To the usual advantages of residential education must be added several derived from local conditions. The climate of Peradeniya is better than that of Colombo, and strenuous games can be played more easily. The great natural beauty and the flora and the fauna both of the University Park and of the Royal Botanic Gardens are of considerable educational value. The heavy concentration on examination qualifications can be diminished by residential education. The authoritarian character of parental control, though in many respects admirable, tends to curb initiative and enterprise, and makes it useful to take undergraduates away from their parents for three or four years. Some attempt can be made, too, to alter the current scale of values, which derives from a combination of caste traditions and Colonial rule.

A VERSATILE FOCUSING SYSTEM FOR VAN DE GRAAFF ACCELERATING TUBES

By P. HOWARD-FLANDERS

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OF the positive-ion accelerating tubes used with high-voltage generators, most have been built with focusing systems which follow the techniques developed by Tuve[1] and many others. In these, use is made of focusing lenses of the type which occur between axially spaced cylindrical electrodes at different potentials.

There is, however, an alternative system of focusing which is very suitable for use in the accelerating tubes of Van de Graaff and other high-voltage machines. This system uses the type of lens which occurs at the aperture in a diaphragm separating two regions of uniform but differing electric field-strength. It is arranged by means of a suitable resistance-potential divider that the electric field is low for a short initial section of the tube and has a uniform high value for the whole remaining length; thus forming a focusing lens at the change of gradient which can be used to bring particles admitted at one end to a focus on the target at the other.

Accelerating tubes are usually constructed with a large number of electrodes at graded potentials, as it is found that tubes of this construction stand up best to use at high voltages[2]. The electrodes are often closely spaced, so that they produce a very nearly uniform field at the tube axis. In this case, it may be assumed that the field is quite uniform, which, of course, greatly simplifies the calculation of particle trajectories, and a simple first-order non-relativistic theory has been worked out for the conditions for focusing particles on to the target.

The focal length of the aperture lens is given by the well-known formula $F = 4V/(E_2 - E_1)$ for a particle accelerated through a potential difference V on passing from a region of field E_1 to a region of field E_2, assuming that the change of gradient occurs within a range of potential small compared with V. This formula has served as the basis for calculating the results which follow. Consider an accelerating tube in which the electric field is E_1 for a distance L_1 and is E_2 for a distance L_2, followed by a field-free target extension tube of length L_3 as shown in the diagram. Let the potentials at the point of injection, at the change of gradient and at the target, be V_0, V_1 and V_2, respectively, measured relative to the potential at which the particles are at rest. Then any particles injected into the tube at a potential V_0 will be brought to a focus at the target if the following condition is fulfilled:

$$\frac{L_2}{L_1}\frac{(3p-1)(p+1)}{p^2} = \frac{4q^2(q+1)(q-3)L_2 + 3(q^2-1)^2L_3}{4q^2L_2 + (3q-1)(q+1)L_3},$$

where $p^2 = V_1/V_0$ and $q^2 = V_2/V_1$.

A real inverted image is formed of the cross-section of the beam at the point of entry into the tube, the magnification M being given by

$$M = \frac{(p+1)}{p}\frac{L_2}{L_1}\left(\frac{1}{q+1} + \frac{(3q-1)}{4q^2}\frac{L_3}{L_2}\right).$$

We can now consider the properties of an accelerating tube in which the field is graded in the way described. The appropriate potentials have been calculated for a tube in which the length of the target extension tube is comparable with the length of the accelerating tube ($L_3 = 1{\cdot}04\ L_2$), and for three cases where $L_2/L_1 = 5$, 10, or 25. The way in which V_1/V_0 must vary with change of V_2/V_0 in order to focus the particles on to the target is shown in the diagram. It will be noted that focusing cannot be maintained below a certain threshold value of V_2/V_0, usually in the range 30–100, but that above this voltage V_1/V_0 varies in an almost linear way. Straight lines can be drawn which will lie almost on top of each curve, but which depart slightly near the origin, in the manner shown by the dotted lines. V_1/V_0 can be made to vary with V_2/V_0 so as to follow the appro-

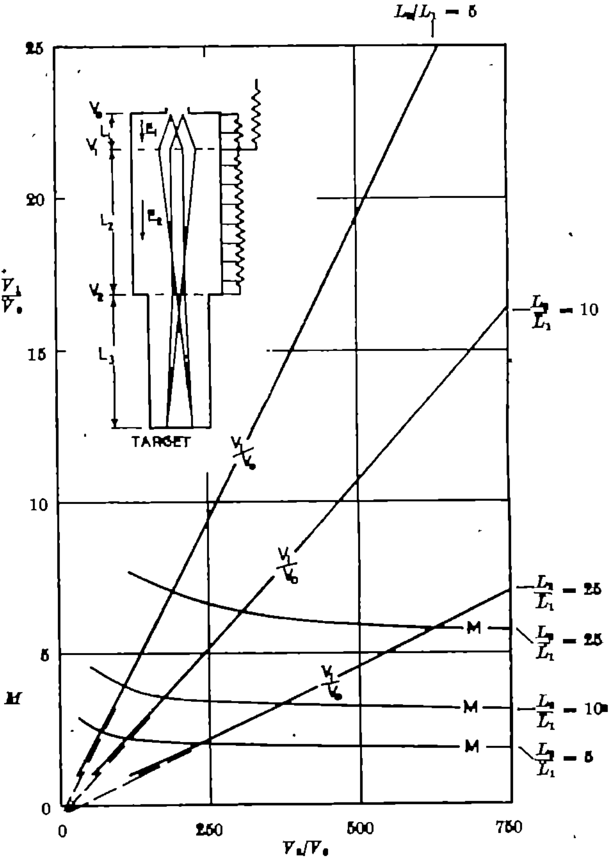

Diagram of an accelerating tube with a resistance chain to control the potential gradient. The values of V_1/V_0 required for focus, together with the corresponding magnification M, are given as a function of V_2/V_0 for an accelerating tube in which $L_3/L_2 = 1{\cdot}04$ and $L_2/L_1 = 5$, 10 or 25 priate straight line by taking V_1 from a suitable resistance chain, terminated at a potential slightly different from zero. It will then be advisable to use a second resistance in parallel with the upper part of the tube, as shown in the diagram, which will serve to grade the potential in the tube between the voltages V_2 and V_1. With a forked resistance chain of this type, V_1/V_2 can be held close to the required value over a wide range of V_2/V_1, so that the tube will be maintained in focus over a correspondingly wide range of operating voltage.

Comparing the curves for different values of L_2/L_1, it will be seen that the longer L_1 is, the wider is the voltage-range over which focusing is maintained. It will also be noted from the second set of curves, which show the magnification, that the longer L_1 is, the lower is the magnification, and hence the smaller is the target spot. The advantages of a long L_1 must, however, be set against the fact that the gradient in L_1 is lower and, for a given total length of accelerating tube, the maximum voltage which the tube will withstand is likely to be reduced by increasing L_1 at the expense of L_2. The choice of the best length L_1 is therefore a compromise, and the best value will depend upon the particular purpose for which the system is to be used.

We can now consider how a machine will behave which uses this focusing system. If particles are injected from an ion source working at, say, 4 kV., and if L_2/L_1 is 10, we can expect the system to be in focus when working at any potential above about 300 kV. There are other useful features of a focusing system of this kind. It will operate with large-diameter electrodes, so that it can be made to accept and focus particles injected at larger angles to the axis than is the case with the focusing system first mentioned. Further, as the current drain to large-diameter electrodes is small, it is not necessary to use any high-voltage focusing power-pack, all potentials being drawn from the resistance-potential divider. This simplifies the construction of the high-voltage terminal and the operation of the machine. It also facilitates the use of a single tube, operated at the appropriate polarity, for accelerating electrons or positive ions.

This focusing system has been tested in a preliminary way on the 2-MeV. pressurized Van de Graaff generator at the Radiotherapeutic Research Unit of the Medical Research Council and is used for accelerating positive ions or electrons as required. Ions are injected into the tube at a potential of about 200 volts into a uniform field E_1 which extends about one-tenth of the distance along the tube to the region where the field increases to the higher value. The full internal diameter of the electrodes in the accelerating tube is maintained without any diaphragm or constriction, so that the change of gradient is spread out axially to some degree. However, good focusing has been obtained over a wide range of voltage and current for both electrons and positive ions. The resistance values in the potential divider are set in advance to the theoretical value and there is no provision for adjustment in use. The resistance-potential divider has proved adequate for controlling the gradient for ion currents three or four times larger than drain through the resistances, indicating that the current to the large-diameter electrodes is very small. The observed magnification has been found to be in rough agreement with that predicted by the theory. The introduction of this focusing system has greatly improved the focus of the beam and has made possible some increase in the maximum currents obtained with this machine. The accelerating tube has been used to carry 350 μamp. of mixed positive ions at 2 MeV. continuously and more than 500 μamp. for short periods.

I am indebted to Mr. T. Wilson, whose formulation of the condition $L_1 = 2V/(E_2 - E_1)$ for the collimation to parallel of a divergent beam of particles injected with small velocities constituted one of the early steps in the development of the general formulæ presented above. [June 20.

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ESTIMATION OF THE 'BOUND FORM' OF NICOTINIC ACID

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IT is now well established that in some cereals the nicotinic acid is present to a large extent in a bound form, which is alkali labile[1–8]. Krehl and Strong[8] called this form the precursor of nicotinic acid. The assay methods employed for the estimation of the bound form are essentially microbiological. These microbiological assays do not give a correct estimate of the amount of the bound form, since the various organisms employed for these assays seem to utilize to a certain extent the intact precursor as a source of nicotinic acid. Thus, for example, *Lactobacillus arabinosus* seems to utilize the precursor up to about 45 per cent[9] or to 80 per cent[8], while *Lactobacillus casei* could utilize it to the extent of 10–20 per cent[10]. These considerations must obviously be taken into account in interpreting the results of microbiological assays.

The method I have employed is based on earlier observations that the 'bound form' does not move on paper chromatograms, developed in *n*-butanol – water solvent system or in 60 per cent *n*-propanol, but remains at the origin[11]. Its position can be located by its bluish-white fluorescence under ultra-violet light and by its orange colour when treated with cyanogen bromide and *p*-aminobenzoic acid[11]. In the case of materials containing the coenzymes, it is better to develop the chromatograms in 60 per cent *n*-propanol, since in this solvent system coenzymes I and II have the R_F values 0·26 and 0·15, respectively[11]. The interference with coenzymes that survive the following extraction procedure is eliminated. Thus it is easy to separate quantitatively the bound form from other nicotinyl compounds by developing the chromatograms in a suitable solvent system.

The procedure for the quantitative estimation described below consists in: (1) extraction with acidic methanol, (2) separation of the bound form on the chromatograms, (3) elution with *N* sodium hydroxide and estimation as free nicotinic acid. The values for the amount of the 'bound form' in the samples analysed were expressed in terms of free nicotinic acid.

(1) *Extraction.* 2–5 gm. of the material was extracted by refluxing on a water-bath with 20 ml. acidic methanol (80 ml. methanol + 20 ml. 0·5 *N* hydrochloric acid) for 1 hr., and after cooling the supernatant liquid was decanted. The residue was extracted with 20 ml. acidic methanol in the same

way for 1 hr. and the supernatant liquid was decanted. The residue was again washed twice with 10 ml. acidic methanol each time and the washings were added to the supernatant liquid. The combined supernatant fluids were kept in the ice chest for 30 min. and the bulky precipitate that separated was centrifuged. The clear centrifugate was decanted off, and the residue in the centrifuge tube was washed with 10 ml. acidic methanol each time and centrifuged. The combined centrifugates were evaporated to dryness at 55–60° C. under reduced pressure. The residue was extracted with 4 ml. of distilled water and centrifuged. The clear 'aqueous extract' contained the whole amount of the 'bound form' (see table).

NICOTINIC ACID CONTENT (μgm./gm.) AS DETERMINED BY DIFFERENT PROCEDURES

Material	Total nicotinic acid (*N* NaOH digestion)	'Aqueous extract' from acidic methanol extraction (*N* NaOH digestion)	Present procedure (*N* NaOH elution from paper strips)
Wheat bran	245	253	249
Rice bran	287	307	291
Groundnut (defatted with ether)	276	218	nil
'Gluten Feed 6' (maize bran)	56*	50	nil

* 5 gm. 'Gluten Feed' was extracted with 50 ml. 0·1 *N* hydrochloric acid on a water-bath. An aliquot was digested with *N* sodium hydroxide for 30 min. on a water-bath.

(2) *Separation of the bound form by paper chromatography*. 0·01-ml. spots of the 'aqueous extract' were placed on Whatman No. 1 filter paper and descending chromatograms were run overnight employing *n*-butanol – water as the solvent system. The chromatograms were dried at room temperature. The spots at the origin of the chromatograms were marked with pencil under ultra-violet light and the strips were cut out.

(3) *Elution with N sodium hydroxide*. The filter paper strips (5–10 spots) containing the 'bound form' were transferred to a beaker and 20 ml. *N* sodium hydroxide added. They were worked into fine pulp with a glass rod and digested on a water-bath for 30 min. with frequent stirring. The contents were cooled and centrifuged. The residue was extracted twice with 10 ml. *N* sodium hydroxide each time and centrifuged. The combined centrifugates were adjusted to *p*H 6·8 and the volume was made up to 45 ml.

The estimation of nicotinic acid was done by means of the colour reaction with *p*-aminoacetophenone and cyanogen bromide[12], following the revised procedure of Wang and Kodicek[13].

Nicotinic acid in the 'aqueous extract'. An aliquot was digested with 20 ml. *N* sodium hydroxide for 1 hr. on a water-bath and the nicotinic acid was estimated.

Total nicotinic acid. 1–2 gm. of the material was digested with 50 ml. *N* sodium hydroxide for 1 hr. on a water-bath and the nicotinic acid was estimated.

From the results (see table) it appears that in wheat and rice bran the entire nicotinic acid is present in a bound form, whereas in groundnut about 21 per cent of the total nicotinic acid is present in a form which is not extractable with acidic methanol. The higher values obtained by alkali digestion by Sohonie and Misra[14] in the case of groundnut digested with alkali were attributed either to the presence of a bound form or to some non-specific substance. Since the nicotinic acid extractable by acidic methanol was not recovered at the origin of the chromatograms (see table, col. 3), it appears that no 'bound' nicotinic acid of the type found in wheat or rice bran was present.

In a preparation of 'Gluten Feed' (a proprietary maize-bran product) there was no bound form and the entire nicotinic acid was extracted with acidic methanol. The chromatograms of the aqueous extract adjusted to *p*H 5·2 showed the presence of free nicotinic acid, and added nicotinic acid occupied the same position on the chromatogram as that present in the aqueous extract. It is quite likely that in 'Gluten Feed' the nicotinic acid is present in a free form. The pellagragenic nature of the 'Gluten Feed' could be attributed to the presence of a factor or factors which somehow prevent the utilization of the nicotinic acid by the animal system. These factors are most probably alkali-labile, since the digestion with alkali converts pellagragenic material into a pellagra-preventive foodstuff[15].

I wish to thank the Flour Millers' Association for the supply of wheat and rice bran. [June 27.

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CELL WALL OF *MICROCOCCUS LYSODEIKTICUS* AS THE SUBSTRATE OF LYSOZYME

By M. R. J. SALTON

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THE rapid lysis of intact cells of *Micrococcus lysodeikticus* by egg-white lysozyme has left little doubt that this enzyme radically alters some structure involved in the maintenance of the cell's morphological integrity[1]. Although Boasson[2] claimed that the cell wall of *Micrococcus lysodeikticus* was not destroyed by lysozyme but merely rendered more permeable to cellular contents, recent work[3] with the electron microscope has shown degradation and final destruction of the cell wall by lysozyme.

In view of the foregoing evidence, it seemed worth while studying the action of lysozyme on the bacterial cell wall. *Micrococcus lysodeikticus* and *Sarcina lutea* have been found to be refractory to sonic disintegration[4]; but the procedure reported by Salton and Horne[5] has been successfully used in preparing the cell walls of these organisms.

Cell walls prepared from 24-hr. cultures of *Micrococcus lysodeikticus* gave a stable, milky-white,

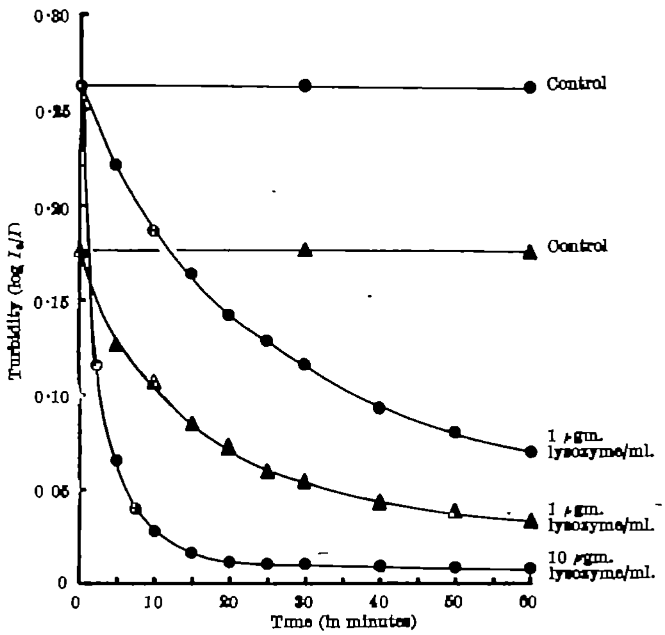
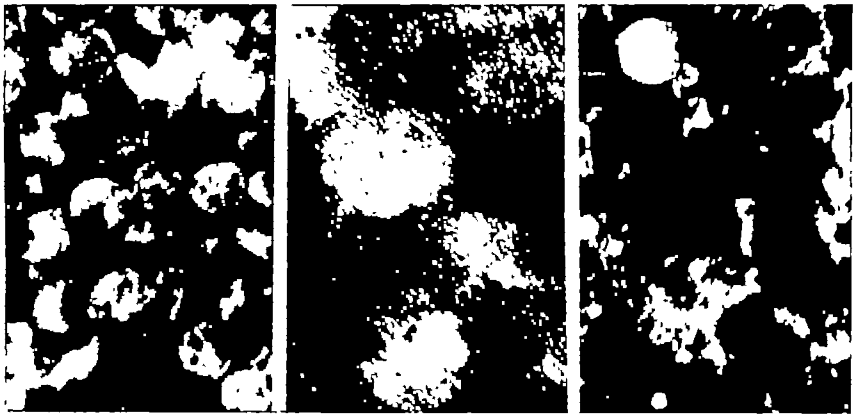


Fig. 1. Progress of dissolution of cell walls of *Micrococcus lysodeikticus* by lysozyme at 37° C., in 0·1 *M* phosphate buffer at *p*H 6·2.
●——●, 150 μgm. dry-weight cell walls/ml.
▲——▲, 100 μgm. dry-weight cell walls/ml.



(*a*) × 5,000 (*b*) × 5,000 (*c*) × 6,500

Fig. 2. (*a*) Untreated suspension of cell walls of *Micrococcus lysodeikticus*. Shadowed at 30° with gold–palladium alloy (60/40 per cent)

(*b*) Cell-wall suspension taken at the point of half-lysis (2½ min. exposure to 10 μgm. lysozyme/ml. at 37° C.). Specimen shadowed at 12°–15° with gold–palladium alloy

(*c*) The concentrated residue remaining after maximum clearing (60 min., 10 μgm. lysozyme/ml. at 37° C.) of the cell-wall suspension. Shadowed as for (*a*)

opalescent suspension. They were suspended in 0·1 *M* phosphate buffer at *p*H 6·2, and the rate of dissolution of the cell walls by lysozyme (Armour Laboratory crystalline, egg-white lysozyme) at 37° C. was followed by measuring the turbidity changes in a Hilger 'Spekker', using yellow-green filters. Lysozyme was dissolved and diluted in 0·9 per cent saline and added to cell-wall suspensions, the dry weights of which were determined by drying aliquots to constant weight at 105° C. The progress of 'lysis' of the cell walls was followed by pipetting 2-ml. aliquots into 0·25-cm. (internal width) cells and reading immediately in the 'Spekker'. Fig. 1 shows the results. A set of curves identical with those in Fig. 1 was obtained when cell walls were suspended in 0·9 per cent saline instead of phosphate buffer.

The rate of dissolution of the cell walls of *Micrococcus lysodeikticus* by lysozyme did not differ significantly over the *p*H range 5·7–7·0 (0·1 *M* phosphate buffers).

In order to determine the nature of the changes lysozyme had effected in the cell-wall structures as seen in the electron microscope, suspensions of the walls of *Micrococcus lysodeikticus* (150 μgm. dry-weight/ml.) were taken at the point of 'half-lysis' (approximately 2½ min. with 10 μgm. lysozyme/ml.) and after maximum clearing (60 min., 10 μgm. lysozyme/ml.). Suspensions were diluted with a large volume of ice-cold distilled water to reduce enzyme action and immediately centrifuged at 10,000 r.p.m. for 20 min. The deposits were re-suspended in distilled water, suitably diluted, and small drops placed on electron-microscope grids and examined in the electron microscope after shadowing specimens with gold–palladium alloy (60/40 per cent). Figs. 2 *a*, *b* and *c* show, respectively, the appearance of untreated cell walls, the half-lysed suspension and the residue (this deposit was re-suspended in two drops of distilled water and therefore represents a considerable degree of concentration of residual material). Partial depolymerization of cell walls, as shown in Fig. 2*b*, is characterized by an apparent reduction in the thickness and rigidity of the wall. The residual material, which accounts for 3–4 per cent of the original turbidity of the cell-wall suspension, consists of cell-wall fragments, a few cell walls which have apparently escaped dissolution and some electron-dense, cytoplasmic debris which probably contaminated the original preparation. These results suggest that there is no evidence for the existence of a lysozyme-resistant framework forming part of the cell wall of this organism, and that lysozyme effects a depolymerization of the whole cell-wall structure, rather than a degradation of a specific part or layer of the wall.

It seems reasonable to conclude that the cell wall of *Micrococcus lysodeikticus* is the insoluble, highly polymerized, mucopolysaccharide substrate of lysozyme. Further investigation of the constitution of the cell wall of *Micrococcus lysodeikticus* and its degradation by lysozyme is proceeding.

I wish to thank Mr. R. W. Horne, of the Cavendish Laboratory, for taking the electron micrographs.

[April 3.

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LETTERS TO THE EDITORS

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Action of Salivary α-Amylase on Amylopectin and Glycogen

Roberts and Whelan[1] have shown that the action of salivary α-amylase on amylose is consistent with the view that the enzyme can hydrolyse any except the terminal α-1 : 4-linkages. This leads to the formation of maltose and maltotriose. Similar studies using the linear maltodextrins[2] have confirmed this hypothesis[3]. We now wish to make a preliminary report of the action of this enzyme on glycogen and amylopectin.

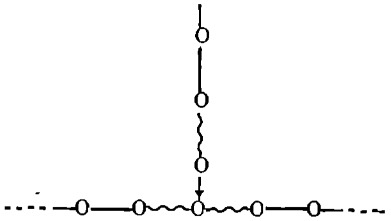

Fig. 1. α-1 : 4-Linkages resistant to α-amylase action
O, Glucose unit; —, α-1 : 4-link; ∼∼, unhydrolysable α-1 : 4-link; →, α-1 : 6-link

Rabbit liver glycogen (from pregnant does) was exhaustively treated with enzyme purified by the method of Meyer *et al.*[4] and the products were fractionated on a charcoal–'Celite' column[4,5]. Maltose ($4 \cdot 57 \times 10^{-6}$ moles), maltotriose ($2 \cdot 25 \times 10^{-6}$ moles) and dextrins containing α-1 : 6-branch linkages were obtained, but a tetrasaccharide fraction was absent. It was confirmed by paper chromatography that the branched dextrin of lowest molecular weight was a pentasaccharide. The branched dextrins were treated with *R*-enzyme, which hydrolyses the α-1 : 6-linkages[6,7], and the products were again fractionated on charcoal. The following substances were obtained (amounts in 10^{-6} moles): maltose (1·73), maltotriose (1·73), maltotetraose (1·32), maltopentaose (0·26) and dextrins of higher molecular weight (0·25). These observations are consistent with the following hypothesis of salivary α-amylase action. In Fig. 1 is shown the portion of a ramified polysaccharide in the vicinity of a branch linkage. and it is postulated that each of the three α-1 : 4-links adjacent to the branch link is, in virtue of its position, resistant to hydrolysis by α-amylase.

In the random action of α-amylase, maltose and maltotriose will be liberated from the linear portions of the molecule. Action in the vicinity of the branch linkages must give rise to a mixture of eight branched dextrins if the hypothesis is correct (Fig. 2). It will be seen in the first place that the smallest of these dextrins is a pentasaccharide. This agrees with the observed absence from the α-dextrins of a tetrasaccharide. Secondly, hydrolysis of the α - 1 : 6-linkages by *R*-enzyme will give rise to a mixture of maltose, malto-triose, -tetraose and -pentaose, in agreement with the experimental results. Maltodextrins of greater chain-length than maltopentaose were also liberated by the action of *R*-enzyme (see above). This observation is not, however, at variance with the hypothesis, since it is to be expected that structures of the type shown in Fig. 3 will also be present in the branched polysaccharides. Both (*a*) and (*b*) will give rise to α-dextrins containing two branch-linkages per molecule, whereas the types illustrated in Fig. 2 contain only one link. The hypothesis of resistant 1 : 4-linkages requires that structures 3*a* and 3*b* should each give rise to twelve possible α-dextrins. Three of those derived from the first type (Fig. 3*a*) would, after *R*-enzyme action, produce maltohexaose, which would also result from the debranching of six of the α-dextrins from structure 3*b*; maltoheptaose would be produced from three of the latter α-dextrins. The measured average chain-length of the mixture of higher dextrins produced by *R*-enzyme action was 6·1, and paper chromatograms confirmed that it consisted of hexa- and hepta-saccharides. It should be noted that, if these inferences can be substantiated, the production of 6- and 7-unit maltodextrins constitutes a proof of *multiple* branching in glycogen. Peat, Whelan and Thomas[8] have already reported evidence of such branching in waxy maize starch.

The information given above may be used to determine the average length of the repeating chains in the branched polysaccharides. A knowledge is required of the difference in the number of molecules in the α-dextrin sample before and after *R*-enzyme action. Thus, in the case of glycogen, calculation gives a value of 12·5 as the number of glucose units in a repeating chain, which may be compared with the value of 13·6 determined in this laboratory by periodate oxidation of the same glycogen.

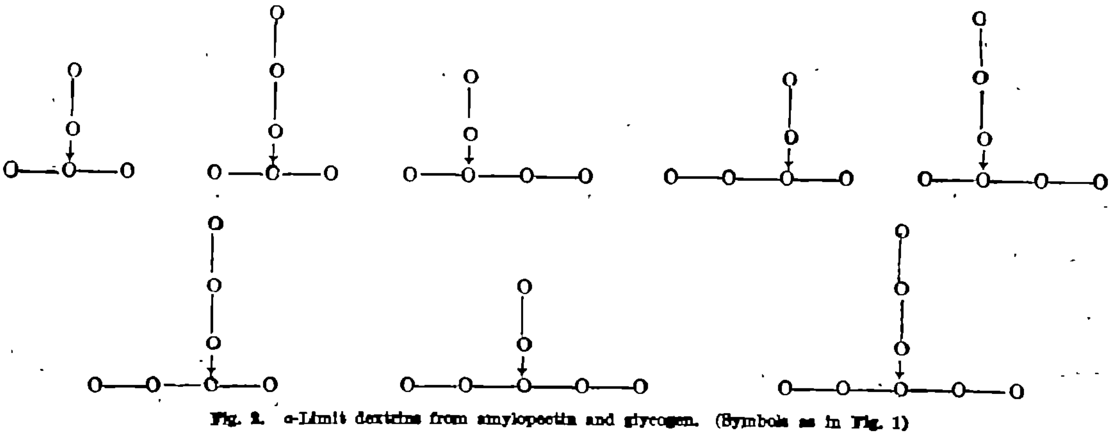

Fig. 2. α-Limit dextrins from amylopectin and glycogen. (Symbols as in Fig. 1)

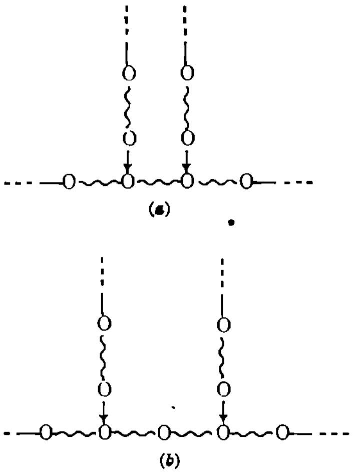

Fig. 3. Structures giving rise to doubly branched α-dextrins (Symbols as in Fig. 1)

Mention must be made of the presence of fructose in these polysaccharides. As reported recently[9], fructose, in the form of maltulose, has been isolated from rabbit liver glycogen after α-amylase action. In addition, fructose has now been detected in the maltotriose and all other α-dextrin fractions arising from this glycogen. This is also true of waxy maize starch[10]. These findings do not, however, influence the above argument with respect to α-amylase action.

We are indebted to Prof. S. Peat for his continued interest in this work, and to Prof. F. Rogers Brambell for the supply of the rabbit livers.

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Cysteic Acid Transaminase

It has previously been reported by Cohen[1] that enzyme preparations catalysing the reactions:

(1) Alanine + α-ketoglutarate $\rightleftharpoons$ glutamate + pyruvate;

(2) Aspartate + α-ketoglutarate $\rightleftharpoons$ glutamate + oxalo acetate;

are also capable of catalysing:

(3) Cysteic acid + α-ketoglutarate $\rightleftharpoons$ glutamate + sulphopyruvate.

(In a succeeding paper it will be shown that reaction (3) is reversible, which has hitherto not been proved.)

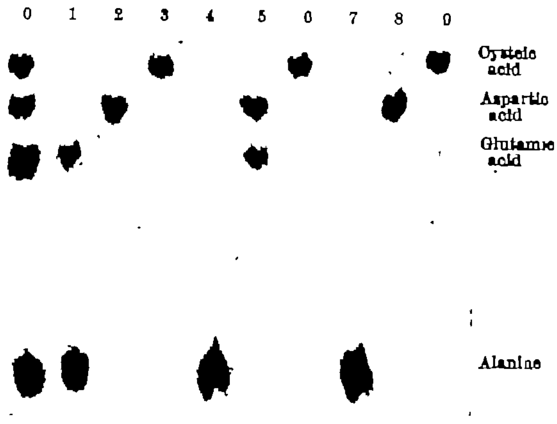
Furthermore, Green *et al.*[2] have shown that (1) and (2) are catalysed by means of two different enzymes, alanine and aspartic acid transaminase.

In experiments reported here, strong evidence is given for the existence of a special enzyme, cysteic acid transaminase, which catalyses reaction (3).

The enzyme is prepared by extraction of acetone-dried ox hearts with water. The liquid is pressed through a linen cloth, and the active material is precipitated with ammonium sulphate at 80 per cent saturation. The precipitate is filtered off and suspended in water and dialysed in a 'Cellophane' tube for 24 hr. The undissolved residue is centrifuged off and discarded. Then the solution is heated for five minutes at 60° C. The heat-coagulated protein is centrifuged off, and the clear supernatant liquid which contains the whole activity is subjected to fractionation with ammonium sulphate. By stepwise increase of the ammonium sulphate concentration, three fractions, *T*(0–50), *T*(50–65), *T*(65–80), are obtained; the numbers in brackets denote the concentration limits, expressed as percentage of saturation, between which the fractions are precipitated. Each of the fractions is examined with regard to its ability to catalyse the three above-mentioned reactions.

The technique adopted in this investigation consisted in incubating the amino-acids together with α-ketoglutaric acid in the presence of the enzyme fractions at 30° C. and *p*H 7·5. After a suitable lapse of time (10 min. in the present experiments), 0·1 ml. of 75 per cent phenol-water mixture is added for each 1 ml. of reaction mixture in order to arrest the reaction. The time of incubation is adjusted so that the relationship between time and the degree of reaction can be considered as linear with good approximation for all of the reactions.

The glutamic acid formed from the ketoglutarate by transamination was separated on filter paper by unidimensional chromatography using 75 per cent phenol as the solvent. In the photograph the qualitative results of a typical experiment are shown. Experimental conditions: 0·5 ml. of 0·1 *M* ketoglutaric acid and 0·5 ml. 0·1 *M* amino-acid solution are incubated for 10 min. with 0·5 ml. enzyme solution, *p*H 7·5, phosphate 1/15 molar, temperature 30° C.



Phenol/water chromatogram showing the formation of glutamic acid from α-ketoglutarate and L-alanine (1), L-aspartic acid (2), L-cysteic acid (3) in the presence of enzyme fraction *T*(0–50); α-ketoglutarate and L-alanine (4), L-aspartic acid (5), L-cysteic acid (6) in the presence of *T*(50–65) and from α-ketoglutaric acid and L-alanine (7), aspartic acid (8) and L-cysteic acid (9) in the presence of fraction *T*(65–80). For comparison, a mixture of cysteic acid, aspartic acid, glutamic acid and alanine is run on the same paper (0)

The reaction is arrested by adding 0·15 ml. 75 per cent phenol – water mixture. For analysis 4 µl. of each mixture is used. The chromatogram is developed with 75 per cent phenol – water mixture on Whatman No. 1 paper. After drying for 1 hr. in an oven at 80° C., the paper is sprayed with 0·1 per cent ninhydrin in butanol. After drying in an air current at room temperature for 5 hr., the chromatogram is photographed.

It can be seen from the chromatogram that (1) is catalysed by *T*(0–50) but not by *T*(50–65), as opposed to (3) which is catalysed by *T*(50–65) as well as by *T*(65–80). Hence alanine transaminase is not identical with the enzyme which catalyses (3). Furthermore, judging from the intensities of the glutamic acid spots, *T*(50–65) is more effective for (2) than for reaction (3), whereas the opposite holds for *T*(65–80). These results are consistent with quantitative results which will be published in due course.

Thus one can conclude that an enzyme, cysteic acid transaminase, exists, which is different from alanine transaminase and aspartic acid transaminase.

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Fœtal Fructose in Various Mammals

FRUCTOSE has been reported to occur in the fœtal fluids of a variety of animals, and it has been implied that this sugar is present generally in mammalian fœtuses[1]. However, the earlier claim that fructose occurs in the human fœtus[2] has been refuted[3]. The problem has been re-investigated here during a comparative study of carbohydrate metabolism and related disease problems in the new-born.

Mixed blood samples were obtained mainly from the umbilical cord, or, in the case of the carnivores, from throat blood after decapitation, at birth. Sheep and rodent samples were from the cord and throat blood respectively of near-term fœtuses. After collection over potassium oxalate, the blood was deproteinized at once with sodium hydroxide and zinc sulphate, except for foal blood, when barium hydroxide and zinc sulphate were used. In a proportion of foal samples, difficulties resulting from inconvenient foaling times necessitated sampling over sodium fluoride to check glycolysis during several hours delay before protein precipitation.

Fructose was measured colorimetrically by a modification of the Seliwanoff reaction, using glycerol as solvent and copper as catalyst, in a boiling water-bath. The method developed, on the average, 1·5 mgm. of fructose colour from 150 mgm. of glucose. Standard fructose solutions were included with each boiling, and blanks of reagents plus distilled water were subjected to identical procedures. Total sugar was measured by a modification of the method of Somogyi[4] and correction made for the unequal reducing powers of fructose and glucose. Both methods, as employed here, had a standard deviation of 1 mgm. per cent on 20 similar samples.

The findings are shown in the accompanying table. The classification into orders, although not strictly exact, aids description in the text.

Order	Animal	No. of pregnancies	No. of young	Blood fructose
Ungulata	Horse	20	20	Positive in all
	Pig	12	60	Positive in all
	Ox	1	1	Positive
	Sheep	8	11	Positive in all
	Goat	1	1	Positive
Carnivora	Dog	1	4	Negative in all
	Cat	2	5	Negative in all
	Ferret	1	3	Negative in all
Rodentia	Guinea pig	5	9	Negative in all
	Rabbit	2	11	Negative in all
	Rat	1	Pooled blood from 8	Negative

In addition, fructose was not found in the amniotic fluid of the hen's egg after eight, nine and eleven days incubation.

Actual fructose-levels in blood are not given for the ungulates, as these must be related to parturition and other factors; but they were of the order as those previously reported for the sheep and, with few exceptions, fell between 25 and 130 mgm. per cent.

Slight fructose values which are obtained in the non-ungulate group are difficult to interpret, because the interfering colour from glucose and other chromogens is slightly variable as, also, is the blank colour. From the fact that this colour never exceeded an equivalent as fructose of 3 mgm. per cent above that calculated to be present from glucose, and was frequently much less, fructose has been assumed to be absent, or present only in such trace amounts as might exist in adult blood.

These results suggest that the presence of substantial quantities of fructose in the fœtal blood of land mammals, at or near term, is peculiar to ungulates.

I have had much kind assistance in this work, which will be acknowledged when a more detailed account is presented.

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Activation of the Fluorescence of Chlorophyll Solutions

CHLOROPHYLL dissolved in pure dry hydrocarbons is (practically) non-fluorescent[1-3]. The addition of traces of water, alcohols or amines to solutions of chlorophyll restores their fluorescent intensity to that observed in solvents such as methanol, ether, etc. It was demonstrated by Livingston, Watson and McArdle[1] that this increase in the fluorescent yield is the result of the formation of an addition compound between a molecule of chlorophyll and one of the 'activator'. These authors postulated that the addition compound was formed by the establishment of hydrogen bonds between labile hydrogens of the activator and the keto oxygens of ring V[4] of the chlorophyll molecule. Afterwards, Evstigneev, Gavriola and Krasnovskii[5] presented evidence supporting the view that the activator adds to the central magnesium atom rather than to ring V. They claimed that the fluorescence of pheophytin is as intense in dry as it is in wet toluene, but that the fluorescence of toluene solutions of the magnesium complex of phthalocyanine is increased by the addition of water.

These results[3] with pheophytin solutions have been fully confirmed in our laboratory. However, the conclusions in regard to the phthalocyanines appear to be in error. A 'solution', prepared by mixing dry toluene with an ethereal solution of the magnesium complex of phthalocyanine and then pumping off the ether, is colloidal in nature. The optical density of such a preparation decreases rapidly with time, and if allowed to stand for a few days the blue pigment settles to the bottom, leaving a clear supernatant liquid. In spite of their misinterpretation of the experiments on phthalocyanine preparations, their contention that the activator molecule becomes attached to the magnesium atom appears to be correct.

The equilibrium constant, K, for the formation of the addition compound can be determined from measurements of either the absorption coefficients or the intensity of fluorescence of the solutions. Using quinoline as the activator and chlorophyll *a* as the pigment, identical values for K, of $1 \cdot 33 \times 10^4$ moles/litre, were obtained from measurements of the fluorescent intensity and of the absorption coefficients. From measurements of the changes in the absorption coefficients, it has been shown that magnesium, zinc- or calcium-complexed mesoporphyrin dimethyl ester, magnesium-complexed tetraphenyl chlorin[5], and zinc- or calcium-substituted chlorophyll form addition compounds with alcohols and organic bases. The stability constants of some of these compounds are listed in the accompanying table.

VALUES OF THE STABILITY CONSTANTS OF THE PIGMENT-SOLVENT ADDITION COMPOUNDS

Activator	Pigment			
	Mg-Porph.	Zn-Porph.	Mg-Chph.	Zn-Chph.
Aniline	41		46	
Benzyl alcohol	1,120		2,900	
Quinoline	8,300	1,800	13,300	15,200
Heptylamine	110,000		160,000	

Since the uncomplexed (that is, metal-free) forms of these pigments do not show any change in absorption spectra or in fluorescent intensity when alcohols, etc., are added to their solutions in dry hydrocarbons, presumably they do not form addition compounds of this type.

The evidence in support of the hypothesis that the 'activator' molecules add to the metal ion of the pigment may be summarized as follows. (1) Only the metal-complexed pigments form such compounds; the corresponding compounds containing imide hydrogens do not react in this way. (2) The stabilities of the addition compounds of chlorophylls, chlorins and porphyrins are all of the same order of magnitude. (3) All the known activators are generalized bases (that is, nucleophilic reagents), and this seems to be the only characteristic which they have in common. (4) Allomerized as well as native chlorophyll[1] shows the effect, although presumably the former molecule cannot undergo a keto-enol tautomerism on ring V [4].

It is noteworthy that, of the pigments investigated, only the magnesium chlorophylls exhibit a marked change in fluorescent yield accompanying the formation of the addition compound. At room temperature the fluorescent yields of the addition compounds of native chlorophylls *a* and *b* are at least twenty-five-fold greater than the yields of the same pigments in base-free solvents. Under similar conditions, zinc-chlorophyll *a* shows about a 20 per cent increase in fluorescent yield. There is no detectable change in the fluorescent yields of the metal-complexed porphyrin or tetraphenyl chlorin.

In dry benzene, the Soret band of the absorption spectrum of mesoporphyrin appears as two maxima of equal height, situated at 4060 A. and 4160 A. The addition compounds of this pigment with methanol, benzyl alcohol, aniline, heptylamine and quinoline exhibit the usual single narrow absorption peaks, at 4100, 4110, 4120, 4130 and 4130, respectively. None of the other pigments exhibits such splitting of their principal absorption bands.

The detailed results upon which this note is based will be published elsewhere. The experimental work was made possible by the support of the U.S. Office of Naval Research (Project 059, 028, Contract N6, ori 212, T.O. I).

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Histochemical Differentiation of *cis-trans* 1-2 Glycols

SINCE McManus[1] introduced his periodic acid technique for histochemical localization of the 1-2 glycol linkage, the field has been well investigated. Other techniques have been devised, utilizing both periodic acid[2] and lead tetraacetate[3-5], to split the carbon–carbon single bond of the glycol to produce leucofuchsin-demonstrable aldehyde radicals. In all these studies, however, little attention was paid to the linkage itself but rather to the parent compound. The present investigation was undertaken to study the *cis-trans* isomerism of the 1-2 glycol linkage during this oxidative process.

The periodic acid – Schiff technique, as now generally accepted[6], consists of oxidation of tissue sections in aqueous 0·5 per cent periodic acid for 5 min. at room temperature, followed by 15 min. staining in leucofuchsin. The stained sections are then processed in the routine Feulgen manner. Glycol cleavage is considered complete in 5 min., and further oxidation is unnecessary.

Criegee and others[7,8] have shown that there is a definite sequence of reaction with both periodic acid and lead tetraacetate in splitting 1-2 glycols. Initially, the *cis* isomers are attacked in preference to the less accessible *trans* forms. Then, as the reaction continues, the *trans* isomers are attacked to complete the cleavage of all the glycol forms.

To study this aspect of glycol oxidation histochemically, two series of experiments were prepared, one utilizing gelatin blocks and the other using tissue sections. The gelatin blocks were prepared after the manner of Lessler[9] and were impregnated individually with isomers of cyclohexane glycols. The tissue sections were routinely prepared by the paraffin method from formalin-fixed blocks of rabbit, rat and human intestine. These preparations were simultaneously submitted to timed oxidations in 0·5 per cent periodic acid. Following oxidation, they were processed by the McManus method. The amount of violet coloration produced by the leucofuchsin was then studied as to intensity, and, in the case of the tissue sections, location.

Cleavage of the *cis* cyclohexane isomers in the gelatin blocks was apparent after 10 sec. oxidation, and the reaction appeared complete after 1 min. The *trans* isomers, reacting more slowly, did not show positive coloration until after 30 sec. oxidation and continued to develop colour until 2 min. after oxidation.

Tissue sections appeared to give a 'diphasic' colour development which could be correlated with the gelatin block findings. After 1 min. of oxidation, leucofuchsin-positive material could be detected on the periphery of the mucin content of goblet cells and in the cuticular margin of the columnar cells. The colour intensified with further oxidation, reaching a maximum in about 3 min. After 2 min. of oxidation, the centre of the mucin mass of the goblet cells also began to show coloration, which increased in intensity with further oxidation, reaching its maximum after 5 min. There also appeared to be a definite variation in the cleavage-rate in the goblet cells at the base of the villi and those toward the lumen. The mucin of the deeper cells gave a positive leucofuchsin reaction much sooner than that of the outer cells, in many cases showing almost complete coloration after only 3 min. of oxidation. Conversely, it often took 6–7 min. of oxidation to demonstrate completely the mucin of the outer goblet cells.

This differential glycol cleavage is more noticeable when uncatalysed lead tetraacetate[4] is used as the oxidizing reagent. The oxidation proceeds more slowly and is not complete until after 30 min. The *cis* isomer cleavage is not completed for almost 15 min., while the *trans* isomers are not initially attacked until after at least 10 min., of oxidation.

These experiments seem to indicate that it is at least empirically possible to differentiate histochemically the *cis* isomers of the 1-2 glycol linkage from the *trans* forms by the rate of cleavage during periodic acid oxidation. Those glycols which can be demonstrated after 2 min. of periodic acid oxidation would appear to be of the *cis* type, while those appearing after that time are probably mainly of the *trans* form. If this assumption is true, it will be a great help in accurately determining the exact nature of the compounds containing 1-2 glycol linkages in various tissue components.

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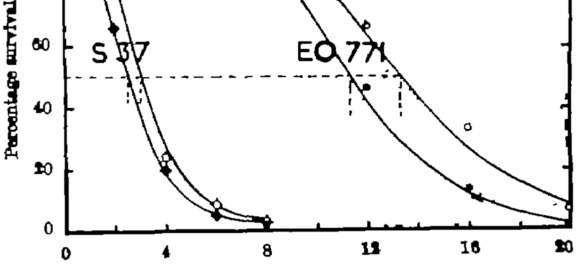
Relative Biological Effectiveness of Betatron and Conventional X-Radiation on the Regression of Mouse Tumours

THE development of more-powerful sources of X-radiation has made possible the investigation of the biological effectiveness of a variety of ionizing radiations. *In vitro* experiments have suggested that radiations of higher specific ionization have a greater lethal effect on mouse tumours[1]. We have compared the relative biological effectiveness, on two types of mouse tumours, of 200-kV. radiations from a conventional X-ray machine with 23·5-MeV. radiations from the University of Saskatchewan betatron.

The tumours used were mammary gland adenocarcinoma *EO*771 and sarcoma 37 and were carried in *C*57 × *C*3*H* hybrid mice. The transplants were made into the right axillary region of healthy hosts by the trocar method. For radiation, the mice were placed in lead containers with the tumour projecting, and irradiation was limited to the tumour. The sarcoma 37 was radiosensitive and the radiation was given in a single dose. Adenocarcinoma *EO*771 was relatively insensitive, and to attain a sufficiently high dosage the dose was fractionated, 4,000 r. being given weekly until the full dosage was reached. Tumours had attained a volume of 100 mm.^{3} when irradiated. Lethal regression was judged both by immediate decrease in size and finally by the disappearance of the tumour within three weeks of radiation. The results are shown in the accompanying graph.

Using the method of Bliss[2], the sigmoid survival curves were converted to straight lines and the mean lethal doses were determined. These were 13,500 ± 700 r., and 11,400 ± 700 r. for betatron and 200-kV. radiation respectively with adenocarcinoma *EO*771; 3,100 ± 200 r., and 2,500 ± 200 r. for betatron and 200-kV. radiation with sarcoma 37. This gave values for the ratio of effectiveness of the two radiations of 0·87 ± 0·05 with tumour *EO*771, 0·81 ± 0·08 for *S*37. It is of interest that the ratios obtained agreed closely with that found with these same tumours, at lower dosage-levels of these radiations, as judged by decrease in volume of the tumour[3], and were of the same order as the ratio obtained for the relative lethal effect on yeast[4]. In contrast, the relative effectiveness of the betatron radiation in causing leucopenia in mice[5] was 0·6, which suggested that the effective dose received by the mouse tumour per unit tolerance dose was higher for the betatron radiation than for the conventional 200-kV. X-radiation. The mean specific ionization for betatron radiation is 6·2 com-



pared to 55 for 200-kV. radiation[6], or a ten-fold difference in specific ionization. Sugiura[1], comparing gamma radiation with 200-kV. radiation, obtained a ratio of biological effectiveness of 0·67 for a sevenfold difference in specific ionization.

The results of this investigation will be published in detail elsewhere[7]. We are indebted to the National Cancer Institute of Canada and the Saskatchewan Cancer Society for generous support of our studies.

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New Hydroxamic Acids as Antitubercular Agents

PREVIOUSLY, one of us suggested using salicylhydroxamic acid as an antitubercular agent[1]. The substance was subjected to clinical examination by another of us (S. H.) and showed promising results in fifteen cases of pulmonary tuberculosis. The substance was well tolerated by the patients, when large doses of 10–20 gm./day were administered.

This led one of us (T. U.) to look for more potent derivatives of salicylhydroxamic acid. Eventually, a number of derivatives of it were prepared. Some of them, for example, 3-bromosalicylhydroxamic acid ('*T* 40'), 2-hydroxy-3-methyl-benzhydroxamic acid (2,3-cresotinohydroxamic acid, '*T* 95'), 2-hydroxynaphtho-3-hydroxamic acid ('*T* 106'), 2-hydroxyquinoline-7-hydroxamic acid ('*T* 139'), proved to be more potent *in vitro* than salicylhydroxamic acid. All these substances are new to the literature.

5-Bromosalicylhydroxamic acid (m.p. 232°) was prepared by direct bromination of salicylhydroxamic acid in acetic acid medium and purified by crystallizing from alcohol[2]. 2,3-Cresotinohydroxamic acid (m.p. 148°–150° decomp.), 2-hydroxynaphtho-3-hydroxamic acid (m.p. 191°–192° decomp.) and 8-hydroxyquinoline-7-hydroxamic acid (m.p. 208°–209° decomp.) were prepared in the conventional way by the action of hydroxylamine on methyl esters of 3-cresotic, 2-hydroxy-3-naphthoic and 8-hydroxyquinoline-7-carboxylic acids respectively. Details of their preparation will be reported elsewhere[3].

The bacteriostatic concentration *in vitro* of these substances against saprophytic mycobacteria was found to be:

Table 1

Sodium salts of *T* 40	of *T* 95	of *T* 106	of *T* 139
15–30	15–75	8–16	2–4 mgm. per 100 ml.

Their toxicity to rats (lethal doses expressed in gm. per kgm. body-weight) is shown in Table 2.

Table 2. Lethal doses (gm./kgm. body-weight)

Substance	*per os*	Subcutaneous	Intravenous
T 40	c. 3·5	0·8	0·12
T 95	c. 3·0	0·6	0·15
T 106	c. 2·0	(insoluble in water)	
T 139	c. 2·0	0·5	0·03

Besides the toxicity control, the products have been examined as to their pharmacological activities on different organs. The experiments showed only a very weak action upon the animal organisms.

Experiments *in vivo* with '*T* 40' were carried out by using guinea pigs (*c.* 500 gm.) inoculated intraperitoneally with 0·1 mgm. of *Mycobacterium tuberculosis* ($H_{37}Rv$ strain). Administration of the drug started on the eighth day after inoculation and lasted for forty-two days. Thirty-five days later the animals were killed and the extent of tuberculous involvement was examined. The results are shown in Table 3.

Table 3

Substance	No of animals	Daily dose (mgm. per animal)	Administration	Mortality	Average tuberc. index	Average survival time
'*T* 40'	20	10	subcut.	4 (20%)	65	80·2
Streptomycin	20	10	,,	2 (10%)	57	84·4
Control	20	—	—	18 (90%)	100	47·2

Similar results were obtained with '*T* 106', the mortality being only slightly greater than that of the animals treated with streptomycin. The results with '*T* 95' were less favourable[4].

The action of bromosalicylhydroxamic acid on human tuberculosis was then investigated clinically. 1 gm. a day was administered in twenty-five cases for periods of 25–102 days; a total of 25–100 gm. was administered in each case. The drug was well tolerated even if the dose was increased to 2 gm. Particularly interesting were nine cases of tubercular meningitis, which did not appear to be influenced by streptomycin. The additional administration of '*T* 40' in most of these cases produced a considerable improvement. The results are shown in Table 4.

Table 4

	After administration of '*T* 40'; number of cases				
	Very great improvement	Considerable improvement	Marked improvement	No improvement	Worsening
Tubercular meningitis unsuccessfully treated with streptomycin	1	4	2	1	1
Miliary tuberculosis		1	2		
Infiltrative pulmonary tuberculosis		2	2	1	2
Chronic cavernous tuberculosis			1		3
Pleurisy with effusion and diffuse tuberculosis	1				

Of twenty patients showing radiologically tuberculous lesions in the lungs, nine showed a pronounced improvement of the radiological picture (two of them very considerable improvement), eight showed no improvement, and three became worse.

Some of the patients resistant to '*T* 40' have been treated with streptomycin; no improvement followed[5].

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Survival of the Perfused Cat's Brain in the Absence of Glucose

In recent experiments in which the cat's brain was perfused through the isolated cerebral circulation with glucose-free 'simplified blood', brain functions were maintained for well over an hour if the rate of flow of blood was kept high. In previous perfusion experiments with glucose-free blood, the vascular resistance in the brain usually rose, reducing the rate of flow of blood considerably, with consequent loss of physiological activity of the brain and reduction of its oxygen consumption after 10–15 min. of glucose-free perfusion. When glucose was added afterwards to the blood, it was not taken up by the brain unless fresh liver extracts were also added[1].

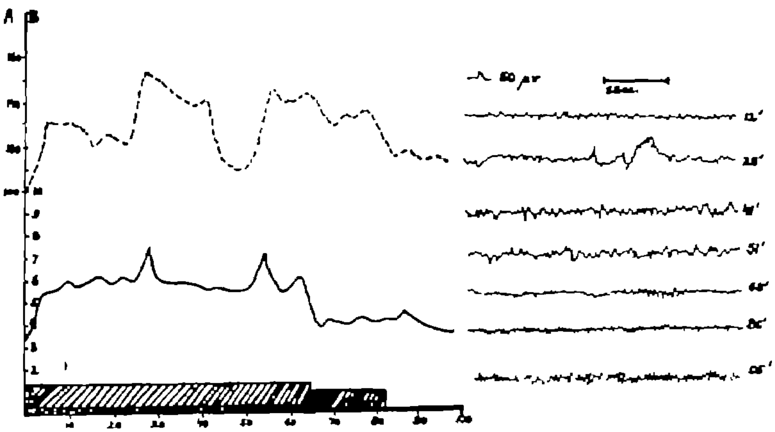
In the present experiments the technique of isolating the brain circulation and the method of perfusion were similar to that described previously[2]. Special care was taken to avoid contamination of the perfusion blood with the cat's systemic blood. Thiocyanate injected into the cat's circulation did not enter the perfusion blood. In some experiments all the extracranial soft tissue was removed from the head. These experiments gave results identical with those in which this precaution was not taken. Brain samples weighing 100–200 mgm. were excised during perfusion for analysis.

The bovine blood corpuscles used for perfusion were washed with 30–60 volumes of Ringer's solution containing penicillin, and 35 parts were suspended in 65 parts of a medium containing 7 per cent bovine serum albumin (Armour and Co.), 0·9 per cent sodium chloride, 0·044 per cent potassium chloride, 0·19 per cent sodium bicarbonate, 0·037 per cent calcium chloride, 0·038 per cent magnesium sulphate, and 0·021 per cent potassium dihydrogen phosphate. This 'simplified blood' was saturated with 5 per cent carbon dioxide in 95 per cent oxygen. A flow of 100–250 ml. per min. of blood for 100 gm. of brain was maintained.

Brain activity. A typical electro-corticogram is reproduced. In some experiments rhythmical electrical activity was still discernible after 90 min. of perfusion. The corneal reflex, respiration and vasomotor activity persisted for 60–100 min. The response to afferent stimulation of the sciatic nerve could be recorded from the cortex for a similar period of time. Addition of 'Metrazol' to the perfusion blood 40 min. after the start of perfusion caused convulsions which could be repeated; 3 mgm. of 'Nembutal' added to the perfusion blood at its entrance to the brain after 50–60 min. of perfusion extinguished the electro-corticogram within a few seconds and the corneal reflex and respiration shortly afterwards.

Oxygen consumption. During the present glucose-free perfusion experiments, oxygen consumption was very nearly as high as in other experiments in which glucose was present in the 'simplified blood'[2]. The usual rates were 5–7 ml. oxygen per 100 gm. brain per min. The total amount of oxygen consumed by the brain during the first hour of glucose-free perfusion exceeded by several times the amount necessary for the oxidation of the carbohydrates available at the start of the perfusion in the brain. During metrazol convulsions, even when 'Metrazol' was administered 50–60 min. after the start of glucose-free perfusion, the rate of oxygen consumption increased two- to three-fold. 'Nembutal' in a concentration of 3 mgm. in 100 ml. blood decreased the oxygen consumption only slightly. The respiratory quotient of the brain was 1·00 at the outset and decreased as perfusion progressed. Values as low as 0·50 were found frequently, even though the oxygen consumption remained high.

The glucose content of the brain was usually very low or dropped to zero after 10 min. of perfusion. In most experiments a small amount of glycogen remained in the brain throughout. A slight increase of glycogen in the brain was also found in some cases towards the end of the perfusion period. The concentration of lactic acid in the brain decreased gradually during perfusion, contrasting in this respect with similar experiments in which the perfusion blood contained glucose[3]. The potassium concentration in the brain decreased gradually and the sodium concentration increased during perfusion. Thus in some cases during prolonged perfusion experiments while



Typical glucose-free perfusion experiment. Ordinate: *A*, blood flow; *B*, oxygen consumption, ml. per 100 gm. of brain per min. Abscissa: perfusion time in minutes. Shaded area, corneal reflex; heavy line on abscissa, duration of natural respiration. Full line, oxygen consumption; broken line, rate of flow of blood. The figures next to the electrocorticograms show perfusion times in minutes

No. of experiments	Perfusion time (min.)	ml. per 100 gm. brain per min.		R.Q.	mgm. in brain			Oxygen consumed by 100 gm. brain in 1 hr. (ml.)	Oxygen not accounted for by carbohydrates (ml.)	Electrocorticogram	Cortical response to afferent stimulation	Respiration	Corneal reflex
		Blood flow	Oxygen consumed		Glucose	Glycogen	Lactic acid						
9	20	165 (115–215)	6·4 (4·8–8·0)	0·75 (0·54–0·90)	4 (0–10)	18 (0–42)	148 (80–216)	407	325	+	+	+	+
9	40	170 (125–220)	5·8 (3·4–7·5)	0·80 (0·34–0·89)	3 (0–6)	18 (6–37)	88 (25–133)			+	+	+	+
8	60	168 (90–220)	5·2 (3·2–6·5)	0·72 (0·51–1·05)	3 (0–10)	20 (14–30)	65 (16–115)			+	+	+	+
4	80	142 (115–190)	4·1 (2·7–5·5)	—	3 (0–7)	27 (20–34)	69 (68–70)			+	+	+	+
2	100	127 (120–135)	3·7 (3·2–4·2)	0·80	7 (0–15)	37 (34–42)	85 (81–90)			+		+	+

The figures in brackets show the lowest and highest values found.

the brain was still active, the concentration of sodium in the brain was higher than that of the potassium.

The non-protein nitrogen in the blood and in the brain increased only very slightly during perfusion.

The observations, which are summarized in the accompanying table, show that the brain continues to function in the absence of glucose, if the rate of flow of blood is high. Presumably substances other than glucose or glycogen are oxidized, while oxygen consumption is maintained at about the same rate as in the presence of glucose. Under these conditions the brain maintains for well over an hour rhythmic electric activity and the ability to respond to chemical or afferent stimulation.

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Necessity of Boron for *Nostoc muscorum*

There are very few reports on the necessity of boron for the growth of lower plants. Koffler *et al.*[1] found that borax increased the penicillin yields of submerged corn-steep cultures of *Penicillium* as well as cultures of *Penicillium* in synthetic medium. No definite requirement by algæ for boron has yet been shown[2].

I wish to report that *Nostoc muscorum* grown in Corning (boron-free) flasks in media free from boron requires boron. The boron-free cultures showed a relatively small reduction in cell count and a chlorosis which started slowly during the third week; they became completely white by the end of eight weeks. The reduction in cell count for an eight-week growth period was 39 per cent for cultures grown at a light intensity of 100 ft.-c. and at a temperature of 32–34° C. Since appreciable boron is transferred through the inoculum, it was found best to use an inoculum which itself was boron-free. The boron-deficiency chlorosis was corrected by the addition of boron. One fairly old boron-deficient culture had become acidic and also had to be made alkaline in order to transform the culture into one with a normal green colour. A detailed study of *p*H and boron-deficiency failed to establish any relationship between the deficiency and a trend toward higher hydrogen-ion concentration.

Cultures grown in Corning flasks with boron added or in 'Pyrex' flasks with or without boron added did not show similar chlorosis. The optimum boron concentration appeared to be about 0·1 p.p.m. Concentrations greater than 1 p.p.m. were toxic, as indicated by a yellowing and a reduced growth. There was very little or no growth at 100 p.p.m. and more.

The cultures of *Nostoc muscorum* were bacteria-free pure cultures, and were originally obtained from Dr. Folke Skoog and Dr. G. C. Gerloff, of the University of Wisconsin. They were grown according to the method of Chu (formula number 10)[3].

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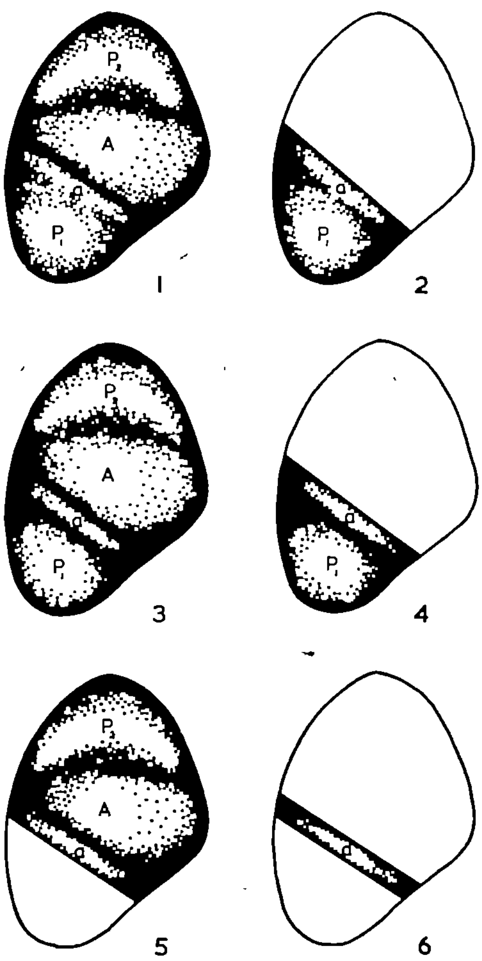
Regeneration of the Potato Shoot Apex

The apical meristem of the shoot in most species of plants is domed above the insertion of the leaf primordia, and its flanks slope symmetrically from the summit to the regions where differentiation is proceeding. When the distal cells in the apical meristem of ferns[1,2] or angiosperms[3,4] are punctured, regeneration of the flanks is promoted. From such experiments it has been concluded that physiological dominance within the apical growth field is an attribute of a small number of cells situated at the distal extremity of the apical meristem[5]. It is appropriate, therefore, to inquire as to the mechanism by which the form of the meristem is preserved. The persistence of such form is the earliest and most fundamental expression of morphogenesis in the shoot, the subsequent morphological developments being conditional on the continued orderly growth of the apical meristem.

As part of a larger series of experiments planned to shed light on this problem, a small panel of meristematic tissue which formed part of the apical flank just distal to P_1, the youngest emergent leaf primordium, that is, just above its axil, was isolated in various ways from either or both P_1 and the remainder of the apical meristem (*A* in Figs. 1–6). It was thereby hoped to isolate the panel *a* from possible hormonal and nutritional competition from P_1 and the apical meristem. From other experiments it was known that there is lateral and acropetal, apolar, transmission of a hormone-like stimulus



Figs. 1–6 Illustrating diagrammatically the apex immediately after the operations. Numbers correspond with those of treatments 1–6 in the table, and the conditions it was hoped to establish in each treatment are indicated there

within the limits of the apical meristem, but coincidental with tissue differentiation the stimulus is transmitted in a strictly basipetal, polar, direction. The incisions were therefore made sufficiently deep to penetrate all the meristematic layers, but not so deep as to interfere with the nutrient supply in the subapical region. Such incisions preclude hormonal inhibition of growth in the panel *a*. Nutritional competition, and the effects of substances which diffuse without polarity from P_1 or the apical meristem, may be prevented by excising one or both of the competing regions.

Results of the six treatments are presented in the accompanying table. Regeneration of the panel *a* involves the formation of a small new apical meristem, the records being made when the first leaf became emergent on it. Casual leaf inception, unrelated to apical activity, was never observed. The results of treatments 3 and 4 are closely comparable to those of treatments 1 and 2 respectively, because, whereas the incision isolating *a* from *A* always gaped, that between *a* and P_1 became compressed and the cut surfaces regrafted. It has not yet been possible to introduce impermeable substances into the incision without damaging the panel.

In treatments 1, 3 and 5 twenty-one of sixty panels regenerated one or two leaves each. None continued to grow further, but remained in an inhibited but embryonic state on the stem flank. Excision of P_1 increased the number of panels on which leaves emerged, not directly, by facilitating leaf inception, but by promoting a more rapid growth of the panel along its proximal–distal axis.

In treatments 2, 4 and 6 nearly all the panels regenerated, and regeneration commenced before that in the other three treatments. P_1, when present, was able to to retard the growth of the panel temporarily, but was unable to inhibit it entirely.

On this evidence the regulation of growth on the flanks of the apical meristem is apparently dependent mainly on the activity of the apical meristem itself, that is, the apical meristem is a self-regulatory field of growth. Hormonal inhibition of growth appears to be of relatively little importance, nutritional competition being the factor limiting regeneration in these experiments. Leaf primordia exert a transitory and localized inhibitory action on the growth of the apical flank, which is indicated by a flattening of the apical surface just distal to the insertion of a leaf. Since inhibition of regeneration by P_1 is strongest before the maximum rate of growth of this leaf is reached, it may be suggested that nutritional competition is of a rather specialized type, confined perhaps to requirements for the growth of meristematic tissues.

Ball[6] has shown that when the apical meristem of *Lupinus* is divided into six sectors all may regenerate, and has concluded that this is the minimal area able to regenerate in this species. In the present experiments the isolated panel was equal in area to one-sixth of the apical meristem. There were four cells along the proximal–distal axis of the panel, and twelve to fifteen along the tangential axis.

Smaller panels, obtained by incising the panel *a* at right angles to the first incisions, have been caused to regenerate by excision of the remainder of the apical meristem. Regeneration occurred whether or

Regeneration of the isolated panel *a* during six days. 20 shoots were used in each treatment. In column 1, H and N refer to hormonal and nutritional competition respectively of the apical meristem *A* and P_1. + and − indicate whether or not such competition is occurring. Ra = regeneration of panel *a*, and L = the total number of leaf primordia on 20 panels of each treatment. The final column gives the average number of leaves on a panel after six days

Treatment		Day 2		Day 3		Day 4		Day 6		$\frac{L}{20}$
		Ra	L	Ra	L	Ra	L	Ra	L	
1	−HA +NA +HP$_1$ +NP$_1$	0	0	0	0	3	3	3	3	0·15
2	−HA −NA +HP$_1$ +NP$_1$	0	0	7	7	14	21	20	52	2·6
3	−HA +NA −HP$_1$ +NP$_1$	0	0	0	0	2	2	5	6	0·3
4	−HA −NA −HP$_1$ +NP$_1$	0	0	7	7	14	23	18	43	2·15
5	−HA +NA −HP$_1$ −NP$_1$	0	0	0	0	8	10	13	16	0·8
6	−HA −NA −HP$_1$ −NP$_1$	2	3	14	18	20	38	20	63	3·15

not a part of P_1 was left attached. The smallest pieces of apical tissue which regenerated had only twelve cells in the superficial layer, and were equivalent to not more than one-twentieth of the area of the apical meristem. The vascular system of such regenerated shoots was invariably solenostelic.

On two occasions out of 123 very small apical panels failed to regenerate as shoots, but underwent a limited amount of growth, developing as centric organs similar to those previously obtained by isolating a presumptive leaf position from the apical meristem[7].

The experimental evidence presented here indicates that very small groups of superficial cells of the apical meristem are able to regenerate a shoot, providing they are freed from the competition of other regions of the apical meristem for the supply of available nutrients from the subapical region, and that such competition between different regions of the apical meristem is one of the regulatory mechanisms by which the form of the apical meristem is preserved.

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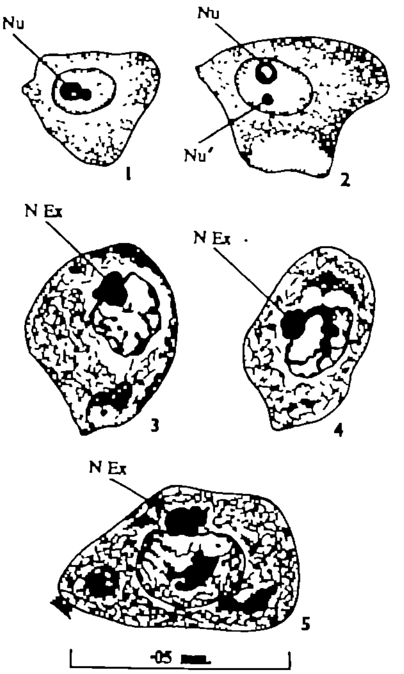
Extrusion of Nucleolar Material in the Female Germ-Cells of *Lumbricus terrestris* L.

So far as I am aware, the extrusion of nucleolar material into the cytoplasm has not been recorded for the female germ-cells of *Lumbricus* or any other earthworm. In this connexion, Harvey[1] remarked that in the nuclei of the "nearly ripe oocytes there may occur little droplets of material, similar in reactions to the plasmosome. They may be lying on the surface of this body, or may be entirely separate. Occasionally they are seen on the nuclear membrane, but never outside it. This may point to extrusion of nucleolar fragments, but only on a very small scale and never into the cytoplasm". Gatenby and Nath[2] observed that: "Neither Harvey nor the present writers have found any satisfactory evidence of nucleolar emission in *Lumbricus*".

My preparations of the ovaries of *Lumbricus*, fixed in Bouin's fluid and stained with Ehrlich's hæmatoxylin or iron-hæmatoxylin, show convincingly that extrusion of nucleolar material takes place. The nucleolus is stained a purplish colour with Ehrlich's hæmatoxylin. Often the nucleus contains two nucleoli, and in such cases the larger one contains one or more lightly stained droplets, while the smaller body appears to be homogeneous (Figs. 1 and 2); the latter seems to originate from the large nucleolar body (Fig. 1) and is ultimately extruded into the cytoplasm. After iron-hæmatoxylin, the nucleolus and nucleolar extrusion are uniformly black throughout.



Oocytes of *Lumbricus terrestris* from sections of ovary fixed in Bouin and stained with Ehrlich's hæmatoxylin (Figs. 1–2) or iron-hæmatoxylin (Figs 3–5).
Nu., nucleolus; *Nu'.*, smaller nucleolus; *N Ex.*, nucleolar extrusion

The nucleolar material which is extruded into the cytoplasm takes the form of a large, spherical nucleolus-like body which seems to press against the nuclear membrane and gradually passes into the cytoplasm, where finally it breaks up into smaller particles. The process appears to take place repeatedly, as I have observed it in oocytes of different sizes. Figs. 3 and 4 show two stages in the emission of nucleolar material; in Fig. 3, a nucleolar extrusion has passed half-way through the nuclear membrane, while in Fig. 4, an extrusion in another oocyte lies almost wholly in the cytoplasm. In Fig. 5, a similar body is shown in the cytoplasm, and already shows signs of breaking up into smaller pieces.

The presence of nucleolar extrusions in the female germ-cells of many animals has previously been described. Among annelids, the classical example of *Saccocirrus*, recorded by Gatenby[3], is well known. Unlike *Saccocirrus*, however, the extrusions of *Lumbricus* are large, spherical bodies resembling a nucleolus; in fact, in this animal the nucleolar extrusions more closely resemble those of *Libellula depressa* described by Hogben[4]. The presence of nucleolar extrusions indicates that the female germ-cells of *Lumbricus*, and probably those of other earthworms, are much more complex structures than supposed by previous workers such as Nath and his collaborators[2,5,6].

I wish to express my thanks to Prof. R. A. R. Gresson, for guidance and valuable help.

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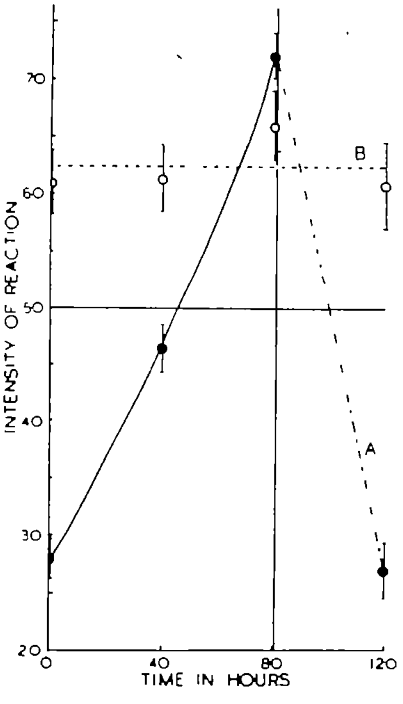
Effect of Desiccation on the Humidity Response of *Tenebrio*

THE ecological significance of an experimentally demonstrated and strongly marked preference for low humidities shown by certain arthropods has recently been discussed by Smith[1]. *Tenebrio molitor* L. is one insect the behaviour of which in humidity gradients has been fully studied and which shows a well-defined dry preference[2-4]. In laboratory cultures of adult *Tenebrio*, however, we have frequently observed that, if a wad of wet cotton-wool be placed in the culture dish, the animals rapidly accumulate on the wool and drink. It is thus clear that the dry preference does not express itself in all conditions.

We have investigated the effect of desiccation upon the intensity of the humidity response of this insect, using a technique similar to that employed by Gunn and Pielou[2]. All experiments were carried out at 25° C. under artificial light and with a gradient of 93–44 per cent relative humidity. Animals from stock cultures maintained at the experimental temperature were placed in dishes containing damp cotton-wool for a period of 12 hr.; the intensity of their humidity preference was determined and they were then desiccated over calcium chloride. The intensity of their response was redetermined after 40 and 80 hr. At the end of this period the animals were returned to the dishes containing the damp cotton-wool and, after a period of 40 hr., their response was again assessed. The results obtained are shown in curve *A* of the accompanying graph, which is based upon seven independent experiments.

It will be seen that there is a change in the humidity preference as the desiccation proceeds. Once the animals are allowed renewed access to water, the original dry preference is shown. There is no significant difference between the reaction intensities of watered animals before and after the period of desiccation. This eliminates the possibility that starvation has contributed to the changing pattern of humidity behaviour, as has been found by Willis and Roth[5] in *Tribolium*.



Effect of desiccation upon the humidity preference of adult *Tenebrio*. Black circles, normal animals; open circles, animals without antennæ. Reaction intensities of less than 50 indicate a dry preference, greater than 50 a wet preference. The lines running through the points indicate twice the standard errors of the mean values

Gunn and Pielou were able to show that the receptors responsible for the initiation of the dry preference of *Tenebrio* lay in the antennæ. Over a short gradient of 100–94 per cent relative humidity they found no response to humidity by animals lacking antennæ. We have been able to confirm this observation. We find, however, that with the wide gradient of 93–44 per cent relative humidity a wet preference is exhibited. The intensity of this preference is but slightly affected by desiccation. Although the intensity of the final wet preference of normal desiccated animals is slightly greater than that of comparable animals without their antennæ, we are unwilling to conclude at the moment that any specific sense organs concerned with a wet preference lie on the antennæ. It is clear, however, that such sense organs must exist elsewhere on the body.

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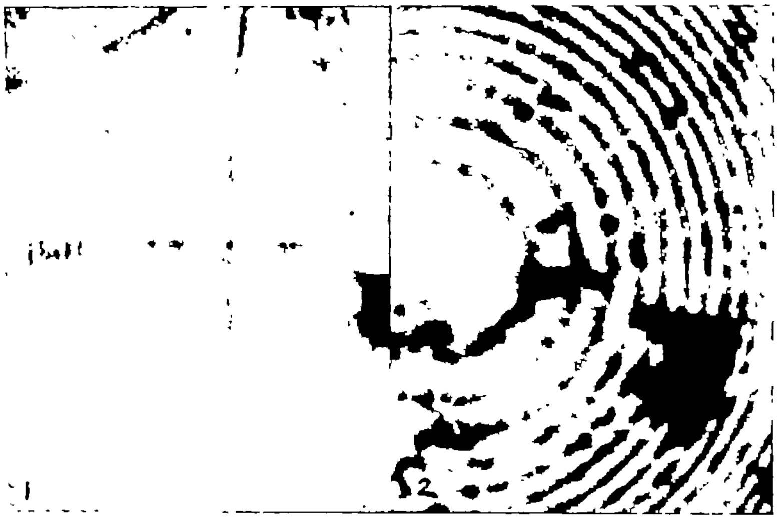
Evaluation of Small Radii of Curvature using the Light-Profile Microscope

THE light-profile microscope described by Tolansky[1] is being applied in this laboratory to several fields, including the study of features of crystal growth[2], the measurement of the thickness of thin film[3] and evaluation of amplitudes of oscillation[4]. In this communication a brief description is given of a further application, whereby the radii of curvature of small spheres, droplets, cavities, etc., can be readily measured.

When the light profile passes over a curved surface, a curved profile line appears in the field of view, a spherical surface leading to a profile which approximates to part of an ellipse, the eccentricity of which is determined by the ratio of the magnifications in extension and in depth. From the curved profile and the known magnifications, the curvature of the surface can be evaluated. (Depending on the flatness of field of the particular objectives available, it may in individual cases be necessary to determine field curvature and correct for this—an easy matter.)

The reliability of the procedure has been tested by using it on a steel ball-bearing of radius 0·6 mm., for with such an object Newton's rings can readily be obtained to give a precise local value of curvature Furthermore, a principal advantage of the light profile is the availability of high power. The stee ball was placed on a cover slip and examined with λ 5,461 at × 875 (4-mm. objective). Newton's ring are seen in Fig. 2. Fig. 1 shows the light profile a × 450 in extension. The optical arrangement suited to the light profile is not the best for interferometry



hence Newton's rings can be seen only faintly, superposed on the profile. The radius of curvature calculated from the interference fringes is 0·596 mm. and from the profile 0·595 mm., the estimated error in the latter being some ± 1 per cent (that is, ± 0·005 mm.).

There is, then, complete confirmation of the reliability of the light-profile method, particularly for measuring curvature of small bodies or small cavities. Spherical cavities, such as those produced in micro-indentation by spheres or ball-ended diamonds, erosion pits, cavities produced by spark discharges on metals, etc., are but some of the features now under examination.

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Thermionic Constants of the Iron Group of Metals

In a recent communication[1], we gave an account of a new method of determining the thermionic constants of graphite, which is based on the determination of the saturation vapour pressure of the electron gas in equilibrium with the substance at different known temperatures, and application of the well-known thermodynamic relation of Clausius and Clapeyron. In the actual experiments, the saturation vapour pressure of the electron gas in a graphite chamber is determined by finding the rate of effusion of the gas into vacuum through a small hole in a thin wall of the chamber. The chamber is in the form of a thin-walled tube, and can be heated to any desired high temperature by sending a suitable heavy electric current through it. In order to eliminate the electrons emitted by the graphite surface adjoining the effusion hole, the surface is covered by a thin sheet of mica, with a small hole punctured in it; this comes just in front of a bigger one in the graphite wall and serves as the effective effusion hole.

This method of determining the thermionic constants, and in particular the coefficient *A* in Richardson's equation, has advantages over the other methods, since it is insensitive to the usual type of contamination of the emitting surface; and further, it does not require a knowledge of the effective area of the emitting surface or of the reflexion coefficient of the electrons at the surface.

The inner walls of the graphite chamber, as also the regions close to the effusion hole, can be coated suitably with other metals, and the method can thus be used for the determination of the thermionic constants of these metals also. We have determined in this manner the thermionic constants of chromium, iron, cobalt and nickel, depositing the metals both electrolytically and by evaporation from a tungsten wire coated previously with the metal, or carrying small rings of the metal. The results were found to be independent of the method used for the deposition of the metal and were reproducible.

The observations fit well with Richardson's equation:

$$i = AT^2 \exp(-\varphi/kT), \qquad (1)$$

in which *A* and φ are independent of temperature, and have the values given in the accompanying table.

Metal	φ (eV)		*A* (amp cm.$^{-2}$ deg.$^{-2}$)	
Chromium	4·58	±0·02	60	±2
γ-Iron	4·31		60	
Cobalt	4·41		60	
Nickel	4·50		120	±5
Note added in proof, October 8.				
Titanium	3·95		44	
Vanadium	4·12		50	
Manganese	3·83		34	

As is well known, the observed fit of the experimental data with formula (1) with temperature-independent constants *A* and φ cannot be regarded as excluding a small linear variation of the actual work function with temperature, since such a variation will be equivalent to a temperature-independent change in *A*. Apart from the normal thermal expansion of the metal, which will lead to a small temperature variation of the work function, there is a further source of such variation in these metals. The *d*- and the *s*-energy bands of these metals overlap, the former being nearly full, and having a much larger density of energy-states than the latter. As a result, (1) the electronic specific heat in the condensed phase will be considerable, and (2) on change of temperature there will be a transference of electrons from one band to the other, and a consequent change in the work function[2]. Hence experimental data for the thermionic constants of the transition elements are of special interest.

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γ-Rays of Radium-D

A Cauchois type of curved crystal spectrometer[1] has been employed to study the γ-radiation from radium-D using a 100-mC. source.

The source was produced at the Radiochemical Centre, Amersham, by anode deposition on a dished platinum foil of area $\frac{1}{4}$ sq. in. The total weight of inactive deposit was 2·1 mgm. An aluminium foil of thickness 0·05 mm. was sealed over the source. The β-particles of radium-E were absorbed in a filter-paper screen of superficial mass 0·45 gm./cm.^{2}.

The γ-spectrum was recorded on Ilford G 5 nuclear plates coated to a thickness of 200 μ. The developed plates were scanned by microphotometer and the resulting observations were corrected for absorption before the photographic plate and for variation of the sensitivity of the photographic plate with wavelength. Exposures of 700 hr. were made, covering at full aperture the energy ranges 62–19 keV. and 50–16 keV. The well-known γ-ray was found at 265·96 ± 0·13 X.U. or 46·52 ± 0·02 keV., in good agreement with earlier observations[2] recalculated on the basis of recent values of the physical constants[3]. No other γ-ray was observed between the upper limit of observation at 62 keV. and the upper limit of the L X-ray spectrum of radium-E ($L\gamma_4$) at 16·2 keV. γ-Rays within this region have been reported by various authors[4,5], though inconclusive or negative results have been obtained by others[6].

The upper limits set by our observations to the intensities of the γ-rays reported by Tsien[4] relative to the intensity of the 46-keV. line are as follows:

Energy of γ-ray (keV.)	46·5	42·6	37	31	23·2	16·1
Relative intensity	1	≤0·015	≤0·015	≤0·015	≤0·025	≤0·06

A full account of the experimental technique and of other measurements will be published at a later date.

The mica crystal used in this work was kindly given by Prof. S. Tolansky. A further gift of mica crystals from Dr. J. M. Rayner is gratefully acknowledged. The work was sustained for two years by a grant from the Department of Scientific and Industrial Research to one of us (G. T. E.).

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Growth Spirals and their Relation to Crystal Habit as Illustrated by Apatite

The observation of growth spirals, as predicted by the theory of Burton, Cabrera and Frank[1], on prism faces (10$\bar{1}$0) of apatite crystals, has been reported earlier[2]. We have now observed completely differently shaped growth spiral patterns on tabular colourless apatite crystals from Sulzbachtal (Austria), which have probably grown from solution. The accompanying photograph (Fig. 1) shows one of the observed patterns. The direction of the c-axis is vertical. The shape and orientation of the spiral are the same in all cases. The dominating system consists of two co-operating spirals, which dominate several other dislocations of equal and of different strengths. In the latter case the formation of residual steps is noticed. Interlacing occurs in one direction. The main growth-fronts have a step-height of 140 ± 20 A.

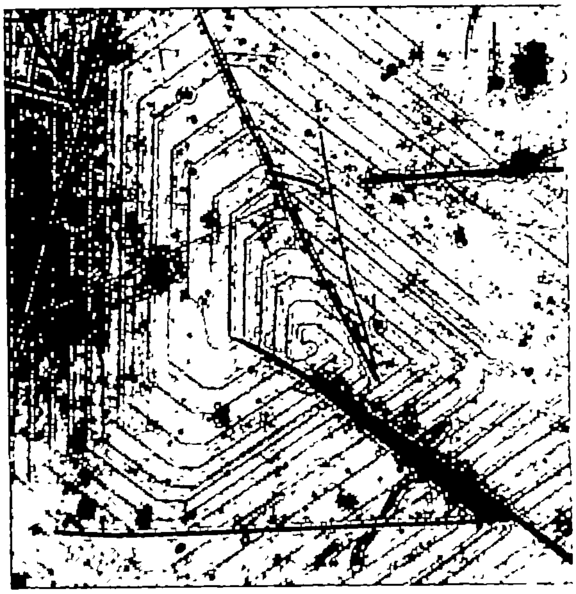

Fig. 1

By introducing a two-dimensional reference system with the apatite parameters $c : a = 0·73 : 1$ as units, indices similar to the Miller indices for planes can be given to the growth fronts. These are, respectively, 01, 11, 10, 1$\bar{1}$, 0$\bar{1}$, $\bar{1}\bar{1}$, $\bar{1}$0 and $\bar{1}$1. Perpendicular to these directions we consequently have eight sharp minima for the growth velocity, and the following relations exist: $v_{10} > v_{01} = v_{0\bar{1}} > v_{\bar{1}\bar{1}} = v_{\bar{1}1} > v_{\bar{1}0} > v_{11} = v_{1\bar{1}}$. The subsequent polar diagram has only a line of symmetry perpendicular to the c-axis, which is consistent with the crystal class of apatite. The spirals are oriented in the same way on the six prism faces, proving the presence of a hexad symmetry axis.

When comparing the shape of the spirals described earlier and the shape of the present ones with respect to the habit of the crystals, a striking similarity will be noticed between the outline of the prism faces and the shape of the spiral growth fronts. This relation is shown schematically in Fig. 2, where (a) represents

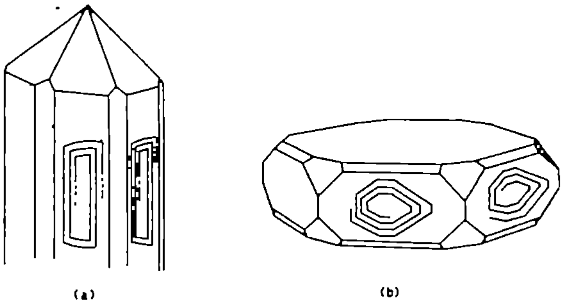

Fig. 2

a prismatic crystal (Jumilla) and (*b*) a tabular crystal (Sulzbachtal), with their respective growth patterns.

As one can scarcely imagine an influence of the edges of the prism faces upon the growth fronts and imposing their outline to them, one must rather accept the contrary, that is, that crystal habit results from the shape of the growth spirals. Agents changing the relative growth-rates of growth fronts would influence crystal habit in such a way that edges will be developed perpendicular to directions of minima for growth velocities on the close-packed faces.

These observations further support the idea that habit modification by foreign substances would proceed rather by selective adsorption along growth fronts than by adsorption on certain crystal planes.

I wish to thank Prof. W. Dekeyser for his kind interest, the C.N.B.C.P.M. for support, and the Mineralogy Department of Koninklijk Belgisch Instituut voor Natuurwetenschappen (Brussels) for the loan of specimens.

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---

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Determination of the Pore-Size Distribution in Porous Metal Bodies

The pore-size distribution of a porous metal body can be defined in three ways, namely, those given by the expressions $\partial V/\partial r$, $\partial\alpha/\partial r$ and $\partial N/\partial r$, where r is the 'radius' of the pore and ∂V, $\partial\alpha$ and ∂N respectively represent volume, permeability and number of pores associated with the pore-size interval r to $(r + \partial r)$. $\partial V/\partial r$ may be determined by observing the capillary rise of a liquid in a narrow strip of the material. If h is the capillary rise, a simple equation relates h to r, and $\partial V/\partial h$ is readily determined by breaking the strip at h_1, h_2, h_3 . . . and weighing the pieces to ascertain the values of V corresponding to the sections $(h_1 - 0)$, $(h_2 - h_1)$, $(h_3 - h_2)$. . . .

If the perimeter of a section through a pore is P and the area of the section A, then equating forces acting on the surface of the liquid that has risen in the pore and neglecting the weight of the liquid above the meniscus, we may write:

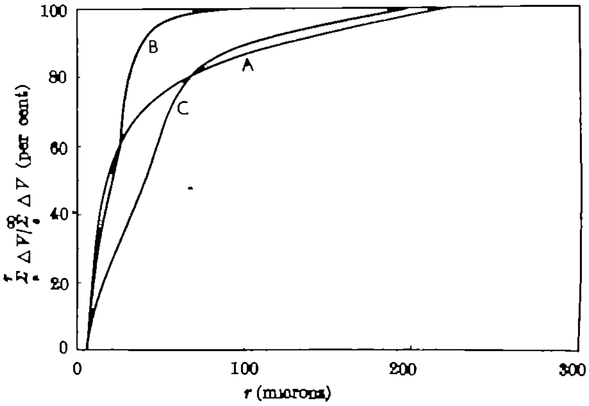
$$P\sigma\cos\beta = Ahdg,$$

where σ is the liquid-air interfacial tension and β is the angle of contact between the liquid of density d and the material from which the porous body is made. The value for A/P thus determined is equal to $r/2$ if the pores are circular in section; it is therefore implied in the sequel that the 'radius' of a pore (r) is that calculated as $2A/P$. This is in error inasmuch as the pores are not circular in section.

The smallest pore that can be determined by a capillary rise method has a 'radius' given by

$$r = \frac{2\sigma\cos\beta}{X},$$

where X is the atmospheric pressure. In order to extend the determination of the distribution of pore size to the very smallest pores, it is therefore necessary to use a liquid of very low surface tension to fill them.



(*A*) and (*B*), pores filled with water; (*C*), pores filled with acetanilide

The values of h corresponding to the values of r (5–250 μ) which commonly occur in metallic filter materials are inconveniently large if water is used as the pore-filling liquid and rises against the force of gravity.

Increasing g by means of a centrifuge enables a determination of the distribution of the pore-sizes from 7 to 250 μ (which contain more than 99 per cent of the total pore volume) to be made on a piece of porous stainless steel 10 cm. × 1 cm. × 0·3 cm. The accompanying graph shows three typical pore-size distribution curves of samples of porous stainless-steel filter materials. Curves *A* and *B* were determined by centrifuging the porous sample in the presence of a slight excess of water, which was thus distributed in the pores under the mutually opposing forces of surface tension and increased gravity. An addition of liquid oxygen by means of a specially designed funnel was made, to freeze the water in the pores while the centrifuge was still spinning. The specimen was then broken at the points h_1, h_2, h_3 . . . into previously weighed weighing bottles before the ice melted. After weighing, the water was removed from the broken pieces in an oven at 110° C. and the broken pieces reweighed to determine their water contents.

Organic compounds may also be used as pore-filling liquids. As an example of their use, the results plotted as curve *C* were determined with acetanilide. A small furnace was mounted in one of the centrifuge tubes, slip rings providing the means of carrying the heating current to it and the thermal E.M.F. from it to a pyrometer. Molten acetanilide (melting point 114° C.) was allowed to distribute itself through the pores of the metallic compact under the forces of its surface tension and the increased g due to centrifugal forces. On being allowed to cool, it solidified in position and its distribution through the metal could be determined in a manner similar to that used for the ice-filled porous metal.

A full account of this work is being prepared for publication elsewhere.

I wish to acknowledge the help of Mr. K. Simpson, who did part of the experimental work; and to thank Mr. D. A. Oliver, director of research to the B.S.A. Group of Companies, for his encouragement and support of this work.

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Stability of Lyophobic Sols

ACCORDING to Verwey and Overbeek[1], the coagulation value of various electrolytes for aqueous sols is given by:

$$c = 8 \times 10^{-22}. \frac{\gamma^4}{A^2.v^6} \text{ mol./litre,} \qquad (1)$$

where $\gamma = \frac{e^z - 1}{e^z + 1}$, and $z = \frac{\varepsilon.v.\psi_0}{k.T}$, $A = \pi^2.q^2.\lambda$.

The coagulating power of electrolytes is thus shown to depend on the electric potential on the surface of the colloidal particle (ψ_0), the valency of the coagulating ion (v), the absolute temperature (T), the number of atoms in 1 c.c. of the substance forming the colloidal particle (q), and the constant λ which appears in the equation $V = -\lambda/r^6$, giving the attractive potential due to the Van der Waals forces; ε is the electronic charge and k the Boltzmann constant. Although equation (1) is based on a rather crude physical model, namely, the interaction of plane electrical double layers, and although it has a limited range of applicability, being valid only if $d.\varkappa \gg 1$ ($1/\varkappa$ is the thickness of the ionic atmosphere and d is the mutual distance of the interacting colloidal particles), that is, for weak interaction of colloidal particles only, it nevertheless leads to a quantitative formulation of the Schultze–Hardy rule.

Wo. Ostwald[2] formulated a theory of coagulation of lyophobic sols which does not consider the mutual interaction of individual colloidal particles, but concentrates on the physical state of the dispersing medium, namely, the electrolytic solution of the coagulating ions. According to this theory, based on a careful study of experimental results, the stability of a given sol is influenced only by the 'activity coefficient' of the coagulating electrolyte. Independently of the type of electrolyte, the coagulation takes place at an approximately constant value of the activity coefficient of the coagulating ('dominant') ion. This theory, which seems to be just the opposite of the Verwey–Overbeek theory, may be formulated as follows:

$$f_0 \approx \text{constant,} \qquad (2)$$

where f_0 is the activity coefficient of the 'dominant' ion at which the coagulation takes place.

It may be of interest to direct attention to the close connexion existing between Ostwald's rule $f_0 \approx$ constant, and the results of the simplified Verwey–Overbeek theory, which according to my knowledge has not been noticed in the literature. In fact, it may be shown that Ostwald's rule follows directly from the Verwey–Overbeek theory.

For symmetrical (1–1, 2–2, etc.) electrolytes the Debye–Hückel theory gives the activity coefficient of an ionic species in water at 25° C. as

$$-\log f_0 = 0{\cdot}509 \sqrt{c.v^6}. \qquad (3)$$

Substitution of equation (1) in equation (3) gives

$$-\log f_0 = 1{\cdot}44\ \gamma^2/A.10^{11}. \qquad (4)$$

Since γ tends to unity even at moderate values of z, and A is a constant, equation (4) may be written as

$$-\log f_0 \approx \text{constant,} \qquad (5)$$

which is another form of the equation (2). Thus it is shown that, at least for symmetrical electrolytes, Ostwald's rule follows from Verwey–Overbeek's theory. The numerical value of the constant depends on the choice of the value for A. Unfortunately, Verwey–Overbeek's theory cannot give a value for A without taking into account experimental results concerning the coagulation values of electrolytes.

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Inactivation of DDT by Soils

WE have read with interest the recent communication in *Nature* from H. Maes[1]. His report of the work of I. Vincke, who has observed a rapid loss of insecticidal power of DDT on the walls of certain African houses in the Belgian Congo, provides further evidence for the sorption of DDT on lateritic soils described by us in 1951[2]. It is also useful to find described a method for preventing this loss of efficiency; but we believe that the connexion between ability of soils to dehydrochlorinate DDT at elevated temperatures and loss of biological effectiveness is misinterpreted by Maes, and that the effect of spraying walls with phosphates is not due to inhibition of decomposition of DDT.

We have shown quite clearly that loss of effectiveness of surface deposits of DDT from wettable powders on certain soils is due to sorption of the DDT, and the presence of the undecomposed insecticide inside the soil structure can be demonstrated both colorimetrically and by recovery of crystalline DDT[3]. In addition, other insecticides, which are not susceptible to dehydrochlorination, disappear from the surface of soils in exactly the same way as DDT at rates which are approximately proportional to their vapour pressures. Possibly the sorbed DDT may be decomposed afterwards, particularly under dry conditions[3]; but the reaction is very slow at atmospheric temperatures compared with the sorption process and cannot account for the rapid loss of killing power against mosquitoes. However, as Downs *et al.*[4] have shown, there is a correlation between ability to dehydrochlorinate DDT in the Fleck and Haller method and the rate of loss of effectiveness on a wide range of soils, and therefore "the reaction of catalytic decomposition at 130° C. affords a rapid method for foretelling the capacity of a soil for inactivating DDT".

We would suggest the following possible reasons for the beneficial effect of pre-spraying mud walls with phosphate solutions. The correlation found by Downs *et al.* between the iron oxide contents of soils and the life of DDT residues on these soils would suggest that it is the iron oxide which provides the active sorbing surface. The phosphate ions may react with this surface to reduce its activity. Also, reaction with the ferric ions in the soil will produce gelatinous complex iron phosphates which may actually block the fine capillaries of the mud and retard diffusion of the insecticide vapours.

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TECHNICAL AND TECHNOLOGICAL EDUCATION IN BRITAIN

IN a brief reference to the importance of encouraging technological education in his Messel Memorial Lecture to the Society of Chemical Industry last July, Sir Henry Tizard manifestly carried his audience with him when he expressed the wish for less talk about the necessity of restoring the balance of science and technology, and more action. It was then a month since Lord Woolton had made his statement in the House of Lords debate on science and industry regarding the Government's intention of "building up at least one institution of university rank devoted predominantly to the teaching and study of the various forms of technology", and it was on June 17 and June 19 that the Minister of Education had promised, in answers to questions in the House of Commons, that the Government's proposals for increased assistance for selected technical colleges and courses would be announced "in a few weeks".

A further three months have now passed, and in the meantime the latest returns from the University Grants Committee have disclosed no indication that under present conditions the proportion of students of technology in British universities and university colleges is increasing: an increase of 0·5 per cent in full-time advanced students of technology scarcely offsets a decrease of three per cent in the total number of full-time students of technology. Lord Woolton, on a previous occasion, had commented on Sir Henry Tizard's summons to a spirit of adventure in urging the fuller use of existing knowledge by British industry; and in referring to the widespread demand for a separate university of technology, he stressed the importance of technology in opening, at the Science Museum, the exhibition to mark the centenary of the birth of Sir William Ramsay. He said that much of the work of British scientific men has not been applied in Britain itself because of our failure to train and absorb into our industrial life the practical scientists we have come to call technologists. If, in the face of world competition through the application of the scientific discoveries of our time, we are to reap the national benefit that fundamental science offers us, it will be necessary to create in Britain technological universities with the status and the distinction that is given to our existing universities; and through them to train a race of people who will see that the successors of men such as Ramsay meet with the encouragement and the rewards that are proper for the services they render to the community.

It is known that Lord Woolton has been inquiring into the practical possibilities of giving effect to the Government's proposal. The choice in practice would seem to lie between building an entirely new university or expanding one or more existing institutions and giving them university status. The former course would involve a delay of five years or more before the new institution came into being, and another three or four years before it contributed to the supply of graduates. For the second course a choice would presumably be made between some of the existing major colleges of technology.

The Manchester College of Technology has submitted a strong case for making it one of the cardinal centres for supplying industry with the larger numbers of first-class technologists that are required. A statement from the governors, and approved by the Manchester Education Committee, shows that the College is already equipping itself to expand its work in higher technological education by strengthening what is already essentially the applied science department of the University of Manchester. The teaching staff is being reinforced by ten new chairs, and while extensions to the College will allow of more departments and more students, effect is also being given to long-cherished plans for decentralizing to new branch colleges much of the work below university-level.

The speed at which these plans can be executed obviously depends upon the readiness of the Ministry of Education to approve the capital expenditure involved, and the statement is worth noting as illustrating the way in which the expansion of technological education is interlocked with that of technical education, and the importance of framing policy so as to ensure that the expansion of both proceeds in step. No estimate appears to have been attempted of the desirable rate of increase in the number of technicians required by industry, although a recent paper on postgraduate activities in electrical engineering related this to the expansion of industry, and suggested that industry would require to increase its recruitment of staff from the universities and colleges by five to ten per cent per annum.

The inquiry into the relation between vocational and non-vocational studies in the education of technologists, which the National Institute of Adult Education is proposing to undertake, in co-operation with the Association of Technical Institutions and the Association of Principals of Technical Institutions, could well have some regard to the quantitative aspect also. Dr. P. F. R. Venables has pointed out that, while the inquiry particularly concerns the major technical colleges, any such investigation must extend far beyond these institutions. It has already been agreed to give the commission the most general terms of reference; and if, in fact, its inquiries extend to the training colleges of industry itself, and the residential colleges maintained by local authorities, as well as to the extra-mural departments of the universities and the educational activities of the research associations and professional institutions, it should have at its disposal much of the information required for a quantitative picture.

The statement regarding the Manchester College of Technology is also worth noting, because it indicates that, whatever choice may be made as to the college selected as nucleus for the new institution, assuming the idea of an entirely new university is rejected, the expansion of these major colleges of technology and of the existing university departments of technology is also essential. They have a vital contribution to make, not only while the new institution is being built up but also as a permanent element in higher technological education. The figures recently published by the University Grants Committee show clearly that so far as numbers of students are concerned, the expansion of existing university departments of technology could probably be pushed as far as Sir John Cockcroft has suggested without distorting the balance of studies. Whether, from the point of view of avoiding wasteful duplication of expensive equipment or those other considerations which Prof. A. R. Ubbelohde has stressed, it would be desirable to go quite so far is another question.

It does not appear, however, why there need be much delay in making the necessary preliminary decisions, such as the location of the new institution and the approximate scale on which it is to be planned. Without prejudice to the merits of the case for the Manchester College of Technology—and the arguments for making it the nucleus of the new university of technology are by no means as convincing as those for the expansion at present projected by the governors, largely because of doubts as to the existence of sufficient room for expansion on the university scale—Manchester had every reason to expect some further statement from the Government when Lord Cherwell and Miss Horsbrugh received the honorary associateship of the College at the commencement of its jubilee celebrations on October 11 Lord Cherwell, in Lord Woolton's absence through illness, said nothing further about the Government's plans for higher technological education, either in relation to the Manchester College of Technology or regarding the new institution. Miss Horsbrugh quite properly disclaimed any responsibilities for highe technological education, but maintained her silenc as to the plans for technical education, which is stil a responsibility of her Ministry. Whether or not th occasion was appropriate for a general statement o technical education, the delay has now far outru any reasonable interpretation of the "few weeks claimed by the Minister in June.

That delay must in itself affect the execution o the plans for the expansion of the Manchester Colleg of Technology. These plans, as already noted, contemplate the decentralization to subordinate centr of some of the more elementary work. Colleges technology cannot give full scope to the mo advanced work, and particularly postgraduate studi and technological research, the importance of whi has rightly been stressed so strongly in the curre debate on technological education, if they are at th same time to house elementary technical studies. may not, indeed, be a wise step, either at Manchest or elsewhere, to divorce the colleges of technolog entirely from work of a non-university standa although if provision is made for part-time studen from industry, the drawbacks of making such colleg exclusively university bodies should be minimized.

To establish satisfactory relations between high technological education and the industrial world i vital matter ; much must depend on the co-operati of industry. One of the assets of existing institutio like the Royal Technical College, Glasgow, Imperial College of Science and Technology, Lond and the Manchester College of Technology is that th have already established links which should be p erved and are indeed capable of extension. There , however, a quantitative aspect also, and it is his that shows up the weakness of the present rrangements for technological and technical educaion in Great Britain.

The colleges of technology cannot divest themelves of their present responsibilities for technical ducation, until alternative arrangements have been nade for the education elsewhere of the technicians nd craftsmen required in even greater numbers than echnologists, and whose supply must expand in roportion as that of the technologists increases. 'hese arrangements remain, however, the responsbility of the Minister of Education; and although hat Minister will cease to be responsible for such of he colleges of technology as are given the academic reedom generally agreed as essential in higher techological education, it has not yet been made clear vhere the responsibility for the latter is to rest.

Meanwhile, the unsatisfactory nature of the resent position and the desirability of placing the esponsibility for the general supervision of higher echnological education unambiguously on the same ody that is responsible for watching over the niversities is emphasized by such piecemeal action s that at Loughborough College. While the Minister f Education dallies in announcing a general policy, he has relieved the Leicester Education Authority of esponsibility for maintaining the engineering and cience departments of Loughborough. These lepartments will now be organized as a separate stablishment, to be known as the Institute of Technology, Loughborough College, maintained rincipally by a grant from the Exchequer. The Minister has set up a governing body which became esponsible for the Institute as from September 1; ut it is not clear whether the new institute will have the academic freedom of a university institution r whether it is primarily a technical rather than a echnological institute. What is manifest is that the levelopment should have followed, rather than receded, the Minister's statement as to general olicy. The development will not diminish the videspread concern that both in technological and in echnical education Government aid will be spread oo thinly over too many institutions. When esources are limited, it is imperative that they should e distributed in accordance with a clearly and careully thought-out policy, and not in response to articular representations.

It is impossible, therefore, to regard Miss Horsrugh's remarks on October 11 with any satisfaction. A clear statement of policy is long overdue, and vague ssurances of doing her best to meet the needs of oth university and non-university work at Manhester and to help the Manchester Education Authority with its plans to build new local colleges re not enough. Some clear thinking is also required s to how and where to meet the needs of the partime students to which Mr. David Cardwell, acting rincipal of the Manchester College of Technology, eferred. Particularly at the present time, such tudents offer a promising means of securing that ubstantial increase in the number of graduates in technology which is so urgently required. Whether this could contribute towards an increase in post-graduate students and research workers in technology may require examination. Much would depend on the co-operation of industry; but so far as the remedying of Britain's weakness in the pursuit of technological research in academic institutions is concerned, Mr. Cardwell possibly put his finger on the real weakness in referring to the need for research grants. These clearly should not be expected to come from the local authorities, and if they are to come from the Exchequer, there is the more reason for giving the technological institutions concerned the independence and academic freedom necessary for the prosecution of research under the guidance of staff of the right calibre.

No one would suggest that, once the Government has made clear its plans for the expansion of both technological and technical education, the execution of those plans can be anything but a slow process. The concentration of technological education in a relatively few institutions, and the divesting by those institutions of their responsibilities for technical education, are bound to be gradual and may be protracted. The upgrading of the selected technical colleges in itself requires time. As an article "Education for a Scientific Age" in *The Round Table* recently observed, in this connexion, status and prestige cannot really be given: they must be won. It is likely to take some time before the degrees and diplomas granted by the upgraded colleges will be recognized as of the same value as those of a university.

Progress clearly depends largely on the calibre of the staff that the technical colleges are able to attract; they must be able to offer the conditions of academic freedom and salary that characterize a university institution, and this is one reason why early decision is imperative. Until policy is announced, the formulation of plans cannot proceed, and waste and frustration are likely to persist, to the detriment of that large measure of agreement which has already been reached as to the lines on which technological education should develop. Even the expansion of the university departments on the lines suggested by Sir John Cockcroft is likely to be hindered until the University Grants Committee has received such guidance from the Government.

Indecision in this matter, moreover, is a great handicap to the task of educating public opinion, which was so strongly urged in the last report from the Advisory Committee on Scientific Policy. Decision on the part of the Government is the first essential; given that, there is no reason for anticipating further delay on the part of the institutions concerned in giving effect to the policy formulated. It is to be hoped that in both Houses of Parliament early opportunity will be taken to press the Government on the matter, and that the pressure will be maintained until a decision is announced. On the Government's own showing, the whole question is too important to the future of Britain to be allowed to remain indefinitely in the position when a change of Government could once again throw the whole matter into the melting-pot.

PROGRESS IN COSMOLOGY

Cosmology

By H. Bondi. (Cambridge Monographs on Physics.) Pp. ix+179. (Cambridge: At the University Press, 1952.) 22*s.* 6*d.* net.

IN his presidential address to Section A (Mathematics and Physics) of the British Association in 1888, G. F. FitzGerald suggested that "a successor in this chair might well devote himself to a review of the cosmical theories propounded within the last few years". He added, "The opportunities for piquant criticism would be splendid". Since there seems never to be lacking a supply of these theories produced "within the last few years", there is naturally not lacking a number of men of science still sharing FitzGerald's attitude towards them.

Criticism there must, of course, be. But the important thing is that general progress is being made in the study of the large-scale problems of the physical universe. Observational evidence is accumulating; this in itself is almost inevitable, but there is also progress in appreciating its relevance and significance from a general physical point of view apart from highly specific theories. On the side of the theories themselves, much has been learned that could be discovered only by the actual working out of the results of their attempted application to the cosmological problem; each serious new theory seeks to overcome the difficulties encountered by its predecessors. In the course of the work, much has been learned, too, about various general physical theories as such, apart from this particular application. Some theorists would claim that fundamental insight has been gained into the origin of laws of Nature. Above all, the main problems to be solved in cosmology are becoming more and more clearly formulated; and, though the theories differ greatly in their ways of getting results, when due regard is paid to the features common to the results themselves, definite progress towards the solution of some of these problems can undoubtedly be claimed.

As a masterly account of this whole state of affairs, it is hard to imagine anything that could be better than Mr. H. Bondi's book. By the exercise of the greatest skill in marshalling his material and of the utmost clarity of expression, he succeeds in making his account effectively complete without any sense of undue compression. Also, he does not shirk the exposition of what is essential in the technicality of the work, while always giving primary attention to the concepts involved.

Though scrupulously fair to other theories, Mr. Bondi naturally states his preference for the "steady-state" theory of cosmology, with its concomitant hypothesis of the continual creation of matter. This theory was originated by him and T. Gold in 1948. They did not claim that it *must* be correct, but Mr. Bondi points out the extreme epistemological difficulty in the way of any fundamental progress if it is found to be false. Actually, it does seem to give a better account of the large-scale behaviour of the universe than does any previous theory. However, it encounters the obvious trouble that the universe does not conform strictly to the "perfect cosmological principle", from which the theory is derived, though there is no evidence that it does not conform statistically. F. Hoyle's alternative approach, originally published about the same time, is more satisfactory from this point of view, but Hoyle was not so concerned to deal with the epistemological situation. All this is clearly explained in the book.

It seems to me that the relationship between the procedures of Bondi and Gold and of Hoyle indicates the way in which further progress may be expected. They illustrate the "deductive" and "extrapolating" procedures so well distinguished by Mr. Bondi (p. 5). Whereas in the past this distinction has been ill-recognized and has resulted in fruitless controversy, we now have an instance of the procedures tending to consistency. A fundamental examination of the conditions for consistency of the two types of procedure is required and may yield the next advance.

W. H. McCREA

AMPHIBIANS OF WESTERN NORTH AMERICA

Amphibians of Western North America

By Robert C. Stebbins. Pp. xvii+539 (64 plates). (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1951.) 56*s.* 6*d.* net.

IT is refreshing to find an author who makes no pretensions to writing for the benefit of some section of his fellow men, but says with simplicity, "I have put into the volume what I have wanted to know . . .". The result reveals Mr. R. C. Stebbins as a naturalist, and for anyone who, like him, wants to know not only what amphibians occur in western North America but also, and above all, how and under what conditions they live, the book provides a great many answers; it also provides a wealth of comparative information for others of similar bent but concerned more directly with other geographical regions.

As a member of the staff of the Museum of Vertebrate Zoology of the University of California, the author is an experienced taxonomist, and the framework of the book is the taxonomic arrangement of the animals. There are keys, accompanied by explanatory diagrams, for the identification of the animals both as adults and larvæ. Species and subspecies are described and figured, and their general and local distribution indicated and mapped. Then, for each form, there are extensive notes on its behaviour, habitat, food, reproduction and so forth. These notes are based on the author's personal observations or are taken from impeccable sources, many of them hitherto unpublished. Twelve plates show typical habitats, and there is a glossary of technical terms as well as an index.

No book of this kind can satisfy everybody. Those whose interests are mainly ecological will doubtless regret the absence of physical data relating to the different types of habitat, information regarding predators, parasites and so on. Others, more taxonomically inclined, will wish that more had been said about the very interesting phenomenon shown by the salamander *Ensatina eschscholtzi*, where the end-terms of two subspecies chains, deriving from a common stem, meet and behave as distinct species; that more, too, had been said about the discontinuous distribution of *Ambystoma tigrinum* and its causes, and that genera and subgenera had been less capriciously treated. But apart from such matters of scope and emphasis, there are few serious defects for criticism. The segregation of the illustrations of the larvæ and of the distributional maps away from the main accounts of the species has the advantage of facilitating direct comparisons but little else to recommend it. Some may also find it a nuisance that habitats are sometimes described in terms of life-zone concepts (for example, Sonoran, Hudsonian, Arctic Alpine) that are not defined in the book, rather than in terms of the natural vegetation the distribution of which is mapped (Plate 47).

There can be no doubt of the quality of this book with its reliable information and excellent illustrations, and equally there can be no doubt that its publication will stimulate studies that must result in an increased knowledge of a group of animals still relatively little known. H. W. Parker

SCIENTIFIC PRINCIPLES OF FURNACE TECHNOLOGY

The Science of Flames and Furnaces

By M. W. Thring. Pp. xiv+416. (London: Chapman and Hall, Ltd., 1952.) 42*s*. net.

THIS book is a useful contribution to the scientific study of flames and furnaces, a subject in which a fairly extensive background of applied science already exists, but is not readily accessible to the average reader of the subject. Furnace design is a somewhat specialized subject, and furnace practice is almost every industrialist's concern. Nevertheless, the systematic treatment of the subject in text-books has been curiously enough neglected. It would be unfair, however, to claim that furnace technology is therefore backward, though frequently such criticism of modern furnace development has been heard. In point of fact it is commonly the rule in the technology concerned with the development of valuable industrial plant that practice is in front of the text-book exposition of the subject. In the present case, however, as the title of the volume indicates, the author is concerned with the science rather than with the technology of the subject.

The introductory chapters are devoted to the heat liberation from the flame and the subject of heat transmission. Novel features deal with the interpretation of the second law of thermodynamics in terms of what has been called the 'virtue' of a system's energy, and a more than usually complete treatment of the subject of flame radiation. One doubts whether the introduction is necessary of such special terms to define the obvious value of the heat potential of the fluid above the levels of temperature in the furnace. Indeed, such may even lead to confusion of ideas. Useful summaries of recent experimental work in furnace investigations, in heat transmission and in the determination of thermal constants are given. These constitute perhaps the most valuable features of the work. Again, under the somewhat pedantic title of "Aerodynamics of Hot Systems" are included those sections of the work which describe the science of draughting of furnaces and of jets of hot gas. This chapter comprises a good collection of references, but resembles so much a series of notes and mathematical formulæ, signs of a worthy effort to collect as much information as practicable into a limited number of pages, that the reader is left with the feeling that for an effective understanding of the subject he must still consult the original papers. The chapter purporting to cover the science of furnace construction is mainly devoted to refractory and insulating materials. It is so condensed that it serves only to give guidance to a very limited series of references.

The final chapter on scientific method is a valuable and suggestive one.

The paragraphs are numbered in the manner of the Cambridge mathematical texts. It is doubtful if the average reader takes much notice of the numbering, but he will profit from the useful summaries at the ends of the chapters. This may in some degree compensate for a somewhat meagre index. The book is well produced, the printing clear, and the illustrations legible.

ORNITHOLOGY OF THE CHANNEL ISLES

The Birds of the Channel Islands

By Roderick Dobson. Pp. xvi+263+25 plates. (London and New York: Staples Press, Ltd., 1952.) 30*s*. net.

IN the middle of the last century a great change began to take place in the use of the land in the Channel Islands, owing to the development of early fruit and vegetable growing for the London market. This necessitated the cutting down of orchards to make room for glass-houses, the draining of wet ground, and clearing of rough areas for early potatoes. Unfortunately there is little information as to the status of the resident species, or summer visitors, previous to 1866 when Cecil Smith published his "List of Birds . . . Summer Visit to the Channel Islands, exclusive of Jersey", which was amplified in his "Birds of Guernsey" (1879). Some species have ceased to breed owing to the increased utilization of the land, and others from some unknown cause. The choughs, for example, were common in Guernsey in 1878, in Alderney they ceased to breed in 1876, in Jersey in 1880, and in 1929 a pair were seen in Guernsey—the last record for the Channel Islands. In the British Isles the increase of jackdaws is sometimes blamed for the decrease of the chough; but in the Channel Islands jackdaws were never very abundant and have now decreased, and only a few nest in the western half of Jersey.

It is interesting to note that during the German occupation carrion crows, which in the breeding season were formerly confined to the cliffs, began to nest in woods and trees inland. This was owing to all the farmers' guns having been confiscated. During the same period the Germans felled many of the tall trees in the sheltered valleys, with the result that in a year or two the undergrowth increased and blackcaps and garden-warblers began to nest again, which they had not done for many years. On the cliffs and rocky islands around Guernsey and the other main islands, many kinds of sea-birds breed and, during the Second World War, an additional species--the gannet—established colonies on the rock of Ortac and Les Etacs, off Alderney.

The information about each species is arranged in this book under the four largest islands, and in some cases the available information is rather meagre; nevertheless this is a valuable contribution to the ornis of the Channel Islands, and no doubt in a future edition there will be many additions to the list of species, especially among the migrants. There are a number of photographs of various birds, nests and well-known breeding places.

UNIVERSITY BOTANICAL TEACHING AND TRAINING

IN *Nature* of April 28, 1951, the leading article raised the importance of university departments of biology (both botany and zoology) for the training of biologists to satisfy the needs of the modern State. We then pointed out that among those working in the wide and varied field of applied biology there was a general conviction that Great Britain and the Commonwealth was suffering from a dearth of plant and animal physiologists. This article inspired Sir William Slater to write shortly afterwards (*Nature* of June 2, 1951) to point out that the Agricultural Research Council was seriously concerned about the shortage of animal and plant physiologists with an adequate knowledge of chemistry and physics and of biochemists with biological experience, and to emphasize the important efforts which the Council was making in this direction.

This adds point, therefore, to the discussion organized by Section K (Botany) of the British Association on September 5 at Belfast. The discussion is fully reported in the following columns by Prof. L. J. Audus. The three main contributors to the discussion—Dr. Eric Ashby, Dr. W. B. Turrill and Mr. Peter Bell—raised issues of the utmost importance. We felt, however, that this was a very important discussion, and that it, like most discussions in connexion with which no special invitations to speak had been accorded to anyone other than the readers of the main papers, might prove to be an unbalanced review of authoritative opinion throughout the country, in spite of the fact that a number of botanists contributed useful points after the papers had been read.

So it was decided to approach a number of other botanists who either were not present at the discussion, or, if they were, did not speak, to contribute their views now. Copies of Prof. Audus's report were sent to them and their comments follow the main report here. In most cases, no department of botany was approached if one of its members had spoken at the Belfast meeting. It should be pointed out, however, that Prof. Audus himself was invited to submit a written comment, since, with the aim of making his written report as objective as possible, he did not speak at the discussion itself. A few authorities, for specific reasons, preferred not to contribute to this discussion.

Although in most cases the head of the department was originally approached, and in some cases it seems that he consulted his assistants, it should not be taken for granted that any one contribution is the considered opinion of the entire department concerned.

It will be noted, as one might expect, that the opinions expressed indicate that the problem is heterogeneous; for example, the small department has problems which the large department does not have to face. Moreover, individual authorities raise special points. But apart from this, there are several general themes which have been brought out, and these might with advantage be given careful consideration by all university and college departments of botany.

The British Association Discussion

THE rapid expansion of botany as a university subject in recent years and its growing importance in a world faced with grave food shortages has recently caused university staffs to reconsider whether present degree courses are suited to modern needs. A whole morning's session in Section K (Botany) of the British Association was devoted to "The University Training of a Botanist" at the Belfast meeting on September 5.

DR. ERIC ASHBY (QUEEN'S UNIVERSITY, BELFAST), who opened the discussion, explained that the purpose of his paper was to examine the botanical curriculum, its determining factors and the case for its reform. To keep the discussion within bounds it was necessary to limit its scope to honours courses in botany considered solely as a training for professional botanists (not including school teachers).

The curriculum should be influenced by: (1) the corpus of botanical knowledge and fields of current research; (2) the requirements of employers; (3) the aptitudes of students. Other 'illegitimate' influences, for example, the bias of university staff and inertia of examiners, would be disregarded.

(1) The corpus of botanical knowledge has changed enormously since 1900. From 1900 until 1910 it was sufficient only to know botany in order to understand any botanical research paper. From 1940 until 1950 many papers could not be understood without some knowledge of chemistry, mathematics and physics. The change was illustrated by a study of examination papers over the past fifty years. Thus the examinee of 1950 was expected to answer some 95 per cent of questions set forty to fifty years ago, whereas an examinee of 1900–10 could not have attempted some 40 per cent of the 1950 questions. By and large, honours botany curricula still contain as much comparative morphology, etc., as they did in 1910, while genetics, much more physiology, ecology and cytology have all been squeezed in without any lengthening of the course.

At the research-level the classical problems are still relevant and no nearer solution than they were fifty years ago, and we would do a serious disservice to our subject if we discarded those problems or no longer taught the raw materials necessary for thinking about them. Meanwhile most botany research workers prefer fields where solutions are easier to obtain, as is shown by the type of research taken up by British postgraduate botany students in 1951 (University Grants Committee data), that is, taxonomy 8; genetics 30; ecology 16; physiology 22; pathology 16; mycology 14. Thus the content of botany has enormously enlarged, yet the material included fifty years ago cannot be entirely discarded. This is the dilemma of the botanical curriculum.

(2) Universities are primarily institutions for training professional men and women. In 1900 most botanists were employed by universities, herbaria and botanical gardens. To-day there is a much wider range of employers. Apart from the teaching profession, the biggest employer of botanists is the Government (Agricultural Research Council and

Department of Scientific and Industrial Research), then the Colonial Service and then the universities. Demands are for physiologists, biochemists, pathologists, plant breeders and experimental ecologists. In 1950 the Ministry of Labour and National Service published a pamphlet stating that over the period 1950–54 the supply of honours botanists was likely to be about twice the demand. Although these demands were probably underestimated, yet even with adjustments the figures are disturbing. Notwithstanding this threatened excess, bodies like the Agricultural Research Council and the Colonial Office cannot get recruits of the right calibre or training for their vacancies [see also *Nature*, 167, 659 and 908; 1951]. The majority of honours botanists that apply can discuss at length the classical problems of morphology but cannot, for example, design the simplest field experiment in agricultural botany. They are therefore of no use to these principal employers.

(3) The aptitudes of botanical students have changed in the last fifty years. On the whole, in 1900, botanical students were naturalists. They had, therefore, good visual memories and enjoyed the techniques of evaluation as contrasted with measurement. But most modern botany students are fundamentally not naturalists. By temperament and aptitude they are experimentalists. For them field-work is difficult, and they must learn their plants anew each year. They are uninterested in the arguments of classical botanists. These two kinds of student are as different as chalk is from cheese yet we are forcing them both into the same mould. The born taxonomist ploughs his way in misery through the tortuous paths of metabolism. The born physiologist suffers resignedly the unconvincing arguments of the morphologists. It is our duty to change the curriculum to meet the needs of both these types of botanist.

The conventional adjustment of the curriculum is usually to reduce the number of types, to skimp reading of classical papers, to cut practicals but never to leave even one group out. As a guide in making reforms, however, one should take as a model the techniques of the classics curriculum. There seem to be two principles involved. The first is to select a few authors and to study them exhaustively until one lives in the climate of their thought; the second is to ensure complete familiarity with comparatively few works of genius. The power of classical education depends on this second principle. This contrasts strongly with the principles underlying an honours course in botany. Here insistence on some contact with every aspect of the subject inevitably means that only the most superficial consideration can be given to any one subject and nothing can be studied exhaustively and really understood. On the experimental side this is particularly marked, and is positively harmful, for it misses the main point of experimental work, that it is not always successful and that the experimenter has to repeat and repeat until results are consistent. Furthermore, one can graduate well in botany without ever having opened a book by Darwin or read a paper by Sachs or F. F. Blackman, but not if one has omitted to struggle through a score of books by industrious but negligible writers just because they contain the most recent information.

Dr. Ashby next turned to some practical proposals He first assumed that it is not possible on economic grounds to lengthen the honours botany course. This means that something must be omitted. The first omission should be compulsory zoology. Although it might be desirable for school teaching and certain very specialized jobs, the professional botanist has far more to learn from the chemist, the mathematician and the physicist. In the first post-intermediate year let all botanists do the same general course. The non-experimental botanist, who is easily distinguishable even at this stage, should take in addition geology and some zoology, while the experimental botanists should take instead chemistry and physics. In the second and third post-intermediate years they should be separated into two streams. The non-experimentalists would take anatomy, comparative morphology and evolution, taxonomy, floristic plant geography, genetics; together with geology, some zoology and some climatology. The experimental botanist would take anatomy, physiology, experimental ecology, genetics, plant pathology, mycology; together with chemistry, biochemistry, physics (properties of matter and some physical techniques), elementary mathematics and statistics. This would leave time for work to be done with a precision and thoroughness not devoted to it for forty years. It would, indeed, turn out botanists who had never 'done' the vascular cryptogams except in an elementary course and others who would not be able to read a modern paper on photosynthesis; but it would produce a taxonomist who has spent time on palæontology instead of wasting it on fat metabolism and a physiologist who knew enough physical chemistry to understand fully modern papers on salt absorption, etc.

DR. W. B. TURRILL (THE HERBARIUM, ROYAL BOTANIC GARDENS, KEW), who followed, confined his attention to the teaching of angiosperm systematics. He was tempted to suggest that taxonomy could not be taught. What can be done is to train the student to teach himself However, the attempts that had been and still were being made to do so could be classified under six heads.

(1) The direct method of selected 'type' families, which is extremely dull.

(2) The historical method, which is wasteful of time as a basis for modern teaching.

(3) Philosophical method. This could be properly effected only with students already possessing considerable experience.

(4) Phylogenetic method. This is the easiest method to teach; but the dangers are that speculations would be taken for established fact.

(5) Practical. Here there are several different approaches; but in all it is essential that the student shall handle material himself and learn to work out characters, constancies and correlations from specimens and not from lecture notes. Advantages are that learning is easy, initiative is at a premium and the research habit is developed.

(6) Synthetic method. This is the method for the future whereby all the good points under the preceding five headings are combined and the bad ones are eliminated. How far is this synthesis possible?

There are clearly two types of botanist, taxonomist and non-taxonomist; but the latter should have a sufficiently wide knowledge of taxonomy to be able properly to appreciate its purpose, methods and problems. Taxonomy cannot be learnt by the 'type' method. Its very essence is the detection of correlations. Selection of material is essential; but too early specialization must be avoided. Early on, the need for a universally recognized system should be simply explained and theories concerning it briefly outlined. Students should then be turned loose in the field with a flora to work out the plants of an area for themselves. Later there should be concentration on a few families limited to the local flora: not as 'types' but for the study of character evaluations, correlations, variation and reticulation. Then there should follow the study of a single genus in detail, perhaps extended to extra-British species.

Since the British flora is too limited to furnish a full appreciation of variation of structure and behaviour, serious study should eventually be made of at least one tropical family.

Detailed theories of classification should be deferred until the student has acquired sufficient facts to appreciate the linkage of practice and theory; but suggestive generalizations should be introduced gradually as factual knowledge grows, and to this end modern methods and detail should replace historical subjects. An experimental garden is essential, since in it students can learn much of fundamental importance, such as distinctions between phenotype and genotype, character plasticity, genetic isolation, etc. The study there of species problems will lead to integration of orthodox taxonomy not only with morphology but also with all that is latest in plant physiology.

The number of posts for professional taxonomists is limited. Only those students who have a definite flair for it should be encouraged to take it up as a career. Only a few universities are at present equipped to give the necessary specialized training. Other university departments of botany should aim at giving their students a sound general training, as already outlined, and leave specialized training to a postgraduate apprenticeship period at some centre of taxonomic research.

MR. PETER BELL (UNIVERSITY COLLEGE, LONDON) regretted the omission from Dr. Ashby's paper of aspects of training bearing on the teaching of botany in schools, since most present-day students came up lamentably equipped for a modern course in botany. The analysis of subjects chosen for research by recent graduates was of no significance in the discussion, since such choice was dictated primarily by the availability of money for specific subjects.

He could not agree with Dr. Ashby that the specific requirements of government departments for special types of botanist should be allowed to influence the content of an honours degree course. He did, however, agree with his two principles of teaching, that is, doing a few things well and becoming familiar with the workings of powerful intellects. This first principle was frequently adopted in morphological teaching. The difficulty of dealing with the second would be to decide who were the great minds in the botanical world.

Turning to Dr. Ashby's concrete suggestions for reform, he held that students could not be divided readily into "naturalists" and "experimentalists". There was a complete dovetailing of both these aspects over the whole field of botany. Up to graduation the botanist's training should therefore be general, and special accessory knowledge for experimental research, for example, statistical methods, physical chemistry, etc., should be picked up when the need arose in postgraduate years. A general view of the advances in the whole subject was essential for anyone attempting research in botany.

In the informal discussion which followed, most of the speakers agreed that Dr. Ashby's suggested reform required specialization at much too early a stage, before students could be reasonably expected to have decided precisely what aspect of botany they wished to follow.

DR. H. HAMSHAW THOMAS (CAMBRIDGE) said that botany courses could and should provide a real intellectual training for students, by no means all of whom were destined to become professional botanists. This should include the writing of clear and intelligent English and an appreciation of the meaning and implications of words. He hoped that Dr. Ashby's suggestion that we might profitably copy the excellent teaching methods of the classicists would be given careful attention.

PROF. JOHN WALTON (UNIVERSITY OF GLASGOW) said that the training of research workers in a special line should be left to the Ph.D. period, when they should take courses in those allied subjects that they specially required, for example, biochemistry, statistics, genetics, etc.

DR. JOHN RAMSBOTTOM (FORMERLY BRITISH MUSEUM (NATURAL HISTORY)) pointed out that botanical courses were designed originally for teaching botany as a discipline, almost entirely to intending teachers, and were correspondingly stereotyped. This tradition persisted. Before steps were taken, however, to make it difficult to study botany as a whole, an effort should be made to produce a more balanced and realistic syllabus.

DR. J. L. CROSBY (UNIVERSITY OF DURHAM) said that the history of botany should be an important part of any university course in order to understand how ideas have developed and to obtain full benefit from the botanical classics.

DR. J. HESLOP HARRISON (UNIVERSITY COLLEGE, LONDON) found it difficult to accept Dr. Ashby's proposition that botanical science could be divided into experimental and non-experimental. If those botanists who are to tackle the unsolved classical problems are to be segregated early from the physiologist stream, then this is the way to ensure that those problems are never solved. Little can now be expected from purely observational methods, and the past forty years have shown us that progress with these problems can best be achieved by application of experimental techniques by those trained in physiology. Specialization must therefore be deferred at least until the student has gained some appreciation of the science as a whole, which is usually not until he has graduated after a broad general honours course.

DR. P. F. WAREING (UNIVERSITY OF MANCHESTER) suggested that 'botanists' did not appreciate the real point at issue. The modern plant physiologist requires a knowledge of very advanced chemistry and this cannot be 'picked up' when needed after graduating. Dr. Ashby's scheme was to meet this difficulty, and so far no other practical alternative had been suggested.

The student point of view was put by MR. J. E. DALE (KING'S COLLEGE, LONDON), who said that the good student would plan his own course of study, irrespective of academic direction. He is the person who ultimately decides where and when specialization will start.

DR. W. MATHIAS (UNIVERSITY OF LIVERPOOL) was sympathetic with the view expressed by Dr. Hamshaw Thomas that a university training should be non-vocational, but how many present-day students are stimulated by considerations other than vocational?

Dr. Ashby replied to the points made during the discussion. He said that the chief objection raised against his suggestions was that they involved specialization at too early a stage in the botanical course. But the honours student is committed to early specialization in any event; and it was therefore necessary to weigh its drawbacks against the advantages of a thorough training. L. J. AUDUS

Further Contributions

PROF. L. J. AUDUS, BEDFORD COLLEGE, UNIVERSITY OF LONDON

The modern professional botanist, whatever his particular specializations, must possess a proper appreciation of modern concepts on form and function in the plant kingdom. For this he needs, in addition to his general botanical training, a thorough grounding in chemistry, physics and mathematics and a knowledge of certain aspects of these subjects as deep as that possessed by the relevant specialist. In addition, the experimental botanist entering Government or Colonial Service needs a knowledge of special techniques that can be neither quickly nor easily acquired. It is altogether too optimistic to suggest that all this can be squeezed into a three-year honours course, even with the modifications and omissions proposed by Dr. Ashby.

A fourth postgraduate year for specialized training is essential if we are to avoid turning out mere 'technicians' as a result of too early and too narrow a specialization. The courses in the three pre-graduate years need not differ in structure from those at present in operation except that physics and chemistry of an appropriate type and standard should be obligate subsidiary subjects. Specialization in botany should not be carried quite as far as it now is in some honours schools, but extra time should be devoted to particular associated techniques, for example, statistics, etc. In the postgraduate year the specialization could be as extreme as the particular types of training demand and could terminate in an M.Sc. by examination. The school teacher would, as now, follow the course up to the first-degree stage, and this would avoid the invidious distinctions, implicit in Dr. Ashby's suggestions, between professional botanists and school teachers, whose prestige has already fallen dangerously low. We must nurture our prospective teacher on the same interesting diet as we nurture our prospective research workers or we destroy at the source the interest and enthusiasm of our future professional botanists.

PROF. T. A. BENNET-CLARK, F.R.S., KING'S COLLEGE, UNIVERSITY OF LONDON

IT was evidently suggested by many speakers that Dr. Ashby's proposed reforms required specialization at too early a stage, and the astounding view was even expressed that "physical chemistry, etc., could be picked up" after graduation. Incidentally, why not pick up extra morphology after, rather than before, graduation?

All this reads like the most unwelcome proposition that pure botany is more desirable academically than a broadly based scientific training with appropriate chemical, physical and biological disciplines. To regard this pure botany as less specialized than Dr. Ashby's experimental course is incomprehensible.

The narrow specialization of the botany of fifty to sixty years ago represents a very arbitrary segregation of a single compartment of natural knowledge largely determined by the direction of research in the eighteenth and early nineteenth centuries. It is no longer a very convenient subdivision, if students are to be forced by syllabuses or regulations to remain confined within it, when current research advance is in the so-called borderline sciences. My support for reform on lines like those suggested by Dr. Ashby is based on the belief that such reform could permit less specialization than frequently occurs now and that it should also blur the very arbitrary sharp boundaries between the sciences. Different universities would no doubt attempt different patterns of reform to permit easy integration of the basic sciences.

PROF. G. E. BRIGGS, F.R.S., UNIVERSITY OF CAMBRIDGE

The system of training botanists which Dr. Ashby criticizes and that which would result if his amendments were adopted are different from that which has developed at Cambridge. As it has been intentionally adjusted from time to time as the subject has developed, it may be useful to others to describe its present state.

During his first two years a student must read at least two other sciences chosen from a wide range, including mathematics, the only restriction being that of the time-table. For example, he can combine chemistry, physics and mathematics with his botany or he may read zoology and geology. A common combination is botany and zoology with organic chemistry and biochemistry, the two latter together counting as one subject. In his third year, when he reads only botany, he is encouraged to attend lectures and practicals in all branches; but the examination allows for specialization.

The bias of the university staff is allowed to have an influence. No attempt is made to cover the whole field of botany, nor do we try to deal with all the sub-sections of a section such as plant physiology. By dealing with the parts of which he has special knowledge, the lecturer hopes to form habits in the student which will be generally useful to him at a later stage.

PROF. A. R. CLAPHAM, UNIVERSITY OF SHEFFIELD

Dr. Ashby is surely incorrect in saying that "by and large, the honours botany curricula contain as much comparative morphology, etc., as they did in 1910": there are several university departments in which only one or two selected groups are treated in the old detail, the time so saved being devoted to modern branches of botany, experimental or non-experimental. I agree with him that honours courses should not be lengthened; but I agree with Dr. Peter Bell and others that there should be no division of the undergraduate class into 'naturalists' and 'experimentalists'. Students cannot be clearly divided into such categories, and they should not be obliged to make the implied decision before they take their first degree. I have known many whose primary interests were taxonomic or ecological but who were either experimentalists by inclination or who at least recognized the desirability of a training in experimental attitudes and techniques. Such men ensure that no branch of botany remains non-experimental, and they contribute in a most valuable way to botanical progress.

It is, moreover, undesirable that there should be any lessening of the opportunities for contact between honours students of diverse interests, for this contact plays an important part in undergraduate training. The experience of many botanical departments is that it is not difficult, by the careful designing of courses and examinations, to continue to give a wide botanical training and yet to foster special interests to an adequate extent. If these courses remain at their present length there is time for narrower specialization in postgraduate courses of training in research.

Prof. Ronald Good, University College, Hull

Many will agree with Dr. Ashby's diagnosis that the problem now facing teachers of botany in universities is due partly to the growth in content of that subject and partly to a tendency for it to become increasingly vocational, though how far the former reflects the latter may be more debatable. It is often suggested that some reduction of the burden by a process of sub-division or dichotomy has become inevitable, and it is therefore important to remember that there is more than one way in which this might be achieved. That most commonly mentioned is by division on the basis of subject-matter, which may be called the 'physiology or morphology' point of view, but there is also the possibility of making the division more clearly one between the academic and the technical.

The real trouble is that at present the fiction that the whole subject of botany can still be taught in a single manner for all purposes results in too frequent failure to do the thing which matters most, namely, to provide, in Dr. Hamshaw Thomas's phrase, "a real intellectual training for students". Might not the inevitable dichotomy be better made between students rather than between parts of their subject, so that the training of those with greater natural scientific aptitude might be different from, and perhaps more academic than, that given to those whose gifts lie more in the application of knowledge ? If this is indeed the direction in which a solution of the problem is to be found, however, then one cannot but wonder how long a design of higher education which contains only one pattern of university institution and but a single system of degrees will continue to be entirely sufficient.

Prof. F. G. Gregory, F.R.S., Imperial College of Science and Technology, London

In recent years botany has developed rapidly as an applied science: in (*a*) pathology, (*b*) plant breeding, (*c*) agronomy or crop physiology. Meanwhile botany remains as before a pure science embracing anatomy, morphology, systematy and physiology. The curriculum should be adjusted to both these needs. It will inevitably be influenced by the interests and capabilities of the teaching staff.

Dr. Ashby's suggestions for the reform of the curriculum seem acceptable and indeed are urgent. There are two types of botanical students, and after the preliminary post-intermediate first year both types should be catered for by a bifurcation in the direction Ashby has indicated.

Perhaps one should go even further in the interests of applied botany, and after the second post-intermediate year separate those who incline towards mycology and plant pathology from those whose interests are physiology and microbiology. In the third post-intermediate year the physiologists should spend a considerable part of their time in the study of advanced organic chemistry, enzymology, biochemistry and physical chemistry.

It may be necessary eventually to separate off physiology completely as an independent discipline. Such a reform would entail a much closer liaison between the teaching departments in the physical and biological sciences and would necessitate an increase in the staffs of the physics, chemistry and biological departments.

Prof. F. M. Haines, Queen Mary College, London

It is agreed that the curriculum for different types of student should be even markedly different and that the different types of student can be recognized by their preferences and aptitudes at an early stage. At the same time, the first essential is to provide opportunity for studying the subject so far as possible as a coherent whole. In doing so, moreover, some preferences change and further aptitudes develop. The now patent dependence of, for examples, taxonomy on cytogenetics, of cytogenetics on biochemistry, of anatomical structure, life-histories and ecology on physiological principles and so forth, emphasizes the artificiality of segregating different aspects of the subject or divorcing any from the rest.

The principles of the different disciplines should be taught side by side for as long as the corpus of knowledge allows and segregated only to the minimum dictated by teaching convenience. The University of London regulations already allow a choice of ancillary subjects to be followed prior to the attainment of the standard of the General Degree, these being optional and suited to the student's aptitude and outlook ; they also allow a considerable degree of specialization in the final pre-graduate year, in which the born taxonomist need not be tortured by any further physiology, or physiologist by further morphology. Further specialization, or at an earlier stage, is not necessary at all events yet, and though deplorable enough on the grounds indicated above, would be even more so to those who still look to a university course for educational or cultural as well as vocational development.

Prof. T. M. Harris, F.R.S., University of Reading

Dr. Ashby deals mainly with the honours course with supporting subsidiary subjects ; but my direct experience has been with the systems of Cambridge and Reading, where a student reads three equal subjects, takes a degree examination and then possibly a final year on botany alone. However, his remarks apply here also, and I am sure the course is apt to be overloaded.

It is difficult to lighten the B.Sc. General all round without skimping practical work and reading; it seems that some neglect is better. I think this can be left to the student by giving him more choice in examination so that he can safely drop certain fractions of the course. This spares him revision and reading ; but I would make him do nearly all the class work so that he knows what he is doing.

The B.Sc. Special course at Reading is a graduate course for a very few selected students, and as they are allowed to do pretty well what they want, its faults are outside the scope of Dr. Ashby's remarks.

Finally, may I plead for more liberty of choice for the student ? I believe that in the years I have seen, planning has narrowed the field of liberty even in university education, and almost entirely to the detriment of the best students.

Prof. C. T. Ingold, Birkbeck College, University of London

Universities are not concerned with turning out graduates in botany tailor-made for applied research. Those employing botanists should be prepared to select graduates of the right calibre. Their training in the advanced techniques necessary for the particular job should come later.

Some measure of specialization for the student in his final year (not earlier) is desirable and necessary because of the huge body of botanical knowledge. In most universities this is already normal practice. Further, all students should have the intellectual satisfaction of pursuing a small problem in some branch of botany at leisure. This is achieved in many departments by honours students undertaking a 'special study' or 'minor thesis' in the final year or in the preceding vacation.

The division of students into experimentalists and non-experimentalists is highly undesirable. The morphologist, taxonomist, mycologist, geneticist and ecologist, no less than the plant physiologist, must now make the experimental approach to problems. The so-called 'classical problems of morphology'' consisting in the main of theories, which cannot be tested by experiment, concerning the phylogeny of organs and of larger systematic groups, no longer command the attention of many academic botanists.

During their course honours students should have an opportunity of seeing the work of research stations and of the national museums. Students thinking of government employment as botanists should, where possible, undertake vacation work at some research institute or at a national taxonomic centre. This is becoming increasingly common.

DR. W. O. JAMES, F.R.S., UNIVERSITY OF OXFORD

It is difficult to comment constructively on Dr. Ashby's suggestions on account of their point of departure. Honours courses in botany should not be based on his explicit assumptions that the 'bias' of the available staff may be disregarded, and that the courses are a training only for professional botanists. Botany has a much wider value in higher education than self-propagation.

We should not, I think, allow ourselves to be browbeaten by a term, even of so impeccable an appearance as over-specialization. Botany students are of many kinds, not of two only, and a degree of specialization that might poison one may be meat to another. Nothing has impressed me more than the transformation that comes over many students when they pass from the classwork stage to the specialist. The real objection to Dr. Ashby's dichotomy is that it is likely to prove impracticable and seems undesirable. Observation and experiment are still the 'Siamese twins' of botany, and the attempt to dissect them would prove dangerous to the more experimental side and perhaps fatal to the other; much of modern taxonomy and morphology is labelled experimental. Neither does it appear probable that the training proposed for experimentalists would enable more than a few to read many modern papers on photosynthesis. Where two sciences converge, the future lies with those who are willing to co-operate on a basis of knowledge of their own discipline with respect and sympathy for the other. The biologist for the team will be more useful if he is widely trained in biology than if he is given a second-rate knowledge of chemistry and physics.

In a three-year honours course, the first year should be non-specialized in the sense that it ranges over the whole subject. Since students hate the apparent repetitions of a concentric system, it should not be a prospectus to be filled out later, but a definitive treatment of topics chosen for their relative ease of absorption. There should also be courses in methodology with round-the-bench discussion. Collateral reading should be judiciously selected, but could not, I am afraid, lean very heavily on the original publications of the great botanists. Unfortunately, the great botanists have not been great writers, and botany has yet to produce its D'Arcy Thompson.

The two subsequent years should continue with the same collateral plan, the major divisions of botany being built up side-by-side. By the end of the first year most students have discovered their preferences and should be allowed to specialize by a moderate discard of topics. In smaller departments this will inevitably be done for them by the 'bias' of the available staff. On no account should 'dead' lecturing on mugged-up material be tolerated in honours courses. If there is to be a Part I examination, it should come at the end of the second year. This plan I believe to be both more realist and more desirable than a naturalist-from-experimentalist split of the subject.

PROF. F. W. JANE, ROYAL HOLLOWAY COLLEGE, UNIVERSITY OF LONDON

That the honours student is committed to early specialization is incontestable; how early, it is difficult to decide. Modern botany shows a trend toward convergence of its several branches, researches in cytotaxonomy, experimental morphology or biochemical mutants, for example, indicating an increasing synthesis of the various aspects of the subject. Precocious specialization would handicap the student in appreciating this modern approach, and he would be less likely to contribute to its progress later. Moreover, in a science which is becoming increasingly experimental, any attempt to segregate students into experimentalists and non-experimentalists seems neither practicable nor desirable. The best initial equipment for any botanist is surely some understanding of living plants, a recognition that they have form as well as function, an environment as well as a history. Early specialization would not foster this understanding.

If the supply of botanists greatly exceeds the demand, many graduates, despite specialization, are likely to become school teachers, concerned with teaching elementary botany, training in which has now been relegated from the universities to the schools. Here, surely, specialization would even prove a liability.

While the vocational aspect of a university course inevitably bulks large, it should not obscure the need for a purely intellectual training or discipline. I like the individualistic outlook of Mr. J. E. Dale: it implies, and I believe truly, that the worth-while student will follow his own bent and achieve success, in spite of, rather than because of, what his tutors may do to guide him.

PROF. IRENE MANTON, UNIVERSITY OF LEEDS

IN my view the only effective way of increasing the quality of the scientific training of botanists without imposing too early specialization, which would defeat its own ends by unbalancing the teaching in schools, is to make available such resources as are most strongly represented in our best departments to a greater range of students than is now the case. This could, I think, be done most effectively by offering a limited number of post-graduate courses of full-time study of perhaps a year's duration, leading to a special qualification such as the M.Sc. by examination, in certain special fields with exacting technical requirements, for example, advanced plant physiology, cytogenetics or biophysics, taxonomy and/or ecology, to name a few at random, on the lines already initiated by the University of Nottingham in its postgraduate course in mycology, and by the University of Sheffield in its similar treatment of biochemistry. Such courses would precede and be the basis for the narrower and in many ways very different training in research on a specific problem which our present Ph.D. students receive.

Such courses would impose a heavy strain on departments giving them and might perhaps in certain cases be held in alternate years or be shared in some way between several strong departments. Use could also appropriately be made of departments in the Commonwealth since, for example, the University of Malaya might be better placed to offer an intensive postgraduate training in angiosperm taxonomy than a British department. Co-operation and some co-ordination between universities would be essential to prevent overlapping. Some adjustment of postgraduate financing of students would be needed, and in some universities it may be necessary to overcome prejudice against the use of higher degrees for such purposes. If these difficulties could be overcome, the technical qualifications of our best students for careers other than school teaching would be greatly enhanced without disturbance to existing undergraduate curricula.

PROF. J. R. MATTHEWS AND P. J. FAULKS, UNIVERSITY OF ABERDEEN

The steadily increasing content of botanical science suggests the need for a revision of the teaching curriculum, and Dr. Ashby's proposed modifications are a possible solution of a real difficulty. While too early specialization in undergraduate training is to be deprecated, provision should be made in the final year (fourth year in Aberdeen) for a student to receive specific training in a selected branch of the subject. This depends partly upon the student's real interests and aptitudes (which the good student seeking to become a professional botanist will have discovered for himself) and partly upon his proficiency in ancillary subjects.

A fair measure of specialization in the final year will at least enable the student to begin the process of fitting himself for his future career; for no undergraduate course of normal duration can expect to complete the task. Special training, however, is valuable only in so far as it is based upon a sound foundation of botanical knowledge which must be laid in the first three years. All students should receive a *general* training in morphology and physiology, and time can be saved for certain 'modern essentials' if classical theories are not elaborated in the early years. They should also derive from abundant practical illustration, rather than from formal teaching a knowledge of taxonomy, while a 'modern essential' for all students is an introduction to the design and analysis of experiments. The vocational aspect frequently influences the student's final choice of 'specialism', and it should be recognized that not every school of botany can specialize in every branch of the subject.

PROF. R. C. McLEAN, UNIVERSITY COLLEGE, CARDIFF

Dr. Ashby's paper gives expression to a concern that has been steadily growing in the minds of teachers in recent years: how to make terms with the future. The problem can only get worse, and a solution must be found. To continue giving all students a sketch of everything, old and new, is entertaining and may broaden their minds, but it is not the way to train professional botanists. Subsequent speakers did not all appreciate Dr. Ashby's limitation of his argument to that aspect.

There are two ways to meet the situation. One is that of the mathematicians, to confine undergraduate courses to the classical aspects of the subject and leave exploration of the frontiers until the postgraduate period. Unfortunately, our frontiers are too close to us to be ignored, and the alternative obliges us to contemplate some such dichotomies of study as Dr. Ashby suggests. A canalization of interests will be forced upon the botanist as soon as he begins professional life: why not recognize this situation and prepare him for it by better (which means wider) training along the lines of his aptitudes. This is where the bias of staffs comes in—not always illegitimately, I beg to think. I am not impressed by the argument that one cannot distinguish between observational and experimental aptitudes during a student's training. Nearly forty years of university teaching has led me to the contrary opinion.

A broad preliminary course is certainly essential; but those who shake their educational heads over subsequent specialization are ignoring the immense capacity for self-teaching possessed by the good mind. It is quite possible for a physiologist to develop an intimate knowledge of the Bryophyta, for example, on no more than an elementary basis, and we could all multiply instances of men who have successfully combined specialization with broad and varied interests of their own choosing. To broaden his outlook is a man's own task; what he is taught is, happily, not the decisive factor.

PROF. P. W. RICHARDS, UNIVERSITY COLLEGE OF NORTH WALES, BANGOR

I agree with so much of what Dr. Ashby has said that I hesitate to range myself among his critics. The 'dilemma of the curriculum' faces every teacher of a rapidly growing science such as botany; but I think Dr. Ashby's solution is based on a dangerous over-simplification of the real situation. As Mr. Bell said, students do not fall into two classes only—the 'experimentalists' interested in applying physics and chemistry to plants, and the 'naturalists'. Both the needs and the aptitudes of students are more varied than that, and if we forget this and plan the botanical curriculum as Dr. Ashby proposes, we shall provide badly for many who do not belong exclusively to either class, such as geneticists, ecologists and plant pathologists. The ecologist, for example, needs training in plant physiology (except perhaps for its more 'biochemical' aspects) as much as in systematics; but how would he fit into Dr. Ashby's 'dichotomous' curriculum? My own solution would be to divide the subject not into two, but into seven or eight, branches and allow the student to specialize in a reasonable number of these.

Apart from objections in principle, I foresee great difficulties in applying Dr. Ashby's suggestion, except in a very large and well-staffed department. In one such as my own without a large staff, and in which future professional botanists form only a small minority of the students, these difficulties would probably be insuperable.

Prof. M. Skene, University of Bristol

Dr. Ashby's acute analysis is very welcome. The problems arising from the increasing amount and range of knowledge are felt by all botanists. There may be less agreement on the solution suggested; indeed, it may be that no uniform plan is desirable.

In undergraduate work we should educate botanists and not train them for particular botanical jobs. All undergraduates should have the same general education. The morphologically minded should gain good experience in experimental work; the physiologist should know how to handle a variety of plants. Natural bias in ability and interest can be allowed for in the setting of the examination papers.

Botany is the meeting-ground of many sciences, and the advantage of this in a liberal education should not be lost: nor is the dichotomy so sharp as Dr. Ashby suggests. The plant pathologist is a good example of a specialist who must be competent in both fields.

The exhaustive study of a few types is valuable in giving depth; but the method should be judiciously tempered by opportunities for getting to know a large variety of material. Diversity of creatures is the essence of living Nature, and, to many, the spice of biological study.

The employers of botanists should not expect the new graduate to be ready trained for a special job. The necessity for this training remains. It would best be met by postgraduate diploma courses of about one year's duration. Such courses might well be shared out between the universities. For very many graduates they would be more useful than the years spent in research leading to a higher degree.

Prof. M. Thomas, F.R.S., King's College, Newcastle upon Tyne

The few words available may be used most economically to state present practice at King's College, Newcastle upon Tyne, in framing "honours courses in botany considered solely as a training for professional botanists (not including school teachers)", to which Dr. E. Ashby limited the scope of his address. We have been experimenting for a number of years, and realize that there is much scope for further experiment.

At present we require all honours students to study all post-intermediate courses given over two complete sessions in the Department of Botany. They all thus cover the ground for the final pass (general) examination. In their third and final year each honours student is informed that about two-thirds of the course is the maximum he can be expected to cover. Experience has shown that the combination of interests varies with the student. The special study of taxonomy has been combined with that of molecular events.

Our view is that the problem of each honours student requires individual consideration, which is extended to the selection of auxiliary subjects. We consider that some knowledge of chemistry is desirable for all; but chemistry is not a compulsory subject. Intending physiologists often extend their chemical studies over two years. As regards our other specializations, zoology has been the most favoured subject for two years of study by intending cytogeneticists and field ecologists. Bacteriology has been studied with much profit by students now carrying out graduate research in mycology. Students having the necessary mathematical ability have been encouraged to study physics above an elementary level.

More than ten years ago two students of special honours quality graduated in what might be regarded as a joint honours school in physics and botany, and another student in chemistry and botany. Unfortunately these combinations of subjects have not been taken in recent years. A case could be made for such schools rather than special honours in botany for certain picked students competent to study physical as well as biological science to a high level.

Prof. T. G. Tutin, University College, Leicester

I cannot altogether agree with Dr. Ashby that the solution of our difficulties lies in earlier specialization. Taxonomists and morphologists are at last applying experimental methods to their studies, and some knowledge of mathematics, physics, chemistry and plant physiology is essential if they are to make real progress.

It is of particular importance in this connexion that the chemistry which botanists learn should include more physical and organic chemistry and less about the lead-chamber process.

For a sound training in botany a four-year course seems desirable to-day, if financial considerations will permit it; the first two years can then be spent on a general course in three subjects, chosen in accordance with the special interests of the student, the next year on a wide botanical course and the final year in specializing in a particular part of the subject. Recent experience here has clearly demonstrated the great value to the student of being able to spend four years over the degree course. The acceptance by many universities of the General Certificate of Education at Advanced Level as a substitute for Intermediate greatly increases the desirability of a four-year degree course, since students often arrive at the university with little real foundation for their subsequent studies.

A less satisfactory, though perhaps more practicable, alternative might be to retain the three-year course with a less detailed treatment of the groups of cryptogams in the first two years and then to allow considerable specialization in the final year.

Finally, would it be unkind to suggest that the pure "naturalists" with no aptitude for experiment or interest in physical sciences should be encouraged to take an arts degree and pursue botany as a hobby?

Prof. D. H. Valentine, Durham Colleges in the University of Durham

I am in general agreement with Dr. Ashby's proposals; but I would suggest some modifications. First, I do not think an honours student should choose his subject until, at earliest, the end of his first year at the university; it is not uncommon for a student to change his mind about his subject, and I think it is well that he should be able to do so. Secondly, I think that it is most undesirable to widen the division between botany and zoology, as Dr. Ashby seems to suggest. On the contrary, I think the subjects should, so far as possible, be brought closer together. Thus, I should like to make it possible for students who have had a good introductory training in both disciplines to specialize in their final year in, say, evolutionary studies, or animal and plant ecology, or cell physiology; the courses would be provided jointly by both botany and zoology departments, with assistance from other departments where it was required.

PROF. W. T. WILLIAMS, UNIVERSITY OF SOUTHAMPTON

I strongly support Dr. Heslop Harrison. There is room for a continuous spectrum of botanists, ranging from the pure morphologist to the biochemist, and it is the traditional task of any one of these to bring his chosen problem one stage nearer to the realm of the chemist. The rigid segregation of students into two groups, whatever its organizational advantages, might easily result in morphologists who are not interested in the physiological problems underlying their study, and in physiologists who are largely unaware of the vast fields of experimental morphology awaiting investigation. If a student genuinely wishes to specialize early, encourage him; but let us at all costs attempt to retain the possibility of training good general botanists, however difficult this may be.

OBJECTIVITY OF COLOUR PREFERENCES*

By DR. G. W. GRANGER
Psychology Dept., Institute of Psychiatry, Maudsley Hospital, London, S.E.5

It has long been supposed that colour preferences are entirely a matter of personal taste, depending on individual associations and other subjective factors, and the results of numerous experimental studies have seemed to support this view. Thus, Chandler[1] in his survey of research on colour preferences remarks that the results of these experiments are "chaotic"; the most careful and thorough work of such acknowledged authorities as von Allesch[2] serves only to emphasize the fact that observers disagree sharply as to the relative preferential value of single colours and colour combinations.

This apparent lack of agreement has led those psychophysicists and sensory psychologists who have explored in great detail the 'objective' stimulus dimensions of colour to dismiss the æsthetic, affective or preferential values of colours as purely subjective and outside the scope of present-day scientific analysis. For quite different reasons, æstheticians and psychologists of *Gestalt* persuasion have declared the whole realm of colour æsthetics to be beyond analysis by the ordinary atomistic and dimensional methods of science. Such writers argue that this field is characterized by "emergent properties" which cannot be accounted for in terms of parts and relations between parts as Spearman[3] and other elementalists have claimed; at every turn the investigator is confronted by *Gestalt* or whole qualities that defy analysis.

Recent experiments by the author suggest that neither of these two extreme views, the subjective nor the *Gestalt*, is justified; indeed, the evidence seems overwhelmingly in favour of objective and fairly atomistic hypotheses. As detailed accounts of the individual experiments on which this evidence is based will be published elsewhere, only a general summary will be presented in this paper.

In the first experiment, sixty sets of standard Munsell colours were selected to represent the entire colour solid along its three principal dimensions: hue, lightness and saturation. Within each set the colours were ranged in order of preference by fifty subjects (twenty-five men and twenty-five women) of normal colour vision, as tested by the Ishihara[4], Rabkin[5], and Farnsworth–Munsell[6] tests. Illumination at 6,500° K. was provided by a specially calibrated tungsten lamp in conjunction with a Macbeth daylight filter, and the colours were viewed against a neutral grey background of Munsell value 5. When subjects' rankings were summed for each set and the amount of agreement calculated in terms of Kendall's[7] coefficient of concordance (W), it was found that the resulting coefficients reached significance at the $P < 0{\cdot}01$ level, indicating quite clearly that the subjects were not independent in their preferences; on the contrary, they showed a remarkable degree of concordance, the average value of W being about 0·3. Further, it appeared that the general order of preference for any one attribute of colour (which remained invariant at different levels of the colour solid) was dependent on stimulus properties in the following way: hues of shorter wave-length tended to be preferred to those of longer wave-length, the more saturated colours were preferred to the less saturated, and colours which contrasted least in lightness with the background were ranked higher than colours showing maximum contrast. Conclusions were necessarily tentative, owing to the small number of items involved in the general order of preference. Contrary to some earlier claims, no marked differences were found between the preferences of men and women.

A second experiment was undertaken in which preference judgments were obtained from twenty subjects for four sets of colour combinations. Three of the sets represented variation along each of the principal dimensions of colour, while the fourth contained fully saturated hues which had been used in a previous experiment by Clarkson, Davies and Vickerstaff[8]. Preference judgments for the hue, lightness and saturation tests were obtained against a background of neutral grey, while preferences for the combinations of fully saturated hues were obtained against a black background to facilitate comparison with the previous research in which this type of ground had been used. Data for all four tests were collected, as in the first experiment on single colours, under an approximation to C.I.E.[9] illuminant *C*. When subjects' preferences were analysed, it was found once again that a large measure of general agreement existed for all four types of colour combination used in the experiment, and, as before, the general order of preference seemed to be dependent on objective stimulus properties: thus, preference tended to increase with increasing hue distance between the component colours making up the combinations, to decrease with increasing lightness, and to decrease with increasing saturation. This dependence was most striking in the case of hue combinations, where there was an almost perfect positive correlation between preference judgments and the size of hue interval between the components. Particularly encouraging was the independent confirmation of results obtained earlier by Clarkson, Davies and Vickerstaff. From data kindly supplie by Dr. T. Vickerstaff, it was possible to calculat correlations between preference judgments and hu interval, and when this was done, the resultin coefficients exceeded 0·95—somewhat larger tha those I have obtained for combinations of full saturated hues.

Finding that preferences for combinations of hue could be accounted for almost entirely in terms the interval between the component colours in the case where one component remained constant for a given series, it was decided to consider the more general case in which not only the interval or relation between the components varied from one combination to another, as in the second experiment, but also in which the component colours were both allowed to vary throughout a given series. Could preference be accounted for at this more complex level ? Moon and Spencer[10], two recent theoretical writers on colour harmony, have claimed that such prediction is possible and, on the basis of certain assumptions concerning the various classes into which harmonies can be divided and Birkhoff's[11] work on 'æsthetic measure', they have developed an 'æsthetic formula' for colour combinations. Unfortunately, this formula, like its earlier counterpart for polygonal figures, leans too heavily on deductive procedures which fail to take into account results of empirical research in æsthetics : in consequence, when submitted to experimental test, its predictive value proved to be negligible. However, a simpler formula, derived not from assumed higher principles but from the results of previous experimental work on 'hedonic summation' and colour harmony, was found to account for the major part of the variance (70 per cent) without taking into account the lack of perfect reliability in the subjects' preference judgments. This formula, conceived along frankly atomistic lines, depended upon two sets of factors : (1) preference for the component colours, plus (2) a relational term concerning the combination as such ; in Spearman's words, upon 'fundaments' and the 'relation' between them.

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* Substance of a lecture to the Colour Group of the Physical Society delivered on February 13.

Further evidence of the objectivity of colour preferences was found in experiments on the influence of background and area. It will be remembered that the experiment on the general order of preference for single colours was carried out under one background condition, namely, a neutral grey of Munsell value 5. But it cannot be assumed without proof that a general order of preference occurring under one condition of background will remain invariant under other conditions. Observation suggested that the order would remain relatively constant only when the general colour–ground relationship was unchanged. Experimental tests of this hypothesis were made using several different achromatic and chromatic backgrounds and, in general, the evidence tended to support it. Further, it was possible not only to predict *when* a significant change in preference would occur, but also, to some extent, the direction it would take, on the basis of results obtained earlier in the experiments on preferences for single colours and colour harmony. As before, there was a substantial measure of agreement between subjects' preferences.

The influence of area was studied in relation to colour harmony. The importance of this factor is generally recognized both by æstheticians and practising artists, who often claim that ". . . the choice of quantity is more important than the choice of colour"[12]. From the practice of artists, an empirical 'rule' has developed concerning the proper balance of areas in a colour design : the accepted principle is that a large area of colour at a low degree of saturation will balance a small area of highly saturated colour ; the principle is sometimes extended to lightness—balancing of the darks against the lights. When stated in quantitative terms, this principle is of particular interest to experimental æsthetics, and my experiments were designed to test the predictive value of two 'formulæ' that have been proposed. The first formula was developed by A. H. Munsell[13], founder of the Munsell colour system, who stated his 'rule' for area balance in the following way : ". . . the stronger the color . . . the smaller must be its area ; while the larger the area, the grayer the Chroma. Thus R 7/6 balances R 3/3 in the proportion of nine parts of the lighter red to forty-two parts of the darker red. In other words, these symbols will balance colors inversely as the product of their factors". The second formula, proposed by Moon and Spencer[14], is rather more elaborate ; these authors claim that a pleasing balance is obtained when the product of each area and its distance from the 'adaptation point' in colour-space is the same. The colour-space to which they refer is a metric-space, developed by making a mathematical transformation of the C.I.E. colour-space.

In order to test these two hypotheses, pairs of Munsell colours were presented to a group of subjects, who were asked to adjust the areas of the two colours in each pair to give the most pleasing balance. Results showed, first, a large amount of concordance between subjects' preferences and, secondly, the superiority of Munsell's empirical 'rule' over Moon and Spencer's formula : whereas Munsell's formula accounted for about 40 per cent of the total variance, Moon and Spencer's gave very small and insignificant correlations between observed and predicted preferences.

Finally, an attempt was made to link results of some of the experiments on colour appreciation with preferences for more complex visual material. The method adopted was first to derive 'scores' for subjects who had taken part in the experiments on preferences for single colours and colour harmony by correlating individual preferences with the general order of preference (a procedure for which justification has previously been given by Eysenck[15] and other investigators of general æsthetic appreciation), and then correlating these scores with scores on the Maitland Graves test of design judgment[16], which involves the ranking of black-and-white designs. Both correlations, between preferences for single colours and design judgment, and between preferences for colour combinations and design judgment, were significant and fairly high, being 0·60 and 0·73, respectively. Although based on a small number of cases, these positive correlations suggest that preferences for elementary colour stimuli may be dependent on an æsthetic factor of a fairly comprehensive kind ; they also do something to counter the assertion, often made by theoretical æstheticians, that the experimental æsthetics of simple sensory stimuli has no bearing on the problem of æsthetic appreciation, especially as the design judgment test used in this experiment has been shown to have a considerable degree of validity when measured against acceptable external criteria.

The main conclusion which seems to follow from the results of these experiments is that colour preferences are objective in the sense that (*a*) they are to a considerable extent independent of personal taste, and (*b*) are dependent to some degree on inherent stimulus properties ; there is no experimental justification for an extreme subjectivist point of view in this field. This suggests that preferences rest on a firm biological foundation in the perceptual equipment of the individual, and such an interpretation gains support from the re-analyses made first by Eysenck[17] and later by me (using different statistical techniques) of data on the colour preferences of subjects from widely different backgrounds and even from different culture patterns: the evidence everywhere indicates a substantial measure of agreement. Results show quite convincingly that the conclusions reached by von Allesch, Chandler and others, and referred to earlier in this paper, were not warranted by their own data; they were arrived at on the basis of inadequate statistical procedures. Finally, there seems to be no justification for an extreme *Gestalt* point of view in this field, for preferences can be accounted for in terms of quite atomistic concepts of relations and fundaments, and knowledge derived from elementary colour stimuli can be applied to preferences for material of a more complex nature. The value of this demonstration may extend beyond the realm of experimental æsthetics to other parts of the psychological field in which problems of organization are encountered; thus, the relevance of these studies to the problem of personality organization has already been considered by Eysenck in a recent publication dealing with "The Scientific Study of Personality"[18].

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OBITUARIES

Dr. W. T. Calman, C.B., F.R.S.

WILLIAM THOMAS CALMAN, who died suddenly on September 29 in his eighty-first year, was a great zoologist. A distinguished pupil of the late Sir D'Arcy Thompson, he was well known as the leading British carcinologist of our time, author of the volume on "Crustacea" in Lankester's "A Treatise on Zoology" (1909) and of "The Life of Crustacea" (1911).

Born at Dundee in 1871, Calman was educated at the High School and, after a spell as clerk in an insurance office, at University College, Dundee (later to become one of the constituent colleges of the University of St. Andrews). On obtaining his B.Sc. in 1895 he was appointed assistant lecturer and demonstrator in zoology, a post which he held until 1903, taking his doctorate in 1900. There he acquired valuable teaching experience and a sound knowledge of zoology which many learned to appreciate in later years.

When he joined the staff of the British Museum (Natural History) in 1904, he was placed in charge of the Crustacea—a group which he had already made his own—and the Pycnogonida, and for a short time he was responsible for the Arachnida as well. In addition to his official duties, he for many years compiled the Arachnida and Crustacea sections of the *Zoological Record*, and it was astonishing how well he remembered references twenty or thirty years later. In 1921, the year in which he was elected to the Royal Society, he became deputy keeper of the Department of Zoology, and in 1927 he succeeded Regan as keeper, a post which he held until his retirement in 1936. In the previous year he had been created a C.B., and in 1937 was elected an honorary Fellow of the Royal Society of Edinburgh.

Calman also took a prominent part in scientific activities outside the Museum. He served on the Council of the Royal Society and as external examiner to several universities. For twenty-seven years he was secretary to the Ray Society, and at the time of his death was an editor of the *Annals and Magazine of Natural History* and a member of the International Committee on Zoological Nomenclature. His longest association was with the Linnean Society of London, of which he was zoological secretary (1923–28), president (1934–37) and Linnean Gold Medallist. At the 1930 Bristol meeting of the British Association he presided over Section D (Zoology).

In a presidential address to the Quekett Microscopical Club, Calman tells us that he was an amateur microscopist before he began the serious study of zoology. D'Arcy Thompson chanced to hear him speak on rotifers and, recognizing his aptitude, made it possible for him to enter the University. After graduation he turned his attention chiefly, though by no means exclusively, to the Crustacea. From 1896 onwards he contributed a steady stream of papers of the highest order. His work impresses not so much by its quantity—several of his contemporaries were more prolific writers—as by its intrinsic qualities. These are already apparent in his earliest papers, notably that in which he demonstrated with remarkable insight the affinities of the recently discovered *Anaspides* with the fossil Syncarida. They appear at their best in the "Treatise" volume which all specialists regard as his masterpiece. The book is much more than a lucid, concise, masterly synthesis of what was known at the turn of the century. Calman possessed, to a degree that has rarely been equalled, a gift for winnowing the significant from masses of detail. He revealed much of the order beneath the diversity of the subclass Malacostraca; the new classification which he introduced in a small paper published in 1904 was accepted, and, with the addition of the small order Thermosbaenacea to the division Peracarida, still stands. Much of his later work was concerned with the elucidation of the more obscure orders of the Malacostraca and with the phylogeny of the Arthropoda. He also wrote on marine boring organisms injurious to submerged structures, and on the Pycnogonida.

Calman had hoped to continue his research work after his retirement, and did, in fact, report on the Pycnogonida and Caridea of the *John Murray* Expedition. Later, however, he moved to Tayport, Fife, and soon we find him acting as temporary war time lecturer in zoology in his own Alma Mater, of which he was an LL.D. A series of lectures delivered to his students on "The Classification of Animals" appeared in book form in 1949.

As administrator of a large museum department, subordinates of all grades found him most approachable. To the younger zoologists of his staff he gave freely of his time, knowledge and experience, and as an editor he excelled. Sociable by nature, he liked to meet all visitors to his Department, whether student or foreign specialist (with whom on occasion he had to converse in Latin). All who knew him appreciated his profound erudition, his great personal charm and his sense of humour. His memory is held in affectionate esteem by all who came under his influence.

In 1906 he married Miss Alice Donaldson, of Tayport, who, with a son and a daughter, survives him.

I. GORDON

Prof. F. C. Lea, O.B.E.

PROF. F. C. LEA, emeritus professor of engineering in the University of Sheffield, died on September 30 at the age of eighty-one.

Frederick Charles Lea was born near Crewe and was apprenticed in the Mechanical and Electrical Departments of the London and North Western Railway. He received his scientific education at Owens College, Manchester, and the Royal College of Science, London. He was Senior Whitworth Scholar in 1896. After a further period with the London and North Western Railway, he became in 1900 senior assistant to Prof. W. C. Unwin at the City and Guilds of London Central Technical College. In 1908 he published the text-book on "Hydraulics" by which his name became known to engineering students all over the world. During 1911–13 he served as one of H.M. inspectors of technical education and in 1913 was appointed professor of civil engineering in the University of Birmingham.

During the First World War he held commissions, first in the Territorial Force and afterwards in the R.N.V.R. and in the R.A.F. He made a special study of materials for aircraft and was concerned in the development of all-metal aeroplanes.

In 1923 Prof. Lea was appointed professor of mechanical engineering in the University of Sheffield, and was dean of the Faculty of Engineering until his retirement in 1936. During this period he carried on experimental research, in association with a succession of students, in several fields related to the mechanical properties of metals, and he published numerous papers on such subjects as fatigue, embrittlement, welded joints, springs, and notably creep at high temperatures.

During his career, Lea took a lively interest in scientific and technical societies, and was perhaps specially attached to the British Association and to the Institution of Mechanical Engineers. He was president of Section G (Engineering) of the former in 1929 and of the Institution in 1944. He served on many committees and consultative bodies concerned with technical and educational matters, and had a considerable part in the development of the National Certificate schemes. During 1936–50 he was a director of Edgar Allen and Co., Sheffield.

Lea's contribution in the field of engineering science was a dual one: on one hand, he was a skilful and energetic experimental investigator with a wide range of interests; on the other, he was a progressive technical educationist and a particularly able teacher. His influence to-day is probably mainly felt through the hundreds of engineering graduates to whom he communicated enthusiasm and the spirit of inquiry.

In his personal life, Lea was a deeply religious man and had a high sense of social duty. Throughout his life he was an active member of the Methodist Church, and he served it in many capacities both in administration and as teacher and speaker. For several years he presided over the Sheffield Council for Social Service.

Mr. Peter Doig

WE regret to announce the death on October 13, after a long illness, of Mr. Peter Doig. He was born in 1882 in Glasgow, where he received his primary education and later he was trained as a draughtsman at the shipyard of John Brown and Co., Ltd., at Clydebank. He then worked at Harland and Wolff's, Belfast, and afterwards at shipyards in Shanghai, where a serious breakdown in health in 1916 necessitated a temporary rest, and he returned to Clydebank, travelling by the Trans-Siberian Railway to Europe. After working for a time at Beardmore's, he went to the United States, and on his return was appointed in 1918 general secretary of the Association of Engineering and Shipbuilding Draughtsmen. He did very good work on screw propeller design, on which he had specialized; but unfortunately ill-health compelled him to retire from the secretaryship of his Association in 1945.

Doig was a keen astronomer, and was elected a member of the British Astronomical Association in 1921 and a Fellow of the Royal Astronomical Society the following year. In 1930 he was appointed editor of the *Journal of the British Astronomical Association*, a position which he held until 1937, when the pressure of work with his professional Association compelled him to resign; but in 1948, after his retirement as secretary of his Association, he was re-appointed editor of the *Journal* and continued with this work until his death. He was an excellent editor, and made considerable contributions himself to the *Journal* in the form of reviews and notes from numerous astronomical publications in various parts of the world. During 1928–41 he was also honorary curator for the British Astronomical Association. In 1927 his book, "An Outline of Stellar Astronomy", was published, and an enlarged and revised edition appeared in 1947; in 1950 "A Concise History of Astronomy" was published, a book which deals with the history of astronomy from the earliest times up to recent years. During 1951–52 he collaborated with eleven other astronomers—each an authority in his own particular subject—in the production of a work on astronomy in which he was responsible for the larger portion of the chapter on the historical side and sole author of the chapter on the stars; he had corrected the paged proofs shortly before he died.

In 1909 Mr. Doig married Mary Scott, who, with a married daughter, survives him.

WE regret to announce the following deaths:

Prof. J. G. Lawn, C.B.E., president in 1930 of the Institution of Mining and Metallurgy, on October 21, aged eighty-four.

Prof. Ernest Vessiot, member of the Mechanics Section of the Paris Academy of Sciences and formerly director of the École Normale Supérieure, Paris, on October 17, aged eighty-seven.

NEWS and VIEWS

Nobel Prize for Physiology and Medicine for 1952 : Prof. S. A. Waksman

THE Nobel Prize for Physiology and Medicine for 1952 has been awarded to Prof. Selman Abraham Waksman, professor of microbiology and head of the Microbiology Department of the College of Agriculture and Experiment Station at Rutgers University, New Brunswick, N.J., for his discovery of streptomycin, the first effective antibiotic against tuberculosis. Prof. Waksman was born in 1888 in Priluka, a small town in the Ukraine, emigrated to the United States in 1910 and became a naturalized citizen there in 1915. The whole of his scientific life since 1911 has been spent at Rutgers University and has been devoted to the study of microbiology, and particularly to that group of soil micro-organisms which are frequently spoken of as ray fungi and belong to the genus *Actinomyces* or *Streptothrix*. Following the discovery of penicillin, which is fully effective only against Gram-positive bacteria, Waksman and his collaborators began, in 1939, a systematic search for an antibiotic active against Gram-negative bacteria and found it, in 1944, in streptomycin, a metabolic product of *Streptomyces griseus* (formerly known as *Actinomyces griseus*). They also showed that streptomycin is highly active *in vitro* against *Mycobacterium tuberculosis*. This observation was quickly followed by the proof by Feldman and Hinshaw that streptomycin exerts a powerful suppressive action in experimental tuberculosis in guinea pigs, and finally by the demonstration by many investigators of its effectiveness in the treatment of different types of tubercular infections in man. Thus, in spite of some imperfections, streptomycin offered the first real hope of chemotherapeutic treatment of a disease which was formerly almost universally fatal.

G. A. Mantell, F.R.S. (1790–1852)

GIDEON ALGERNON MANTELL, who died a century ago, on November 10, 1852, belongs to that interesting band of medical men who have won both fame and popular applause in extra-professional pursuits. Son of a Lewes shoemaker, he was born on February 3, 1790. After serving as apprentice to a local surgeon and studying at St. Bartholomew's Hospital, London, he qualified M.R.C.S. in 1811 and thirty-two years later was elected one of the original three hundred Fellows of the Royal College of Surgeons. A busy medical practitioner in Lewes and the surrounding countryside, Mantell made many valuable contributions to geology, collecting specimens from the chalk around Lewes and from the Sussex Weald, sending reports to the Linnean Society, and building up a private geological museum, which he later sold to the British Museum for £5,000. A pioneer in the study of fossils at a time when this was regarded as impious, he is known for his discovery in the sandstone of Tilgate Forest of the iguanodon, which he reported to the Royal Society in 1825. A popular lecturer and a facile writer, his works, some of which went through several editions and were illustrated by plates engraved by his wife, include "The Fossils of the South Downs" (1822), "Thoughts on a Pebble" (1837) and "The Wonders of Geology" (1838). Mantell played a leading part in securing a free pardon for Hannah Russell in the Burwash case, and published his "Observations on the Medical Evidence Necessary to Prove the Presence of Arsenic in the Human Body" (1827). He was elected to the Royal Society in 1825 and was awarded a Royal Medal in 1849; he received the honorary LL.D. of Yale University in 1834. A victim of extreme lateral curvature of the spine, which made him hypochondriacal and acrimonious, Mantell died of an overdose of opium.

British Museum (Natural History) : Appointments

THE Trustees of the British Museum have promoted Mr. Wilfred Norman Edwards, keeper of the Department of Geology at the British Museum (Natural History) to the rank of deputy chief scientific officer, with effect from December 1; Mr. Edwards will continue to hold the keepership of geology. The Principal Trustees have also appointed Dr. Frederick Allan Bannister to be keeper of the Department of Mineralogy; and Mr. Alexander Cockburn Townsend to be deputy keeper in charge of the Library of the British Museum (Natural History) both with effect from December 1. Mr. Edwards was a scholar of Christ's College, Cambridge, where he took first-class honours in the Natural Sciences Tripos in 1911. He entered the Museum in 1913 and has been keeper of the Department of Geology since 1938. He has specialized in fossil plants. Dr. Bannister was educated at Clare College, Cambridge, and took a first class in both parts of the Natural Sciences Tripos in 1922 and 1923. He entered the Museum in 1927 as an assistant keeper and has specialized in the analysis of mineral structure by means of X-rays, in the development of which method he has taken a leading part. Mr. Townsend was educated at Shaftesbury Grammar School, St. Paul's School and Magdalene College, Cambridge. He obtained second-class honours in the Classical Tripos in 1926 and in the Modern Languages Tripos in 1928. He entered the service of the Trustees in 1930. During 1931–39 he was honorary secretary of the University and Research Section of the Library Association, and since 1948 has been honorary secretary and editor of the Society for the Bibliography of Natural History.

Groundnuts Scheme in East Africa

IN the House of Commons on October 29, a written reply was given to a question by Mr. A. R. Hurd asking the Secretary of State for the Colonies if he was satisfied, after another season's operations at the Kongwa, Urambo and Nachingwea centres of the East African groundnut scheme, that the large-scale experimental development proposed in Command Paper No. 8125, January 1951, was practicable; and if the policy and financial provisions then decided for the scheme had been adopted by the Government. Mr. J. G. Foster, Under-Secretary for Commonwealth Relations, stated that neither the board and chairman of the Corporation nor the Secretary of State is satisfied with the scheme as laid down. The experimental data which it was the object of that scheme to provide can certainly be obtained; but the board considers that there are fundamental agricultural problems in Urambo and Nachingwea which should be worked out on a lesser scale. The board is considering revised plans for this purpose which will keep the cost within the balance remaining of the £6 million. These should be available by December and the Secretary of State will then make a further statement.

Cartographical Needs of the Airman

The activities of the Institute of Navigation include the investigation of various problems by working-parties under the general guidance of the technical committee, and several of these were referred to by Rear-Admiral A. Day, Hydrographer of the Navy, in his presidential address to the Institute. One working-party has undertaken to inquire into the precise requirements the airman needs of his maps and charts. The nautical chart has been built up to its present shape by many centuries of knowledge and experience of what the seaman wants. The air chart, like aviation itself, has grown up quickly, so that just what it should be like and exactly what is wanted of it has not been so easy to establish without question. The basis from which the Institute's working-party proposes to begin its investigations is one that accepts air navigation as it is to-day, but does not necessarily relate it to a system which uses charts in their present form. This means that their examinations will go much deeper than merely questioning whether, say, a map used for aircraft operating at a height of some 40,000 ft. should give the characteristics of lighthouses, or should show the 100-fathom line. Another problem is how to determine the quickest flight-path from one place to another, a problem which bears directly on the economy and efficiency of navigation in long-distance flights. A workable method of being able to determine, for any given set of meteorological conditions, the route of least time would be of considerable assistance to air operators. For some time now the Institute has had a working-party investigating the whole problem of determining the optimum flight-path; the task is a long one, partly because the aim is to produce a practical method which will offer clear advantages over those used in flight-planning to-day.

Oil in Pakistan

A speech on the development of the oil industry in Pakistan was recently given in Karachi by M. J. Condon, chairman of the board of directors of Pakistan Petroleum, Ltd. The sole producing region is the Potwar Basin, south-west of Rawalpindi, where four fields are established—Khaur, Dhulian, Balkassar and Joya Mair—but production is relatively small. Exploration is, however, active, six major tests being in operation at Bains and Chak Naraung in Punjab, at Sui in Baluchistan, at Patharia and Sylhet in East Bengal, and at Patiya near Chittagong. Mr. Condon's forecast on these prospects does not, however, appear particularly optimistic. As he rightly points out, prospecting costs in Pakistan are fifteen times what they are in the United States, primarily because all plant and equipment has to be shipped to the former country from overseas whereas "in America these things are available to the end of a telephone line", a pertinent comment on petroleum economics in other countries besides Pakistan. There is the prospect of a refinery being erected in Karachi, and a technical commission is being set up to review the whole situation. It is clear that the Pakistan Government and the industrial enterprises concerned are doing everything possible to develop petroleum resources in this geologically difficult territory.

An Atlas of the Asclepiadaceæ

Under this title, and with the help of some seventeen maps, Prof. R. Good (*New Phytologist*, 51, 198; 1952) has illustrated the distribution of the family, sub-families, tribes and selected genera of this highly distinctive group of tropical plants. The Asclepiadaceæ, by some taxonomists included in the order Apocynales, include perennial herbs, undershrubs, shrubs and climbers, all having a specialized pollen-transfer mechanism. Because of their particular and highly unusual features, the two constituent sub-families thus afford very useful materials for geographical study. The maps represent a summation of all available information regarding the distribution of the family. The family has a general distribution both in the Old and New World tropics, and of its two sub-families the smaller is confined to the Old World, while the larger is present in both hemispheres. The family, however, is poorly represented in isolated islands. The proportion of narrowly distributed or endemic genera is very high, some being very local; that of endemic species is even higher, no such species being common to both worlds.

A New Circumpolar Plant Species in Scotland

With the discovery in 1951 of *Diapensia lapponica* L. (Ericales) at 2,500 ft. in the Arisaig district of Inverness-shire, Scotland, a new species, genus and family have been added to the British flora. Several hundred specimens have now been observed in this locality, the habitat being completely exposed, on stony and gravelly schists, and with a rainfall of 120 inches. *D. lapponica* is one of the small group of circumpolar, arctic-montane species—a group not represented in the mountains of Central Europe—with a wide distribution in the several continental and insular areas in the Arctic region (see J. Grant Roger, "*Diapensa lapponica* in Scotland", *Trans. Bot. Soc., Edin.*, 36, Pt. 1, 34; 1952).

N.P.L. Colour Temperature Scale

In July of this year the Director of the National Physical Laboratory announced that in future the 1948 International Temperature Scale would be used in assigning colour temperatures to light sources calibrated at the Laboratory. Previously, the 1927 International Temperature Scale had been used. The Laboratory has now issued the following comparisons and conversion factors. Corresponding values of temperatures on the two scales, in the range of importance in the calibration of tungsten filament lamps, are as follows:

1927 Scale	1948 Scale
1500·6° K.	1500° K.
2003·8	2000
2508·6	2500
3015·1	3000
3523·7	3500

If a lamp has been found by calibration to give a particular value of colour temperature on the 1927 Scale when it is run at a certain voltage V, the voltage to give the same numerical value of colour temperature on the 1948 Scale is obtained by multiplying V by the factor shown in the following table:

Colour temperature (° K.)	Multiplication factor for voltage
1500	1·001
2000	1·005
2500	1·009
3000	1·014
3500	1·019

These factors may be taken as correct to about one-tenth of one per cent.

Illuminant A. The factor by which the voltage of a lamp calibrated at 2848° K. on the 1927 Scale must be multiplied to give 2854° K. on the 1948 Scale (the current definition of colorimetric illuminant *A*) is equal to 1·018.

Scottish Postgraduate Scholarship Awards in Agriculture

THE Department of Agriculture for Scotland has awarded the following postgraduate scholarships in agricultural subjects, tenable for periods up to three years, commencing October 1 at the university or institute shown: ***Agricultural Economics***, A. V. Vickery (Agricultural Economics Research Institute, Oxford); ***Husbandry***, J. Eadie and A. O. Ballantyne (continuation of current award) (University of Edinburgh), D. S. Hay and R. R. Shepherd (University of Cambridge), R. Laird and T. D. MacLean (University of Reading), and A. F. Gristwood (continuation of current award) (Ohio State University); ***Statistics***, St. C. S. Taylor (continuation of current award) (University of Edinburgh).

University of London

THE following announcements have recently been made from the University of London: the title of reader in mechanical engineering has been conferred on H. Hampson in respect of the post held by him at Queen Mary College; the degree of D.Sc. has been conferred on Miss Olive N. Purvis (Imperial College of Science and Technology) and C. A. Rogers (University College).

University of Leeds

THE University of Leeds has conferred the title of emeritus professor upon Prof. J. W. McLeod on the occasion of his retirement from the Brotherton chair of bacteriology. The following have been appointed lecturers in the University: Dr. R. W. Owen (zoology), F. R. Mobbs (mechanical engineering), and G. Hay, G. W. Reed and Miss Margaret T. Morrison (medical physics).

Fourteenth International Congress of Zoology, Copenhagen

THE Fourteenth International Congress of Zoology will be held in Copenhagen during August 5–12, 1953, under the presidency of Prof. R. Spärck, with Dr. Anton Fr. Bruun as secretary-general. It is proposed to hold three general meetings for all members of the Congress; but otherwise the proceedings will be divided into various sections, each dealing with specialized topics. Two excursions to West and East Jutland have been planned after the Congress, and possibly a third one to study marine fauna of the deeper part of the Skagerrak; no excursions will take place before August 5. Membership fee for the Congress is 100 Danish kroner (approximately £5 5*s*. or 15 dollars).

Conference on Race Problems

THE British Social Biology Council is holding a one-day conference on Saturday, December 6, on race problems. The subject will be approached from three angles: the biological, the psychological and the anthropological. The main speakers will be Dr. A. F. Mourant, Dr. Kenneth L. Little, W. R. Bion and M. Freedman. Chairmen will include Dr. Julian Huxley and Dr. B. W. Gussman. The conference will be held in the Chemistry Lecture Theatre at University College, London, and tickets can be obtained from the Secretary, British Social Biology Council, Tavistock House South, Tavistock Square, London, W.C.1, price 7*s*. 6*d*. (or 5*s*. for students whose applications are endorsed by some person of suitable status).

Announcements

H.R.H. THE DUKE OF EDINBURGH will open the new wing of the Department of Engineering in the University of Cambridge on November 13.

SIR HARRY GARNER, chief scientist to the Ministry of Supply since 1949, is to retire early next year. He will be succeeded by Dr. O. H. Wansbrough-Jones, principal director of scientific research (defence) in the Ministry since January 1951 and formerly scientific adviser to the Army Council (see *Nature*, 157, 688; 1946).

AT the opening session on October 4 of the academic year at the University of Liège, the degree of doctor of medicine *honoris causa* was conferred on Prof. Réné Fabre, doyen of the Faculty of Pharmacy, University of Paris, and on Prof. D. Keilin, director of the Molteno Institute, University of Cambridge.

THE third meeting of the European Association of Exploration Geophysicists will be held in the Stadthalle, Corvinusplatz 2, Hannover, during December 4–5, the business meeting being held the previous evening. Twenty papers from various European countries will be presented as follows: nine on seismic, seven on gravity, one on magnetic, two on telluric and electrical, and one on radioactivity methods of prospecting. Further particulars can be obtained from the secretary/treasurer, Dr. B. Baars, 30 Carel van Bylandtlaan, The Hague, or from Dr. D. T. Germain-Jones, Kirklington Hall, Nr. Newark, Notts.

UNDER the provisions of the Fulbright Programme, travel grants are available to citizens of the United Kingdom and British Colonies to go to the United States for academic or educational purposes, provided that they have the financial support in dollars for the visit and are affiliated to an American institution of higher learning. The grants cover the cost of direct travel from the candidate's home to America and return, and are available during June 1, 1953–May 31, 1954. Applications must be submitted by March 16, 1953 (those travelling between June 1 and July 31) or June 15 (those travelling after August 1). Further information can be obtained from the United States Educational Commission in the United Kingdom, 55 Upper Brook Street, London, W.1.

IN a notice of the *Journal of Scientific Instruments* published in *Nature* of August 23, p. 298, it was remarked that: "When the *Journal* was started in 1923 it was the only periodical devoted to . . . scientific instruments". Mr. L. B. Tuckerman, of the National Bureau of Standards, Washington, D.C., points out that the first issue of the *Journal of the Optical Society of America and Review of Scientific Instruments* appeared in January 1922, and that the *Zeitschrift für Instrumentkunde* was a well-established journal by 1923, having been started in 1881.

THE new photoelectric absorptiometer referred to in *Nature* of October 25, p. 694, is manufactured and sold by the Hilger Division of Hilger and Watts, Ltd., 98 St. Pancras Way, Camden Road, London, N.W.1.

THIRD INTERNATIONAL SYMPOSIUM ON THE CHEMISTRY OF CEMENT

A SYMPOSIUM on the chemistry of cement, sponsored jointly by the Building Research Station of the Department of Scientific and Industrial Research and the Cement and Concrete Association, took place in London during September 15–20, the opening session being held in the Royal Institution and the others at the Royal Society of Arts. Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, was president of the symposium, and Sir Francis Meynell, director of the Cement and Concrete Association, vice-president.

More than two hundred and fifty specially invited representatives attended, including more than a hundred from overseas, twenty-six countries in all being represented. In addition to the scientific meetings, visits to laboratories and factories and social events were arranged, all of which were well attended and appreciated.

In opening the symposium, Sir Ben Lockspeiser outlined the organization of research on cement and concrete in Great Britain and directed attention to the close co-operation which is maintained between Government institutions such as the Building Research Station and the Road Research Laboratory and those supported entirely by the industry, such as the Cement and Concrete Association and the individual laboratories maintained by the larger manufacturers. The annual production of concrete and concrete products in Great Britain amounts to a value of about £180,000,000, and of this sum only about one-fifth of 1 per cent is spent on research. This leaves room for further expansion of research on cement and its derivatives. Sir Francis Meynell, in a following address, brought out in greater detail the functions of the Cement and Concrete Association. It is supported by a levy on the tonnage of cement produced, and by the end of 1951 the grand total raised in this manner amounted to nearly 1¼ million pounds. Nearly £100,000 has been used for capital expenditure in the recently opened Research and Development Station of the Association at Wexham Springs. Other introductory addresses were given by Dr. R. H. Bogue, on behalf of Dr. A. A. Bates, vice-president of the United States Portland Cement Association, Prof. H. Lafuma, director of the Centre d'Études et de Recherches de l'Industrie des Liants Hydrauliques (France), and Prof. G. Wästlund, director of the Swedish Research Institute for Cement and Concrete. The final event of the opening session was a paper by P. Gooding and P. E. Halstead, on the early history of Portland cement in England.

The first of the technical sessions was devoted to studies of the constitution of Portland cement clinker. Papers were presented on tricalcium silicate (J. W. Jeffery, United Kingdom), dicalcium silicate (R. W. Nurse, United Kingdom), the interstitial phases (H. Insley, U.S.A.), the ferrite phase (G. L. Malquori and V. Cirilli, Italy), the alkali phases (T. F. Newkirk, U.S.A.), and tricalcium aluminate (F. Ordway, U.S.A.). Dr. R. H. Bogue, director of the Portland Cement Association Fellowship (U.S.A.), closed the session with a paper on "Studies on the Constitution of Portland Cement Clinker". It emerged from this series of papers that the crystal structures of the two main cementing agents, tricalcium silicate (Ca_3SiO_5) and dicalcium silicate (Ca_2SiO_4), are now known. Good approximations to the structures of tricalcium aluminate ($Ca_3Al_2O_6$) and the ferrite phase have been found. All these minerals take up minor oxides in solid solution, the composition of the ferrite phase being particularly variable, and some are further complicated by polymorphism. The information derived from crystal-structure studies has supplemented that obtained from phase-rule studies and from microscopic and X-ray examination of cement clinker. Methods of dealing with systems of four to six components were discussed by Dr. Bogue, and advances in technique, such as the high-temperature centrifuge and methods of growing single crystals for X-ray structure analysis, were described.

In the session devoted to the setting and hardening of Portland cement, papers were presented by Prof. J. D. Bernal (United Kingdom), H. H. Steinour (U.S.A.), G. L. Kalousek (U.S.A.), F. E. Jones (United Kingdom) and Prof. T. Thorvaldson (Canada). Much progress was reported in the chemistry and crystallography of the hydrated calcium silicates. The unit-cell dimensions have been determined for ten of the natural or artificial hydrated calcium silicates, which appear to form two groups, having respectively a fibrous or non-fibrous character. The fibrous group is characterized by a short fibre repeat unit of 3·65 A., which may imply the existence of silicate tetrahedra joined by hydrogen bonds, or may arise from columns of Ca—Si—O linkages. $(SiO_3OH)^{3-}$ ions have been shown to exist in afwillite. At normal temperatures two closely related calcium silicate hydrates are formed in the system $CaO—SiO_2—H_2O$, both belonging to the fibrous group and also having a layer structure, the spacing of the layer varying with the state of hydration between 9 and 14 A. This behaviour is reminiscent of certain clay minerals, and may be related to the shrinkage properties of concrete. The method of differential thermal analysis has been applied to the study of the hydrated calcium silicates, and many of the advances reported were made possible by new techniques in X-ray crystallography.

Some divergence of opinion developed regarding the constitution of set cement, the results of differential thermal analysis being interpreted as showing the existence of a single phase, whereas limited X-ray data seemed to show the independent existence in the set mass of calcium silicate and aluminate hydrates. The two methods do, however, give consistent results when applied to the study of cement cured at high temperature and pressure. Although steam treatment is commonly applied as a method of accelerating the development of strength in concrete products, it has long been known that under certain conditions the expected gain in strength may not materialize. This was shown to be related to the formation under transient conditions of a calcium silicate hydrate of the non-fibrous group.

An interesting development in the study of chemical attack on concrete is the use of radioactive sulphur as a tracer to determine the rate of diffusion of the sulphate ion in cement pastes and mortars.

The Second International Symposium (Stockholm, 1938) dealt only with Portland and high-alumina cements; but the scope of the present meeting was extended to include a session on special cements.

Papers were read on high alumina cement (T. W. Parker, United Kingdom), slag cements (F. Keil, Germany), expansive cements (Prof. H. Lafuma, France), oil-well cement (W. C. Hansen, U.S.A.) and masonry cement (C. E. Wuerpel, U.S.A.).

The constitution of high-alumina cement is complicated by the division of its fairly high iron content between the ferrous and ferric state. Theories of constitution have, in the past, been based mostly on the results of petrographic examination, since phase-rule studies have not been of great value. At the recent meeting, it was shown that if MgO is used as a 'model substance' for FeO, phase data in the system $CaO—MgO—Al_2O_3—SiO_2$ can be applied to this problem. Thus the blue pleochroic mineral described by Sundius and others has been shown to have the composition $6CaO.4Al_2O_3.FeO.SiO_2$. In identifying the calcium ferrites and alumino-ferrites, measurement of reflecting power of the microscopic grains has been found useful.

The principal constituent of slag cements is a glass formed by the rapid quenching in water of molten blast-furnace slag. Such glasses vary widely in their reactivity as cements, and many attempts have been made to relate this activity to chemical composition. Work on artificial glasses containing only a few components was described, and also preliminary attempts to elucidate their structure by chemical means. A number of useful empirical tests for the quality of granulated slag were discussed.

The deliberate production of a controlled expansion is one method of compensating the shrinkage which accompanies the drying of normal cements. For certain applications, such as patching, underpinning and post-stressing, a larger expansion can be produced if necessary. The method employed is to bring about the formation of calcium sulphoaluminate in the set mass; this reaction is the principal cause of the disintegration of concrete in sulphatic waters; but in the present application the expansion is kept under careful control.

Oil-well cements are required to set at considerable depths below the ground under conditions of high temperature and pressure; but the setting time must be long enough for the cement slurry to be pumped down to the required depth. In the paper presented to the symposium, the various organic substances used for regulating the set were classified and it was suggested that HO—C—H groups are particularly effective in retarding the action of water on cement.

For use in masonry jointing or as a rendering, ordinary cement requires to be diluted with lime, limestone or fine sand, to reduce the formation of shrinkage cracks, and to improve the working properties of the mortar. Air-entraining agents may also be added. A modern development is to market the accurately proportioned mixture as masonry cement. Various problems arise in testing such cements, involving a knowledge of the rheological properties of stiff and semi-plastic pastes.

In the final session, the applications of research in cement manufacture were discussed in papers by H. Gygi (Switzerland) and T. Heilmann (Denmark), while A. R. Collins (United Kingdom) and M. A. Swayze (U.S.A.) presented papers on problems in the utilization of cement.

The closing address was given by Dr. F. M. Lea, director of building research, Department of Scientific and Industrial Research, who surveyed the work of the symposium and suggested lines along which future research might be developed. He referred to the great advances made since the last symposium in the application of X-ray analysis to cement research. One of the most baffling problems in this field has been the determination of the state of the water held in set cement. By means of X-ray structure analysis, it has been shown that some of the water chemically combined can be present as hydroxyl groups and some as molecular water. There must be a relationship between the expanding lattice of the hydrated silicates and shrinkage and moisture movement of concrete. The picture that is emerging as a result of this work and of the physical studies made on cement pastes using the adsorption isotherm technique is much more satisfactory than the earlier theories based solely on capillary phenomena and the Kelvin equation.

The combination of electron microscopy with electron diffraction is proving in this, as in other fields, a powerful research tool, and the use of ultrasonic energy for dispersing material and hastening chemical reaction is of great interest and may possibly have practical applications.

As a result of the research already done, the civil engineer is now presented with a choice of cements eminently suited to particular applications. As old problems are solved, however, new ones arise, and there is a constant need for a background of research in an industry so important as that of cement manufacture.

The proceedings of the Symposium, including the written and spoken discussion, will be published. Inquiries should be made to the Organizing Secretary, P. Gooding, Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1. R. W. Nurse

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INTERNATIONAL ASTRONOMICAL UNION

The eighth General Assembly of the International Astronomical Union was held in Rome during September 3–13, on the invitation of the Consiglio Nazionale delle Ricerche. The inaugural ceremony took place in the Hall of Orazi and Curiazi in the Campidoglio, when the Mayor of Rome, the president of the Consiglio Nazionale delle Ricerche, Prof. Gustavo Colonnetti, and the Minister of Education welcomed the Congress, and the president of the Union, Prof. Bertil Lindblad, replied. More than four hundred delegates from thirty-six countries were present. After the opening session of the General Assembly, the Union resolved itself into a number of small groups: thirty-nine commissions of the Union covering all branches of astronomy met either separately for their special work or jointly for discussions of common interest. In addition, two Joint Commissions of the International Council of Scientific Unions—Spectroscopy and Solar and Terrestrial Relationships—took the opportunity of the gathering to hold meetings in Rome at the same time. Further, three symposia were organized, each for a full day. These were on "Stellar Evolution", on "The Astrometry of Faint Stars" and on "Instruments".

The following took part in the first symposium: V. A. Ambartsumian, O. Struve, B. Lindblad, W. Baade, E. Kukarkin, L. Gratton, F. Hoyle, A. Severny, G. A. Shajn, C. Fehrenbach, V. G. Fessenkov, E. Schatzmann, G. P. Kuiper, M. Schwarzschild,

T. Gold, H. Alfvén, R. A. Lyttleton and D. Martynov. The papers of Shajn and Fessenkov were read for them in their absence. The discussion, as may be judged by the names of those taking part, was lively and at times argument was intense; naturally, no decisions were reached, but a most stimulating meeting was held. The importance of Baade's two stellar populations came prominently into view. The chairmen were H. Bondi and O. Struve.

In the second symposium, which was concerned with the positions and motions of faint stars, the chairmen were J. Jackson and A. A. Nemiro. The subject-matter was less controversial, but perhaps more fundamental, than in the case of the first symposium, and the speakers or contributors of papers included M. S. Zverev, A. Blaauw, A. N. Deutsch, A. Kopff, J. Larink, J. H. Oort, E. W. Rybka, S. Vasilevskis, A. N. Vyssotsky, D. Brouwer and R. H. Stoy. In the third symposium E. H. Linfoot, A. Couder, A. Lallemand and I. S. Bowen presented papers on various telescopes and auxiliary apparatus.

Several of the meetings of groups of commissions must be mentioned. The Commissions on Ephemerides, Astronomical Constants, Celestial Mechanics, the Moon, Minor Planets, Comets and Satellites held a joint meeting at which the recommendations were adopted which had been made to the Union by the Paris conference, held in 1950, on the fundamental constants of astronomy. A whole day was devoted to a discussion of the spectra of variable stars at a joint meeting of the Commissions on Variable Stars and Stellar Spectra—more than thirty papers were presented. A joint meeting of the Commissions on Radio-astronomy, Interstellar Matter and Stellar Statistics produced, perhaps, the high lights of the meeting—Oort's account of the possibilities of exploring the dark arms in the Milky Way spiral structure through the use of the 21-cm. line due to atomic hydrogen, and Baade's account of the discovery of rings and wisps of nebulosity surrounding the positions of radio stars located by the observers at Cambridge and Manchester.

During the meeting, visits were paid to the Observatories at Castel Gandolfo and Monte Mario. On the former occasion, His Holiness Pope Pius XII addressed the Union on the progress achieved by astronomy and astrophysics in the past fifty years, and afterwards met individual members and spoke with them on their work.

At the closing session of the Union, a number of recommendations from the Commissions were adopted. Among others, mention must be made of the folowing: an appeal for observations of the transit of Mercury across the sun's disk in November 1953; an amendment of Brown's Tables of the Moon by removing the empirical term and applying a correction to the mean longitude; an appeal for further work in the southern hemisphere in the field of fundamental meridian astronomy, catalogues of faint tars, and an extension of the Lick sky survey; another appeal for systematic measurements of the general magnetic field of the sun; a suggestion for a oint commission with the Unions of Geodesy and Geophysics and of Radio-Sciences to arrange, possibly n connexion with a proposed International Polar (or Geophysical) Year in 1957–58, for a third set of eterminations of an accurate network of world ongitude; and a general adoption of the three-letter omenclature for constellations. Financial recommendations approved by the Finance Committee and dopted included a number of regular items and, in addition, a grant for the Astronomical News Letters which summarize work published exclusively in Russian; a grant to Meudon Observatory to put into operation the photo-electric photometer of the late Bernard Lyot, for measuring the intensity of solar coronal spectral lines; a grant to P. Swings for the publication of a photographic atlas of typical spectra of comets; and a grant to facilitate the exchange of astronomers between countries.

Invitations for the next General Assembly of the Union had been received from Eire and Poland. A vote by countries was in favour of accepting the invitation from the Dublin Institute for Advanced Studies, and the next General Assembly will be held in Dublin in 1955. The Bureau for the next three years was elected as follows: *President*, O. Struve (U.S.A.); *Vice-Presidents*, V. A. Ambartsumian (U.S.S.R.), A. Couder (France), E. Rybka (Poland), P. Swings (Belgium) and R. v. d. R. Woolley (Australia); *General Secretary*, P. Th. Oosterhoff (Netherlands). The retiring president and secretary, B. Lindblad (Sweden) and B. Stromgren (Denmark and U.S.A.), are *ex officio* members.

The above account indicates clearly the crowded nature of the activities of a very successful meeting. Although the symposia and group meetings were most successful and added greatly to the interest of the meeting, there were signs in several quarters of a tendency to crowd out the administrative organizational work of the separate commissions. This tendency must be watched carefully, as such work is the real fundamental basis of the Union's continued success. No account of the meeting could be regarded as complete without reference to the most generous hospitality received in Rome from the Mayor of Rome and from the Consiglio Nazionale delle Ricerche, who placed every facility at the disposal of the Union.

F. J. M. STRATTON

THE BRITISH PHARMACEUTICAL CONFERENCE, 1952

THE eighty-ninth British Pharmaceutical Conference was opened at Nottingham on September 1 and the attendance exceeded five hundred. The chairman, Mr. H. B. Mackie, approached the subject of pharmaceutical education with originality when he entitled his address: "An Education for a Pharmacist". He pictured the pharmacist as a professional man, comprehending the scientific basis of drugs and drug action, able to evaluate critically the products he handles and competent to advise physicians concerning drugs and their uses.

The early education of the future pharmacist, Mr. Mackie said, should be as broadly based as possible, designed to discover aptitudes and latent potentialities and should seldom degenerate into formalized, didactic instruction. Latin might be restored to its original place, for young people lacking Latin have a hard road to travel to be completely literate. The test of a successful early education is not the amount of knowledge that a pupil takes away from school but his appetite to know and capacity to learn.

Of professional studies, there is little to be said concerning pharmaceutical chemistry—now fairly clearly delimited. Pharmacology and pharmacognosy used in the broadest sense mean the same thing, 'knowledge about drugs', both terms having now assumed an acquired meaning. Pharmacology is important, since it provides a link in the chain of knowledge between pharmacy and medicine. A modern education for a pharmacist must strengthen the link. The changing and enlarging field of therapeutics confronting the physician makes it imperative that he have assistance in finding his way through the labyrinth of complex, controversial materials. The pharmacist should be so trained as to be a source of authentic, unprejudiced information and able to inform the public as to the merits of new therapeutic agents. Probably all would agree that any course of applied science should provide information, useful to the student in solving problems of to-day and to-morrow, while teaching principles in preference to communicating isolated facts. Facts are quickly forgotten and are found in hand-books. Understanding is more difficult to acquire, but once acquired becomes an integral part of the student's mind.

The use of drugs has a very long history; but pharmacognosy as a science dates from the beginning of the nineteenth century. Despite increased chemical knowledge about natural products, there has been little influence upon the teaching of pharmacognosy. The subject could be usefully integrated with pharmacology. Although doubts have been expressed about the necessity of pharmacognosy for the practising pharmacist, it is pharmacy's specific and peculiar contribution to the cause of science. It behoves us to esteem it well.

Galenical pharmacy enables us, Mr. Mackie pointed out, to present trains of thought and methods of scientific manipulation, which as yet lie outside the domain of equations and formulæ. Terms such as 'tincture' and 'syrup' apply to a complex association of materials derived from vegetable structures, and processes involved in their preparation date to the beginning of man's historical record. Galenical pharmacy is and always has been based on colloidal complications. As the normal structure and juices of most or all plants are colloidal, the study of pharmacy as applied to natural substances is that of colloidal research and colloidal manipulation. Accepting that non-crystalline substances compose the major part of plant tissues, it becomes the pharmacist's duty to disentangle these complicated structures, providing a product not having undergone fundamental re-arrangement.

There is no 'alkahest', no universal solvent, as was dreamt of by Paracelsus. The most promising neutral liquids for extracting natural colloidal groups are listed by Uri Lloyd. These solvents may virtually exhaust most plant contents. A saturate is not an ultimate, but may be complex and require subdivision, giving more closely related substances. Such manipulation individualizes colloidal plant structures to a degree of pharmaceutical satisfaction, though not absolute chemical perfection. The use of a neutral liquid as an excluder is exemplified in ox-bile and the piecemeal separation of certain opium alkaloids; then reassembly produces well-known injectable products. There appears practically no limit to the production of medicaments which evoke the precise therapeutic response desired, plus the synergistic effect that frequently accompanies this, while free from inhibiting or damaging reaction. Colloidal scales possessing all the properties of the original drug may be produced. A new field has been introduced by the discovery of the alkaloidal affinities of hydrous aluminium silicate, though it is not yet certain if it will enable us to obtain plant substances in a purified and active form.

In the therapeutic application of a substance its condition is most important; for example, the superiority of finely divided mercury. The alkaloidal strength of a nux vomica galenical may be increased by adding strychnine, but has the quality improved?

The attempt to achieve standardization by a single dominating constituent is but a struggle towards a pharmaceutical standard of excellence in which therapeutic quality should be the ideal and which for the moment should be stressed in our scheme of training. It is fanciful to believe that there is some analogy between elaborately processed 'foods' and the substitution of synthetic chemicals in medicine for naturally occurring substances. The future pharmacist will not be chiefly a purveyor of tablets, and it may be true to-day as when written in medieval times that "Contra malum mortis non est medicamen in hortis".

Mr. Mackie completed his address by reminding his fellow-teachers that some of the most important men in history have been teachers. Many of the biggest advances in civilization have been the chief work, not of politicians or inventors, not even of artists, but of teachers. We have Ruskin's assurance that pay alone never made a better soldier or a teacher. We are servants of reality; our responsibility is to the young and through them to the future.

Among the scientific papers read and discussed at the Conference, there were several which reflected the tone of the chairman's address. Factors influencing the separation of hyoscine and hyoscyamine by elution development of a chromatographic column had been studied and a simple assay described. Another paper was concerned with the detection of common medicinal alkaloids by the chromatographic method. Much work was reported on the assay of *Digitalis* glycosides. One group of workers had investigated the assay of mixed chloroform-soluble glycosides, while others dealt with the colorimetric estimation of digitoxin and compared the method with biological assay.

Assay methods were, in fact, a prominent feature of the papers read. The polarographic estimation of riboflavine was found to be more reliable than the simple colorimetric method and more rapid than other methods used. The available methods for the determination of ascaridole were reviewed and a possible polarographic method examined. The use of emission spectrography in pharmaceutical analysis was reported upon, and the methods outlined showed a considerable saving of time over normal chemical methods. A useful contribution was made to the evaluation of surface-active agents, based on the measurement of stability of the emulsions yielded. Two workers indicated that a small lymphocyte count is a more accurate method of pyrogen assay than temperature measurement.

Studies on tuberculostatic compounds reflected the vitality of pharmaceutical research. Papers dealt with methods of assaying *iso*-nicotinic acid hydrazide and the more general pharmacology of *p*-aminosalicylic acid.

Antibiotics featured prominently in the discussions of the Conference, and it was reported in one paper that the pharmacodynamical groups present in the chloramphenol series fall into two categories, namely, specific and relatively non-specific. Recent developments in the pharmacy of antibiotics were dealt with in a symposium session which covered aspects of general and hospital practice. A contribution to the latter session gave a more widespread picture of the subject and illustrated the remarkable expansion of knowledge achieved since the general discussion on penicillin at the 1946 Conference.

Other developments in the field of pharmaceutics included the successful use of infra-red radiation for drying a wide variety of products. Bacterial survival in systems of low moisture content was further reported upon, namely, the effects of increasing moisture content on heat resistance, viability and growth of *B. subtilis* spores. The determination of quality of surgical dressings had been further investigated, on this occasion being concerned with their water retention.

S. B. Challen

FISHERIES RESEARCH UNIT OF THE UNIVERSITY OF HONG KONG

THE need for a Fisheries Research Station in Hong Kong has long been realized; but the various plans for one which have been put forward from time to time have for various reasons been found impracticable. However, a satisfactory scheme was recently worked out by the University of Hong Kong in conjunction with the local Government, and a Fisheries Research Unit commenced work recently in the University's Department of Biology. The University has provided approximately a thousand square feet of laboratory accommodation for the Unit, and the director is reader in marine biology on the University's staff. The association between the Unit and the Department of Biology esembles that existing between various agricultural esearch units which are attached to a number of universities in Great Britain, for example, the Bureau of Animal Population and the Department of Zoology n the University of Oxford.

The director, Mr. Alan Tubb, who was formerly director of fisheries in the Colony of North Borneo, will take up his duties in April next year; meanwhile, Prof. D. Barker, professor of zoology and head of the Department of Biology in the University, is acting irector. The director will be assisted by a chief scientific officer and three assistant scientific officers; so far, two assistants have been engaged. The rest f the staff establishment consists of a laboratory teward and attendants, and the skipper and crew f a research vessel at present under construction. The laboratory accommodation includes marine quaria supplied with running sea-water, and a aboratory suitable for chemical and biological work. here is a considerable library of books and journals n fisheries research, and the Unit has access to the University's scientific library. Provision has been made for equipping the Unit's laboratory with the ppropriate research facilities and apparatus. The cost of establishing the Unit is being met out of olonial Development and Welfare funds, while ecurrent expenditure is being met by the local overnment; in each case the government conibution is by means of block grants made over to he University for its administration.

The research vessel is a 66-ft. diesel-power ter trawler. The keel is now being laid a e should be in commission by the summer o 953. She will be equipped with a laboratory, ech sounder, radio telephone and wireless telegraphy, bottom sampler, bathythermograph, and various other apparatus required for oceanographical work. The vessel will work in waters up to a hundred miles distant from Hong Kong, and the longest trips will be of from seven to ten days duration.

From the point of view of marine research, Hong Kong is very favourably situated, being at the extreme south-east corner of Asia almost at the junction of temperate and tropical waters and within easy reach of ocean and estuarine fishing grounds. The Fisheries Research Unit is the most easterly of a chain of Commonwealth fisheries research stations, and its researches and findings will not only be correlated with those of Ceylon, Malaya and India, but will also be of value to the Dominions of Canada and Australia and to other countries which border on the Pacific Ocean or the China Sea. It is expected that the research carried out by the Unit will lead to improvements of catch in the immediate neighbourhood of Hong Kong and will contribute substantially to general fisheries research in the Indo-Pacific region. Under the auspices of the Indo-Pacific Fisheries Council, the Unit will pool its results and collaborate with similar stations in the Philippines, North Borneo, French Indo-China and Malaya in research projects relating to the China Sea. Among other problems the Unit will aim at undertaking the following research: survey the existing fishing grounds around Hong Kong, map them, and determine their species population and production; survey the sea-bottom, salinity and plankton in local waters; study ocean currents and the effect of such currents and prevailing winds on the movement of fish, with the possibility of discovering new fishing grounds; determine the influence of the Pearl River on the fishing around Hong Kong; study factors influencing the yield of catch in the local fishing grounds with the view of forecasting production; investigate the movement and feeding habits of fish, and, wherever possible, locate spawning grounds, etc., with the aim of trying to initiate control; make studies in relation to the extension and improvement of salt, brackish and freshwater fish-pond culture.

UNESCO INSTITUTE FOR EDUCATION, HAMBURG

UNESCO has recently sponsored an unusually interesting experiment in West Germany, on a smaller scale than those activities with which Unesco is popularly associated. The experiment consists of the establishment of three Institutes, each of which began work during 1952. One is for Social Sciences at Cologne; one for Youth, at Munich; and one fo Education, in Hamburg.

These Institutes are remarkable in two respec First, each has an international governing bo consisting of seven non-German and six Germ members, the funds of which are derived not from general Unesco budget but in response to an ap by the Director-General to individual nati Secondly, the Federal Republic of Germany agreed [illegible] the establishment w [illegible] amounts to the Institutes are to be found India and the Philippines; and the United Kingdom is not to be found among the principal contributors, France, Germany and the United States.

With regard to the Institute of Education at Hamburg, the objects are briefly: (1) to foster international study of educational problems (particularly to enable German educators to meet educators from other countries); (2) to carry out research into educational aims and methods; and (3) to participate in action undertaken by Unesco in its campaign for the maintenance of peace and in its programme of education for international understanding.

The Governing Board determines policy from time to time and is responsible for framing an annual budget. The Board consists of representatives of Germany (six), Canada, Denmark, France, Italy, Switzerland, the United Kingdom and the United States of America (one each), together with a representative of the Director-General of Unesco. From among the members of the Board, a Standing Committee of five has been appointed, again with a marginal majority of non-German members.

The Governing Board decided that the first item on the programme of the Institute should be a seminar on "Adult Education as a Means of Developing and Strengthening Social and Political Responsibility". This seminar opened on September 8 and continued for one week. Thirty-five participants from fourteen countries (including three from England) were the guests of the Institute. The physical atmosphere of the Institute provided assurance of a favourable meeting place. The introductory remarks of the director of the Institute, Prof. Walther Merck, and of the chairman of the Governing Board, Prof. J. Novrup (but in his capacity as an ordinary participant) led the seminar along the road of realistic discussion of some of the problems of adult education. The five groups into which the members divided (two English-speaking, two German and one French—but with a wide distribution of nationalities) discussed aspects of political responsibility, social responsibility and special methods in adult education. It was generally agreed that nothing really new had emerged, or indeed could be expected to emerge, but that for the first time the issue of political responsibility had been squarely faced. A full report will be published later in English, French and German.

Anyone attending the Institute's social evening, with cold supper and wines served in the Institute House, and joining the subsequent gathering in the library, would have found it difficult to believe that such a diversity of nations could behave and indeed think and act with such bon-accord, despite difficulties of language.

The Institute received many valuable suggestions for further action, and these are now being examined to find out how far they can be implemented, and whether some of them can be pursued in co-operation with the Youth and Social Sciences Institutes.

The second major item on the Institute's pro- [illegible] seminar on "The Factors of Pre- [illegible] ch influence the Development [illegible] able to participate in a [illegible] e of this seminar has [illegible] ill be held in the [illegible]

HUGH MILLER, 1802-56

COMMEMORATION AT CROMARTY

By SIR EDWARD BAILEY, F.R.S.

COMPARATIVELY few now remember the stir attending the centenary of Hugh Miller's birthday, celebrated in 1902. Some 1,500 pilgrims from far and near assembled under the great column and statue which already commemorated Cromarty's most distinguished son. Sir Archibald Geikie was that day chief among a dozen speakers, including Principal Rainy, of the United Free Church, Prof. Clarke, of Albany, U.S.A., Dr. John Horne, of the Geological Survey, and Sir James Grant, president of the Royal Society of Canada. Geikie gave of his best in love and gratitude to the memory of the man who had introduced him, and many others of his generation, to the wonderland of geology. In doing so he remarked, a little pathetically, that he found himself the last survivor among geologists who could lay claim to intimate friendship with the erstwhile stonemason. Fortunately, his beautiful address is fully reported in *Nature* (66, 426, 1902), while the ceremony as a whole is detailed in a valuable booklet entitled "The Centenary of Hugh Miller" (Glasgow, 1902).

Carnegie was among those present at the centenary gathering, and shortly afterwards he generously presented Cromarty with a Hugh Miller Library and Institute—a further fitting memorial. Then, in 1938, the National Trust of Scotland, which meanwhile had come into existence, took over from the Town Council the cottage where Hugh Miller had been born, already functioning as a shrine. The occasion was marked in *Nature* (142, 696; 1938) by an appreciation of Hugh Miller's work.

On October 14 of the present year, on the invitation of the Earl of Wemyss, chairman of the National Trust, a small gathering of about fifty met in the paved courtyard of Hugh Miller's cottage to celebrate the hundred and fiftieth anniversary of the great man's birth. After the chairman had explained the Trust's need for additional memberships and subscriptions to carry on its vitally important tasks of conservation, he asked Sir John Erskine, general manager of the Commercial Bank of Scotland, to recall a significant episode in Hugh Miller's career. Sir John reminded us how, after fifteen years as stone-mason, Hugh Miller, in 1834, accepted an offer of the accountantship of the Commercial Bank's agency at Cromarty; and how he held this post until, at the beginning of 1840, he agreed to edit *The Witness*, a militant newspaper launched to represent the views of an important section of the Presbyterian Church of Scotland. Sir John cited contemporary evidence of Hugh Miller's speedy adaptation of himself to a totally new style of endeavour, which brought him not only increase of money—very welcome to a man in love—but also increase of opportunity for study and writing.

Subsequent speakers were the Rev. J. H. Baxter (University of St. Andrews) and the Rev. John Macleod (University of Aberdeen). Both stressed the intensely religious outlook of Hugh Miller and his extraordinary (and also successful) introduction of ological discovery into the pages of *The Witness* om the very start of his editorship.

The anniversary meeting was blessed throughout ith perfect weather. An additional delightful feature was the presence of two great-grandchildren of Hugh Miller (Brigadier A. A. Middleton and his sister), along with two great-great-grandchildren and one great-great-great-grandchild—the latter, Louisa Gordon, aged six. Brigadier Middleton's father, Sir Thomas Middleton—a mere grandson—had been one of the speakers at the centenary fifty years ago; now Louisa Gordon was invited by Lord Wemyss to head the roll of attendance with her signature.

COBALT IN THE NUTRITION OF RUMINANTS*

Response of Cobalt-deficient Sheep to Massive Doses of Vitamin B_{12}

We now have unequivocal evidence that the deficiency-syndrome suffered by sheep grazed on cobalt-deficient pasture is, in fact, the result of vitamin B_{12} deficiency.

Experiments[1] conducted here in 1943–44, which showed clearly that, to be effective for the prevention or for the cure of the malady, cobalt must be administered *per os*, focused attention on the nutritional importance of cobalt for the development of some at least of the mixed population of organisms which normally inhabit the rumen, and indicated that cobalt might exert its activity, primarily, by favouring the proliferation of organisms responsible for the production of accessory food factors essential for the animal.

The fact that a profound macrocytic anæmia is a feature of the terminal stages of the cobalt-deficiency syndrome led us, early in our studies, to examine the effects of dosing with liver extracts, and much later, when small supplies of vitamin B_{12} became available, the effects of administration of the pure, cobalt-containing vitamin. The doses used in these earlier experiments were of similar order to those employed for depot therapy in the treatment of Addisonian pernicious anæmia (that is, 15–30 U.S.P. injectable units a week: the U.S.P. unit of liver extract contains approximately 1 μgm. vitamin B_{12}). In a series of experiments which would have enabled small effects to be measured, no significant change in the progress of the syndrome was observed to supervene on treatment with these amounts of liver extract or of vitamin B_{12}, irrespective of whether the dose was administered *per os* or parenterally.

More recently, Becker and Smith[2], who had identical experience with similar doses, reported that injection of much larger quantities of liver extract (15 U.S.P. units a day) into cobalt-deficient lambs elicited responses of the same order of magnitude as those brought about by administering adequate cobalt *per os*. These authors mentioned in an addendum to their paper that "larger amounts of vitamin B_{12} do result in a positive response in cobalt-deficient lambs", and, later, supporting evidence was published[3].

The first report led us to study the effectiveness of parenteral injection of relatively large amounts of vitamin B_{12} (equivalent to 300 μgm. vitamin B_{12} a week) into experimental sheep which had developed cobalt-deficiency while grazing on cobalt-deficient pastures, and which had failed to benefit from intramuscular injection of the equivalent of 15 μgm. vitamin B_{12} a week.

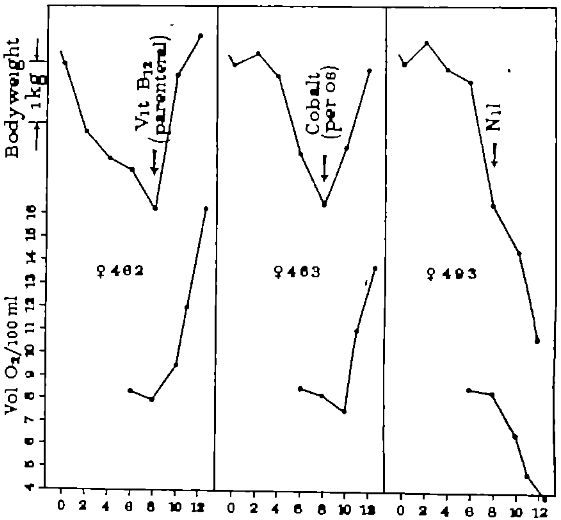

Fig. 1. Effect of treatment with cobalt and with vitamin B_{12} on the body-weight and oxygen-carrying capacity of the blood of ewes in an advanced stage of cobalt deficiency

The responses reported in Fig. 1 are typical. This group of three young merino ewes was one of a series drawn from an experimental flock that had grazed for approximately a year on frankly cobalt-deficient pastures, and which had not previously been treated with cobalt. All were in an advanced stage of cobalt-deficiency. The first criterion adopted for the selection of the animals into groups was the degree of anæmia —the oxygen-carrying capacity of the bloods of the animals in this particular group was close to 8 vol. oxygen per 100 ml. at the period when they were selected for treatment. The animals were of similar body-weight (c. 20 kgm.). At the point indicated, No. 462 was treated with 300 μgm. vitamin B_{12} a week, injected into the gluteal muscles in doses of 100 μgm. thrice weekly; No. 463 was treated with the equivalent of 7 mgm. cobalt a week administered *per os* thrice weekly at similar intervals; No. 493 was untreated and served as a control. The effects of the treatment are obvious. The slight lag in the response of No. 463 was typical of many but not all of the animals which received cobalt.

These observations, together with others from more intensive studies[4] of cobalt-deficient sheep confined in metabolism cages under laboratory conditions, leave little doubt that the syndrome of cobalt-deficiency in ruminants is the result of a shortage of vitamin B_{12}, and point to the probability that ruminants require much more of this vitamin than do other animals. Normally, when the cobalt concentration of the ingesta imposes no limit to the proliferation of organisms responsible for the synthesis of vitamin B_{12} in the rumen, the amount produced there is large (see footnote 5 for references).

A full account of these experiments will be published elsewhere.

HEDLEY R. MARSTON
H. JOHN LEE

June 3.

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* See also p. 807.

[1] Marston, H. R., and Lee, H. J., *Nature*, 164, 529 (1949).

[2] Becker, D. E., and Smith, S. E., *J. Nutrition*, 43, 87 (1951).

[3] Smith, S. E., Koch, B. A., and Turk, K. L., *J. Nutrition*, 44 455 (1951).

[4] Marston, H. R., and Smith, R. M. (see accompanying communication).

[5] Marston, H. R., *Physiol. Rev.*, 32, 66 (1952).

of Cobalt-deficiency in Sheep by Injection of Vitamin B_{12}

ES of experiments with merino ewes confined abolism cages and fed on cobalt-deficient has proved, *inter alia*, that vitamin B_{12}, iced parenterally in relatively massive amounts, revent the development of cobalt-deficiency oms and will spectacularly restore normal to sheep which have developed the malady. ndings imply that, in the nutrition of ruminants, functions merely to stimulate the proliferation se micro-organisms in the rumen which produce obalt-containing vitamin B_{12}; the activity of icro-organisms responsible for the fermentation rbohydrate in the rumen remains unimpaired the cobalt concentration of the fodder is reduced level which induces the profound deficiency-syndrome in the animal, as critical balance experiments have proved that the digestibility of the rations remains unaltered in these circumstances. The failure of appetite, which is the first symptom to appear, and which is progressive, is thus the result of a metabolic defect and not of a reduced capacity of the animal to digest and absorb its foodstuffs.

In these experiments the ration offered each day was comprised of 1 kgm. of cobalt-deficient wheat hay and 50 gm. of washed wheat-gluten: it provided 4,100 kcal. (gross) of combustible energy, of which between 40 and 42 per cent was voided in the fæces; it provided the protein equivalent of 18·3 gm. nitrogen, of which 5·9 gm. nitrogen appeared in the fæces; and, as the chaff contained 0·025 μgm. cobalt per gm. and the gluten rather less, it provided < 25 μgm. cobalt a day, which is less than one-third of the minimum requirement estimated from experiments with sheep on cobalt-deficient pastures[1]. When supplemented with cobalt, these rations maintain mature sheep (40–45 kgm.) in positive energy balance and in excellent health.

After being taken from normal pastures and confined to these rations, all the ten mature ewes which comprised the experimental animals referred to here increased gradually in weight for a period which, in some, extended for several months before their tissues became depleted to a degree which no longer allowed the animal to deal effectively with the whole of its rations; appetite then began to fail and eventually the syndrome progressed steadily in all the animals that were untreated.

The performance of the three ewes recorded in Fig. 2 is typical of the individuals which were the first to develop deficiency symptoms. The responses of No. 5009 to a supplement of 1 mgm. cobalt a day, *per os*, and of No. 7019 to 50 μgm. of vitamin B_{12} per day, injected intramuscularly, are virtually identical, and leave little doubt that the cobalt-deficiency syndrome is the consequence of a metabolic defect resulting from a deficiency of vitamin B_{12}.

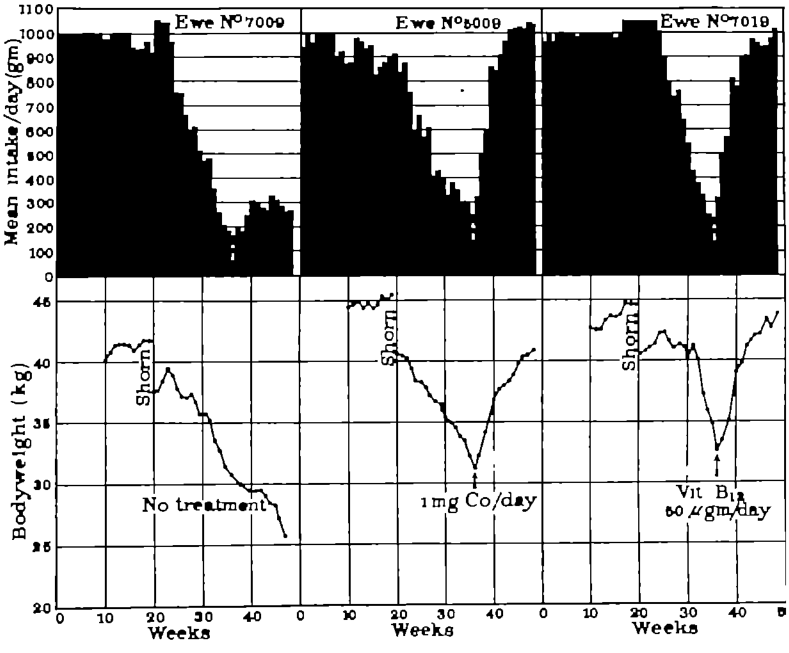

Fig. 2. Effect of treatment with cobalt or with vitamin B_{12} on the progressive failure of appetite and consequent loss of weight of sheep confined on rations short of cobalt

Of another group of three ewes, which after thirty-five weeks under identical conditions had not become depleted to the stage at which appetite begins to fail, one was treated with 1 mgm. cobalt a day *per os*, one with intramuscular injections of 50 μgm. vitamin B_{12} a day, and one was left untreated. The overall digestibility of the rations, and the vitamin B_{12} activity of the excreta, were determined in two 14-day periods, one immediately prior to treatment and one which began 14 days subsequent to the day on which treatment was started. Cobalt administered *per os* to No. 5012 increased the vitamin B_{12} activity in its fæces from 490 to 3,700 μgm. vitamin B_{12} (equiv.) per day as assessed by the *Escherichia coli* assay and from 245 to 720 μgm. vitamin B_{12} (equiv.) a day by the *Lactobacillus leichmannii* assay; whereas vitamin B_{12} administered to No. 9072 effected no significant change, the mean activities of the fæces passed in the pre- and post-treatment periods being 590 and 520 μgm. vitamin B_{12} (equiv.) a day (*E. coli*) and 250 and 280 μgm. vitamin B_{12} (equiv.) a day (*L. leichmannii*) respectively. The appetite of the untreated ewe, No. 9090, began to fail during the second collection period; at that juncture the mean vitamin B_{12} activity of its fæces was 400 and 270 μgm. vitamin B_{12} (equiv.) a day, as estimated by the respective methods.

As the treated animals in this group consumed the whole of their rations during both periods, the overall digestibility of cellulose and the quota of the combustible energy in the fodder which was excreted in the fæces could be estimated precisely. Neither cobalt (*per os*) nor vitamin B_{12} (parenteral) effected any change in the overall digestibility of the fodder, although a considerable alteration in the nature of the microbial population of the intestinal tract of the animal which received a supplement of cobalt is implied by the increase in the vitamin B_{12}-activity of its fæces. Similar balances were conducted on the other three animals mentioned above. The vitamin B_{12} activity of their excreta is discussed by our colleagues, Dawbarn *et al.*[2], who were responsible also for the microbiological assays reported here.

In all, these findings are in complete accord with the hypothesis that the syndrome of cobalt deficiency in the ruminant is the result of a metabolic defect arising from a profound deficiency of vitamin B_{12}. Ruminants apparently require much more vitamin B_{12} than other animals, but the reason for this is not yet clear. There is no evidence that cobalt performs any physiological function in the tissues of animals other than as a constituent of vitamin B_{12}. The details of these experiments will be published elsewhere.

HEDLEY R. MARSTON
RICHARD M. SMITH

June 3.

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[1] Marston, H. R., and Lee, H. J., cf. Marston, H. R., *Physiol. Rev.*, **32**, 66 (1952).

[2] Dawbarn, M. C., Hine, D. C., and Hughes, P. (see following communication).

Influence of Cobalt on the Production of Factors possessing Vitamin B_{12}-like Activity in the Fæces of Sheep

WE have estimated the vitamin B_{12} and similar factors in the urine and fæces of a number of sheep which were confined in metabolism cages and fed on cobalt-deficient rations, and which were employed by Marston and Smith[1] for the experiments referred to in the preceding communication.

During the collection periods referred to here, an aliquot of the urine passed each day was treated with cyanide, adjusted to pH 6·8 and stored at − 20° C. until composite samples were made up immediately before the assays were conducted. Aliquots of the fæces were taken each day and stored at − 20° C. in sealed containers until required.

Table 1. Effects of Administration of Cobalt and of Vitamin B_{12} on the 24-hr. Excretion of Vitamin B_{12}-like Substances in the Urine and Fæces of Sheep on Cobalt-deficient Rations

Sheep No.	"Vitamin B_{12}" in urine (μgm.) (*L. leichmannii*)		"Vitamin B_{12}" in fæces (μgm.) (*E. coli*)		(*L. leichmannii*)		Treatment in period *B*
	Period *A*	Period *B*	Period *A*	Period *B*	Period *A*	Period *B*	
7009	0·18	0·26	—	135	—	95	Nil
5009	0·15	2·9	110	2,500	50	320	1 mgm. cobalt a day (*per os*)
7019	0·83	12·7	100	310	60	115	50 μgm. vitamin B_{12} a day (parenteral)
9090	0·78	0·85	—	400	—	270	Nil
5012	0·23	3·1	490	3,700	245	720	1 mgm. cobalt a day (*per os*)
9072	1·03	6·1	590	520	250	280	50 μgm. vitamin B_{12} a day (parenteral)

TABLE 2. VITAMIN B_{12} EQUIVALENT PER GM. FÆCES AS VOIDED

During period *A*, the first three animals were in an advanced stage of the cobalt-deficiency syndrome and were refusing the greater part of their rations (ref. 1). The appetites of the other three had not begun to fail during period *A*, but during period *B* the untreated No. 9090 refused to consume the whole of the ration

Sheep No.	Period *A* Assay by *E. coli* (μgm.) (*C*)	Assay by *L. leichmannii* μgm. (*L*)	Ratio *C/L*	Period *B* Assay by *E. coli* (μgm.) (*C*)	Assay by *L. leichmannii* (μgm.) (*L*)	Ratio *C/L*	Treatment in period *B*
7009	—	—	—	0·66	0·46	1·4/1	Nil
5009	0·56	0·25	2·2/1	3·7	0·47	8/1	Cobalt (*per os*)
7019	0·77	0·46	1·7/1	0·75	0·28	2·7/1	Vitamin B_{12} (parenteral)
9090	—	—	—	0·45	0·30	1·5/1	Nil
5012	0·52	0·26	2·0/1	3·8	0·74	5/1	Cobalt (*per os*)
9072	0·50	0·21	2·4/1	0·46	0·25	1·8/1	Vitamin B_{12} (parenteral)

The active material in the urine was measured by its capacity to promote the growth and lactic acid production of *Lactobacillus leichmannii* 313 under strictly controlled conditions. Extracts of the fæces were analysed by this method and also by the plate method of Harrison *et al.*[2], in which the test organism is a mutant of *Escherichia coli*. The results are shown in Tables 1 and 2. All animals had been on the deficient rations for 35 weeks before the treatments were begun. Period *A* was the 14 days immediately prior to treatment; period *B* was the 14 days beginning a fortnight after treatment was started. The first three animals were in an advanced stage of the cobalt-deficiency syndrome and their food intake in period *A* was less than 250 gm. per day; in period *B* animals No. 5009 (cobalt) and No. 7019 (vitamin B_{12}) consumed more than double this amount, whereas the intake of No. 7009 (untreated) remained practically unchanged. The second three animals had not become sufficiently depleted for their appetites to fail and consumed the whole of their rations, 1,050 gm. a day, in period *A*. The intakes of No. 5012 (cobalt) and No. 9072 (vitamin B_{12}) were unchanged in period *B*, but No. 9090 (untreated) began to lose its appetite[1].

Ford and Porter[3] have reported that several "B_{12}-like factors" occur in the fæces of calves, and that these differ in their capacity to promote the growth of the two micro-organisms *E. coli* and *L. leichmannii*. We have found that the estimate of vitamin B_{12} activity in sheep fæces obtained with *E. coli* as the test organism was always higher than that with *L. leichmannii*. The relation between the two measurements has been expressed as a ratio (Table 2).

In the fæces of the cobalt-deficient sheep, the ratio was between 1·4 and 2·4 to 1. After the animals had been treated with cobalt (1 mgm. per day *per os*), each method of assay showed an increased concentration of 'vitamin B_{12}', and the ratio rose to 5 or higher. Injection of vitamin B_{12} (50 μgm. a day) into the animals had no appreciable effect on the vitamin B_{12}-like activity of a given weight of fæces.

It would seem that there are at least two "B_{12}-like factors" in sheep fæces and that their absolute and relative concentrations depend upon the level of available cobalt in the gut.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Possibility of the Quaternary Fission of Uranium-235

IN their classic paper[1] discussing the theory of the fission process, Bohr and Wheeler estimated the energy release to be expected in binary, ternary and quaternary fission of the compound nucleus of uranium-239. In the binary case, for fragments of equal mass, an energy release of 200 MeV. was obtained; for three nearly equal fragments, the energy release is slightly greater, being about 210 MeV., while for division into four comparable parts it falls to 150 MeV.

Experimental observation of the quaternary fission of uranium-235 was claimed by Ho, Tsien, Vigneron and Chastel in 1946 [2], when they observed an event in a photographic emulsion which they believed could be represented best as four-particle fission into masses of 81, 99, 36 and 20. In the analysis applied, there are an infinite number of solutions for the mass values but the chosen one gave a kinetic energy release of 114 MeV., which they regarded as fitting the theoretical estimate well. A second case, reported in 1947 [3], had three heavy fragments and one light fragment, and the estimated masses were given as 84, 76, 72 and 4, and the total kinetic energy release as 102 MeV. These two events occurred in the examination of 10,000 binary fission tracks, and the frequency of quaternary fission was derived as 0·0002 ± 0·00015 of that binary fission.

In a recent detailed study of the slow neutron fission of uranium-235 with special reference to rare modes of fission[4], more than 600,000 binary fission events have been examined. Some 1,000 ternary events with a long-range light fragment have been observed in this work, but only two events were recorded which could possibly be classed as quaternary fission. The two events concerned are small, having a maximum particle range of 14 μ. This makes measurement difficult, particularly with a heavily ionizing track suffering from multiple scattering, and analysis of the type employed by Tsien *et al.* does not yield satisfying results. It is not possible to determine whether the events are truly quaternary fission or whether they are explicable as due (1) to recoils projected by the pair of fission fragments in the act of separating, or (2) a ternary event with a random track superimposed. In any event, if quaternary fission is a physical possibility, these experiments suggest that the cross-section given by the French group is too high by at least a factor of ten.

Quaternary fission has also been looked for in the fast neutron fission of uranium and thorium[5], and the photo-fission of uranium[6] and thorium[7]. No evidence for fission into four fragments of equal mass has been found in these experiments, although in the photo-fission of uranium[8] and the fast neutron fission of thorium[9] an event consisting of the two heavy fission tracks and a pair of α-particles has been observed. In each case it was possible to show[8,9] that the disintegration could be explained as a ternary fission in which the third nucleus was the unstable beryllium-8 emitted in the ground-state and which immediately broke up into a pair of α-particles.

This body of evidence suggests that quaternary fission is a highly improbable process whatever the nucleus and mode of excitation.

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Canberra. March 10.

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Viscosity and Thermal Conductivity of Liquid Argon

SOME time ago[1], I put forward certain very simple suggestions concerning the mechanism of the viscosity of liquids. These notions led to, among other things, a formula for the viscosity of simple (monatomic) liquids at the melting point which has been surprisingly successful in representing the melting point viscosity, η_M, of liquid metals[2]. My assumption is that in a simple (monatomic) liquid at melting point the atoms are vibrating about a mean position which very slowly migrates, and that momentum is transferred from layer to layer of the liquid at the extreme librations. This gives for the viscosity at melting point:

$$\eta_M = A\frac{\nu m}{\sigma}, \tag{1}$$

where ν is the frequency, m the mass of the atom and σ the interatomic distance, while A is a constant the precise calculation of which would be very difficult, but which must be about 1. I took it as 4/3 in my original paper.

Now if this simple theory has any physical meaning, the ratio of the thermal conductivity k to the coefficient of viscosity at the melting point should be given by considerations similar to those which apply in the case of gases. We are led to the formula:

$$\frac{k}{\eta} = Bc_v, \tag{2}$$

where c_v is the specific heat in cal. per gm. at constant volume and B is again a constant which should be about 1. This formula should apply to monatomic liquids but, among them, not to metals, since with these the heat is transferred mainly by electrons, which transport very little of the momentum.

The recent determination of the thermal conductivity of liquid argon[3] enables us to test (2). The thermal conductivity extrapolates to $3·08 \times 10^{-4}$ at the melting point, the viscosity[4] to $2·82 \times 10^{-3}$, which gives $k/\eta = 0·109$, while c_v at the melting point[5] is 0·138 cal./gm. The value of B therefore comes out to be 0·8, which is as near 1 as we can well expect with an approximate formula of this kind.

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Theories of Magnetic Storms and Auroræ

RECENT theories of magnetic storms and auroræ due to Alfvén[1] and Martyn[2] have had considerable success in explaining various observations, though Alfvén and Chapman have both pointed out[3] that the most satisfactory test of these theories would be an experimental one. Further insight into these theories may also be expected using a different theoretical approach: instead of calculating typical orbits for the particles, the continuous gas model may be used. This facilitates the use of Maxwell's equations in considering the effect of the charged particles on the electromagnetic field; the knowledge gained about the field can then be used in discussing the orbits.

This approach leads to a criticism of that aspect of the theories mentioned which concerns the acceleration of the auroral particles; the acceleration of these particles gives rise to a 'back effect' which has not been taken into account by Alfvén or Martyn. In both theories the auroral particles are supposed to be accelerated by a steady electric field occurring within a few earth radii of the earth, although the mechanism by which this field is supposed to be set up is different in the two theories. If there were a region containing such an electric field, it is obvious that all charged particles in that region would be accelerated, and, if they were to acquire the necessary energy of 10 keV., all the electrons in this region would be moving in nearly the same direction with velocities of 6×10^9 cm./sec. Then if there are 100 electrons per c.c., as inferred from one theory, the current density is 300 e.s.u., which is relatively large, and Maxwell's equation:

$$c \operatorname{curl} \mathbf{H} - \partial \mathbf{E}/\partial t = 4\pi \mathbf{j},$$

must be considered. The displacement current becomes important only for phenomena at radio frequencies, so that $|\operatorname{curl} \mathbf{H}|$ must be of the order of 10^{-7} gauss/cm., which again is relatively large. Just how curl H attains this magnitude must be discussed using another of Maxwell's equations:

$$\partial \mathbf{H}/\partial t = - c \operatorname{curl} \mathbf{E}.$$

I have investigated this question[4], using the approximation $\mathbf{E} = - \mathbf{u} \wedge \mathbf{H}/c$, where $\mathbf{u}$ is the bulk velocity of the gas; this approximation is valid before the current density becomes large and is therefore good enough to decide whether the current density becomes large. The point of the discussion is that the magnetic field reacts on the gas through the force density $\mathbf{j} \wedge \mathbf{H}/c$, and, since the temporal rate of change of the magnetic field depends on the velocity of the gas, the important question is whether this force density favours or opposes the type of motion which will increase $|\operatorname{curl} \mathbf{H}|$ and therefore also increase the current density. It is found to oppose this type of motion except in the neighbourhood of a neutral point of the magnetic field, and hence, if $|\operatorname{curl} \mathbf{H}|$ is to be increased elsewhere, some force is needed 'to drive the dynamo'. Alfvén and Martyn have not allowed for this reaction of the field on the gas, and it is therefore doubtful whether the accelerating processes they have proposed can occur.

The suggestion that an electric discharge would occur at a neutral point was first made by Giovanelli[5] in connexion with solar flares, and Hoyle[6] has proposed a theory of the aurora in which the auroral particles are accelerated at neutral points. The neutral points are due to the combination of the magnetic field of the earth and a magnetic field carried out from the sun. Alfvén's model does, in fact, incorporate a magnetic field of solar origin, and further discussion of all aspects of such models seems likely to be fruitful.

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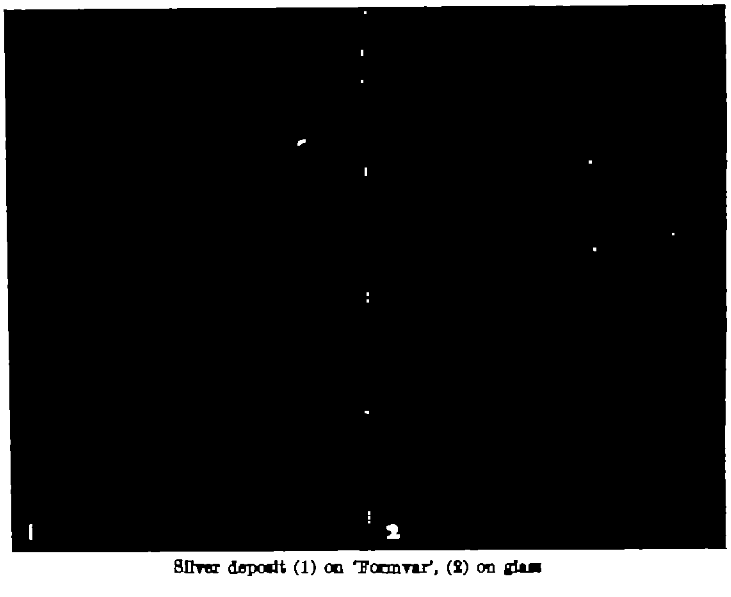
Thin Glass Layers as Supports for Electron Microscopy

IN the usual technique of electron microscopy, 'Formvar' or collodion layers are used as supports. We have been studying the electrical properties of thin metallic layers and determined their structure by means of the electron microscope. The electrical resistances were made on glass strips, while 'Formvar' layers were used as support for the electron microscope examination. We have always hesitated to consider the picture obtained on 'Formvar' as identical with the structure obtained on the glass surface; therefore we tried to use very thin glass layers as supports, and eventually succeeded.

The technique is as follows. A closed glass tube is heated in a coal gas – oxygen flame and blown out suddenly into the air. Thus the room is filled with very small pieces of glass flakes floating down to the floor. The thickest ones come down first, while the



Silver deposit (1) on 'Formvar', (2) on glass thinnest ones fall very slowly. The thin pieces of glass are caught on the surface of a vessel filled with water. Afterwards they are taken up from this water surface on the silver support for the electron microscope. The water is sufficient for the adhesion of the glass layer to the support. It is better, however, to fix the glass layer at one point by means of 'Formvar' used as adhesive material. In Figs. 1 and 2 are reproduced pictures, taken with a Philips electron microscope (*E.M.* 100), of the same silver layer obtained by sputtering on glass and the other on 'Formvar'. The magnification is about 20,000 for each.

It can be seen that the pictures obtained are similar in first approximation and are composed of small grains on a continuous underlayer. However, the grains on glass seem to be somewhat larger, as is also the separation between them. The macroscopic thickness, evaluated by weighing a test-plate, was found to be 950 A.

We are now trying to use much greater magnifications by making still thinner glass layers. At present the glass layers are made from Jena Gerate Glass 20.

We wish to thank the Centre Belge des Brasseries et des Malteries for financial help for this research.

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Dielectric Constant of Water Films

In order to explain some recent high-frequency (430 Mc./s.) measurements by Cownie and Palmer[1] on the variation in the dielectric constant of moist clay with water content, it was assumed[2] that the dielectric constant of the water increased exponentially from 3 (the high-frequency value for ice) at the water – clay boundary to 80 (the normal value for water) at an infinite distance from the boundary. It was supposed that the maximum change occurred in the thin layers of water close to the solid, and that the effects extended into the bulk of the liquid for appreciable distances.

That thin layers of water do exhibit abnormal mechanical and electrical properties is well known, and the terms 'bound' water[3] or "l'eau "solide" "[4] have been used to indicate the ice-like properties of thin water films. The restricted movement of such 'bound' water molecules would presumably result in a value of the dielectric constant less than the normal value of 80.

In addition to the assumption that the dielectric constant of a water film varies with its thickness, it was found desirable to make a further assumption that the clay particles were both uniform in size and spherical in shape, although no steps had been taken to ensure this when the original experiments were undertaken. Consequently it has been decided to continue the investigation into the dielectric constant of thin water films by using certain composite or 'synthetic' dielectrics which are more amenable to theoretical treatment than is a clay – water mixture.

Preliminary experiments were made at frequencies of 2 and 3 Mc./s. with thin mica plates separated by layers of water. It was found that the dielectric constant of the water decreased with the thinness of the film from more than 20 for films about 5 μ in thickness to less than 10 for films about 2 μ in thickness (thickness calculated assuming no absorption). Even with very wet composite dielectrics, the dielectric constant of the water did not exceed 60.

It is known[5] that the dielectric constant of ice at a temperature not very much below 0° C. changes rapidly from about 90 to 3 when the frequency increases from just below to just above 10 kc./s. It was therefore thought that 'solid' water might exhibit a comparable variation about this frequency. To test this possibility, composite mica – water dielectrics were measured at 2 Mc./s. and at 2·5 kc./s. The value of the dielectric constant of the block of dielectric at the lower frequency was approximately double the value obtained at the higher frequency, indicating that the value of the dielectric constant of the inter-layer water was probably trebled or even quadrupled. In order to prevent evaporation between successive measurements, it was not possible (in these preliminary experiments) to make the necessary weighings which would enable the dielectric constant of the water alone to be calculated. A check experiment showed that the dielectric constant of the mica remained constant for this range of frequencies. Thus, since the dielectric constants of both water and mica are not frequency-sensitive over the range of frequencies used, whereas ice is frequency-sensitive at about 10 kc./s., it would appear that the water film is tending to act not as 'solid' water but rather as 'liquid' ice.

This is perhaps a subtle distinction; but it is an important one when problems relating to the dielectric properties of thin water films are under consideration. It is also conceivable that this point of view may contribute to a better understanding of the abnormal mechanical properties of thin liquid films.

Further experiments are in progress to confirm these conclusions, and it is proposed to extend the investigation to various forms of 'synthetic' dielectrics with liquids other than water as the matrix. We are indebted to our colleague Mr. J. Muir for assistance with the lower-frequency measurements.

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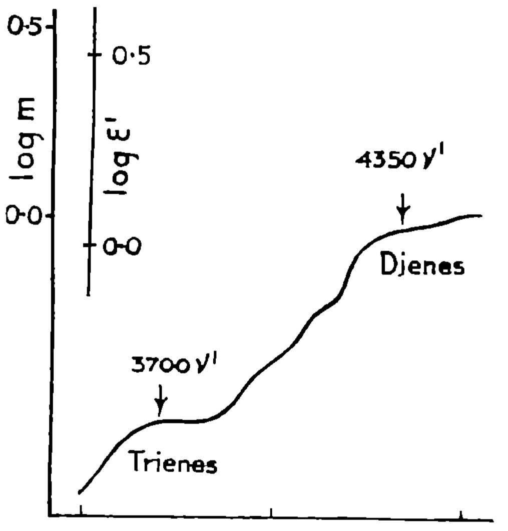
Relations between Small-Angle Interferences of Silk and the Wax Content

In previous papers[1] it has been established that alkali treatment of fresh preparations of silk fibroin gives rise to the appearance of new equatorial small-angle reflexions which were believed to be higher orders of a ground-period of 45 A. At first this effect was ascribed to a structural change of the silk lattice. Continued investigations, however, made it very likely that the new reflexions are due to some waxy substances. This assumption has now been confirmed by means of the following experiments : (1) The new reflexions disappear if the sample is treated with 1 : 1 ether–alcohol for 8 hr. at 40° C. (2) After removing the solvent by evaporation, a waxy substance (1·6 per cent of the weight of the degummed silk) is obtained. This is in good accordance with the data of other authors, who have found 1–2 per cent wax in *Bombyx mori* silk[2]. The extracted substance shows sharp reflexions corresponding with the net-plane distances given in column 2 of the accompanying table. Column 1 gives the net-plane distances of alkali-treated fresh silk samples, and shows the good accordance between the inner reflexions of the extract and the strongest ones of the alkali-treated silk. The outer reflexions of the extract identify the substance as probably a wax. It is to be noticed, however, that the reflexion corresponding to the smallest angles is not so sharp. (3) Extracting the alkali-treated silk with ether–alcohol gives also a waxy residue (1·6 per cent of the degummed silk) showing practically the same diagram as is described under (2). (4) The ether–alcohol solution shows absorption bands in the ultra-violet at 3,700 and 4,400 mm.$^{-1}$ which are characteristic for conjugated unsaturated fatty acids. The extracted fat (or wax) contained 0·8 per cent conjugated dienes and 0·2 per cent trienes.

Net-plane distances (A.)	Reflexions (A.)
45	45
16	15
9·3	9·8
4·20	4·06
3·46	3·70
3·01	3·25
2·50	2·68
2·25	2·40
	2·22

This was to be expected, since Bergmann[4] has found liquid fatty acids in extracted silk wax, and linoleic and linolenic acid have been extracted from cocoons of *Bombyx mori*[6]. Bergmann, investigating the relations between fat content and mechanical properties, could not find any quantitative relations and concluded that the wax simply protects the fibre against wetting influences'. (5) Films of 'renatured' silk after alkali treatment do not show any new reflexions, as stated in previous papers[3].

The appearance of the new small-angle reflexions in the X-ray diagram of alkali-treated fresh samples of silk indicates that the hot alkali brings the primarily amorphous waxy substances to crystallization. Apparently the fresh samples with well-formed intermicellar spaces give better chances for such crystallization than older preparations with probably closer-packed units.



The net plane corresponding to the large wax period runs parallel with the well-developed plane of the micelles (grid-plane). Since this period coincides apparently with the longitudinal extension of the wax molecules, it seems probable that the chains of the fatty acids stand more or less perpendicular to the grid-plane of the micelle. This points to some interaction with the polar side-chains of the fibroin.

The fact that the silk fat (or wax) is primarily not crystallized points to a very subtle and perhaps monomolecular distribution.

Since it has been stated that unsaturated fatty acids promote distinctly the polymerization of proteins in general, and since Müller[7], for example, has shown that the fibrous denaturation of globular serum proteins is rendered possible by lipoidal substances, one is tempted to suggest also a functional significance for the silk fat in the transformation of the globular into the fibrous form.

We are indebted to Mrs. O. Gold for experimental assistance.

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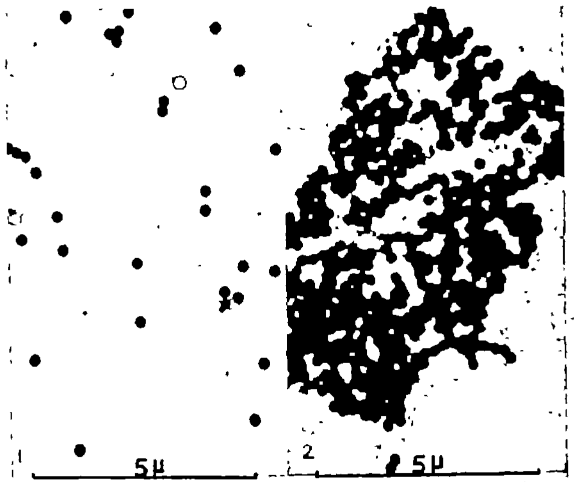
Resuspension of Dow Latex '580*G*' by Ultrasonics

Attempts to resuspend a sample of Dow polystyrene latex '580*G*'[1], which had dried out from 40 per cent suspension, by wet grinding and by shaking with water were only partially successful. Ultrasonic dispersion has been used and found to be successful under certain conditions.

Quantities of approximately 2·5 mgm. solidified latex in 10 ml. of soft tap water (hardness 20–30 p.p.m.), in a glass test-tube, diameter 2 cm., were placed in an oil-bath over the centre of a quartz crystal generating approximately 100 W. ultrasonic energy. Samples were treated for 30 sec., 90 sec., and 15 min., respectively, at 300 kc./s. with a continuous dissipation of approximately 10 W. in the sample. The suspensions produced were all found to be stable. Specimens prepared in an identical manner were examined in the electron microscope in an unshadowed condition, together with a sample of Dow latex '580*G*', which had not previously dried out, supplied by Dr. V. E. Cosslett.

The 30-sec. sample contained several undispersed fragments of the original solid together with single spheres and small planar groups. Very few fragments remained in the 90-sec. sample. The individual particles were still spherical and discrete (Fig. 1).



Ultrasonic treatment for (1) 90 sec., (2) 16 min.

The 16-min. sample, in addition to the usual single spheres and planar groups, contained many spheres which had been re-aggregated by the treatment and which had begun to coalesce, with a resultant loss of sphericity and diameter (Fig. 2). No such degenerate groups were found in the other samples.

As Jellinek and White[2] have shown that ultrasonic treatment of a polystyrene solution in benzene resulted in a progressive reduction of the average degree of polymerization, attention was paid to any possible changes in size and shape of the latex as a result of the treatment. Comparative measurements of the four samples were made at a fixed setting of the lens controls (magnification approximately 20,000) using several grids from each sample in order to minimize errors due to possible small magnification fluctuations between grids. No significant change was found in sphere diameter in either the 30- or 90-sec. treated samples, and it is concluded that a period of 90 sec. gives satisfactory resuspension. It is probable that the duration is not critical. It should be mentioned that in the samples from both sources a very small proportion of spheres appreciably larger or smaller than the average size exists, but these are quite readily recognized.

It is interesting to note that conditions for satisfactory resuspension of the latex are the same as those previously found by one of us (P. H.) for producing a stable carbon-black dispersion in water. The main requirements are: (*a*) low concentration of solid in liquid; (*b*) short period of ultrasonic treatment, usually less than 2 min. with the unit described above; (*c*) soft tap water. If these conditions are not satisfied, then a coarse dispersion is formed which settles out.

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Chemical Mechanism of Permanent Set

Some years ago[1] it was argued that the permanent set which strained wool fibres acquire in steam is due to two consecutive intramolecular reactions, namely, disulphide bond breakdown, which leads to the dissipation of stress, and linkage rebuilding, which stabilizes the relaxed structure. Indirect evidence of many kinds led to the conclusion that the reactions take place according to the following scheme:

$$R.CH_2.S.S.CH_2.R + H_2O \rightarrow R.CH_2SH + R.CH_2.SOH$$
$$R.CH_2.SOH + H_2N.R' \rightarrow R.CH_2.S.NH.R' + H_2O.$$

Following a suggestion of Phillips[2], evidence was afterwards obtained[3] that, when alkalis are used as setting assistants, —CH=N— as well as sulphenamide linkages are formed:

$$R.CH_2.SOH \rightarrow R.CHO + H_2S$$
$$R.CHO + H_2N.R' \rightarrow R.CH{=}N{-}R' + H_2O.$$

The above conception of the chemical mechanism of permanent set has, however, failed to command general acceptance, because Cuthbertson and Phillips[4] and Lindley and Phillips[5] found little or no fall in free amino-nitrogen, as estimated by the van Slyke reagent, after wool had been boiled for 1 hr. with borate buffers at *p*H 8 or *p*H 10, nor was there any rise in the content of cysteine. Direct evidence that the lysine side-chains of wool take part in the linkage-rebuilding reaction has now been obtained in the following way.

Several bundles of Lincoln wool fibres were stretched 40 per cent and set by immersion in a boiling 2 per cent solution of borax for 1 hr. After being washed in several changes of distilled water, the wool was treated with 1-fluoro-2 : 4-dinitrobenzene for 48 hr. at 37° C. under Sanger's conditions[6]. The fibres were washed thoroughly with alcohol and water before being hydrolysed for 24 hr. with 6 *N* hydrochloric acid, and the ε-N-dinitrophenyllysine was estimated after separation on a silica column in the usual way. Four sets of experiments were carried out, and the lysine content of the set fibres, after correction for decomposition during hydrolysis, was found to range from 2·15 to 2·53 per cent. Since the lysine content of the untreated wool, determined by the copper-complex technique[7], was 3·27 per cent, it is clear that the lysine content of wool is reduced when stretched fibres are set in a boiling solution of borax.

In another experiment, several bundles of set fibres were mixed and divided into two parts. One part was treated with 1-fluoro-2 : 4-dinitrobenzene, and the lysine content was found to be 2·02 per cent. When, however, the second part was hydrolysed with 6 *N* hydrochloric acid, without previous treatment with 1-fluoro-2 : 4-dinitrobenzene, the lysine content, estimated by the copper-complex technique, was found to be 3·33 per cent, the same as that of untreated wool. It is clear, therefore, that the lysine side-chains take part in the formation of new cross-linkages which are broken, with liberation of lysine, when the set fibres are hydrolysed in boiling 6 *N* hydrochloric acid.

Either —S—NH— or —CH=N— linkages would fulfil these requirements for, in experiments with model compounds, it was found that the sulphenamides are decomposed into sulphenic chlorides and amines by boiling 6 *N* hydrochloric acid. When the sulphenamides were boiled with hydrochloric acid in presence of mercaptans, disulphides were obtained.

Any rise in the cysteine content of set fibres would not, therefore, be detected in the hydrolysate if set is due mainly to the formation of sulphenamide cross-linkages.

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A Method for Overcoming 'Unsoundness' in Magnesian Limes

Building failures arising from the use of limes with a high content of magnesia have frequently been observed. These failures—such as spalling and blistering of plaster coats, disintegration of mortar joints and expansion of brickwork—are, according to Wells and others[1,2], caused by the slow hydration of the magnesia in these 'unsound' limes, and may extend over periods up to several years. Complete hydration of these limes can be obtained by treatment with high-pressure steam; this treatment, however, which is extensively used by American lime manufacturers, is expensive both in equipment and operation, and a simpler one is desirable. Experimental work in this Division has been based on the principle underlying Sorel cement manufacture, in which inert basic salts of magnesia such as magnesium oxychloride or magnesium oxysulphate are formed by the reaction between magnesium oxide and magnesium chloride or magnesium sulphate.

For the initial stages of the work in the laboratory, artificial mixtures of calcium oxide and magnesium oxide, prepared from the precipitated carbonates in proportions found in natural limestones, were used. The salts calcium chloride, magnesium chloride, magnesium sulphate and ammonium chloride were added to the samples, either in the hydrating water or after the hydration of the lime to powder or putty. In all instances the unsoundness as determined by a modified Le Chatelier autoclave expansion test (National Building Studies Special Report No. 3, 1948) was so reduced by calcium chloride, magnesium chloride and ammonium chloride that the material could be classed as sound. Magnesium sulphate was found to be much less effective than the other salts. The best results were obtained with calcium chloride added to the mixing water after hydration.

The salt treatment, when repeated with dolomite and magnesian limes made from natural materials, produced a similar decrease in expansion. On a pilot-plant scale the treatment proved equally satisfactory.

The effect of the salts on the general properties of mortars and plasters made from treated material has been investigated. The consistency, bulk density, workability and hygroscopicity were found to be practically unchanged, and the amount of water-soluble salts was well within the permissible limits. Plaster panels applied to a wall in the ordinary way are at present under observation.

The theoretical background of the reactions taking place in the process is being studied.

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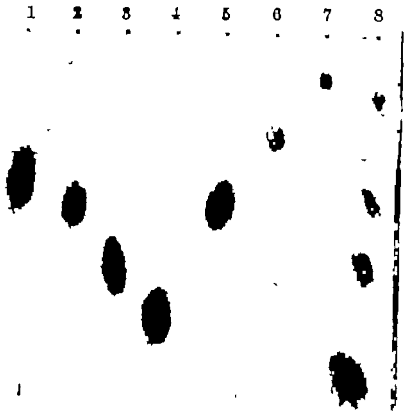
Salting-out Chromatography of Amino-acids and Peptides in Filter Paper and other Media

Earlier investigations in this Institute[1] have shown that substances like dyestuffs and some proteins show a very marked increase of adsorption on to filter paper and other adsorbents in presence of salts in large concentrations. The adsorption may thus be increased from practically zero (in pure water) to considerable amounts, and the phenomenon may be utilized for chromatographic separations, using salt solutions of lower concentrations or even water for the elution. Similarly, Holman and Hagdahl[2] found that the adsorption of fatty acids on to carbon from solutions in ethanol was very markedly increased if the solubility was reduced by adding water to the solution.

In general, it is to be expected that the adsorption will increase as the solubility is reduced by changes in the medium which do not appreciably affect the adsorbing surface[3]. Recently, we have found that amino-acids and peptides show the same phenomenon both on charcoal and filter paper, and it is possible to obtain very satisfactory paper chromatograms based upon the salting-out principle by using, for example, strong phosphate buffer solutions as a medium. Figs. 1 and 2 show some paper chromatograms obtained in this way. (In absence of salts the adsorption is very small.) It is interesting to note that the order of the R_F values is to a certain extent reversed as compared with ordinary partition chromatography in butanol - water systems.

There seems to be a tendency for the salt to collect at the solvent front in the paper even if evaporation is prevented, and therefore the best results are obtained if the original spots are applied at a considerable distance behind the front. This enrichment of salts towards the advancing front points to a negative adsorption of the salts, that is, the water is more strongly bound by the cellulose than are the salts. This provides the necessary conditions for a salting-out effect, which may, of course, also be regarded as a kind of partition between a salt-rich and a salt-poor medium. There may also be some relations between this phenomenon and those described by Herbert and Pinsent[4] and Martin and Porter[5], where a second phase is created in ethanol - water or 'Cellosolve' - water systems by salting out, by which suitable conditions for chromatography of some proteins have been realized. The analogy to the effects of high salt concentrations in counter-current extraction according to Craig should also be noted[6].



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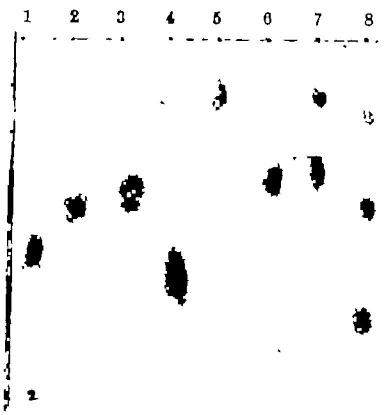

2

Fig. 1. Ascending filter paper (Whatman No 1) chromatograms by the salting-out method. Salt medium. 1 *M* Na_2HPO_4 + 2 *M* NaH_2PO_4. The substances were applied as spots along the upper line after the paper had been soaked with salt solution to the lower line. (1) 0 005 ml 0·25 per cent *dl*-leucine; (2) 0·0025 ml. 0·5 per cent *dl*-valine; (3) 0·0025 ml. 0·5 per cent *dl*-alanine; (4) 0 0025 ml. 0 5 per cent glycine; (5) 0·0025 ml. 0·5 per cent *dl*-methionine; (6) 0·0025 ml. 0 5 per cent *dl*-phenylalanine; (7) 0·005 ml. 0·25 per cent *dl*-tryptophane; (8) 0·01 ml. 0·125 per cent (*dl*-tryptophane + *dl*-phenylalanine + *dl*-leucine + glycine)

Fig 2. Same as Fig 1, but with the following substances: (1) 0·005 ml. 0·5 per cent *dl*-leucyl-glycyl-glycine; (2) 0·005 ml. 0·5 per cent *d*-leucyl-glycine; (3) 0·005 ml. 0·5 per cent glycyl-*l*-leucine; (4) 0·005 ml. 0 5 per cent glycyl-glycine; (5) 0·01 ml. 0·25 per cent glycyl-*l*-tryptophane; (6) 0·005 ml. 0·5 per cent glycyl-*l*-tyrosine; (7) 0·01 ml. 0·25 per cent (glycyl-*l*-tryptophane + glycyl-*l*-tyrosine), (8) 0·01 ml. 0·25 per cent (glycyl-*l*-tryptophane + glycyl-*l*-tyrosine + glycyl-glycine)

The principle appears to have wide applicability in chromatography, even if the large amounts of salt involved will sometimes present difficulties. On the other hand, the procedure can probably be used with advantage in many cases where lack of solubility in one phase makes it difficult to apply the partition method.

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Paper Chromatography of Phosphoric Esters

Bandurski and Axelrod[1] have recently published a paper describing modifications in Hanes and Isherwood's method[2] for the separation of phosphorylated sugars and adenosine phosphates by paper chromatography. Since these modifications are in certain respects similar to those being employed in this laboratory, this opportunity is being taken of indicating briefly the methods in use here.

Upward migration at 4° C. on acid-washed[3] paper is used in a similar manner to Bandurski and Axelrod, but the solvents used (Table 1) give higher R_F values and shorter running times than Hanes and Isherwood's mixtures, and tend to give smaller spots than Bandurski and Axelrod's mixtures. R_F values are difficult to reproduce accurately, but typical values are given in Table 2. For the detection of phosphate spots on the finished chromatogram, Hanes and Isherwood's reagent has been modified to allow the papers to be dipped instead of sprayed, by replacing part of the water with acetone[3]. *Molybdate reagent*: 1 gm. ammonium molybdate is dissolved in 8 ml. water and 3 ml. concentrated hydrochloric acid; 3 ml. perchloric acid (70 per cent) are added, and the mixture diluted to 100 ml. with A.R. acetone. Heating and treatment with hydrogen sulphide are as in the original method. Compounds absorbing ultra-violet light are detected by Markham and Smith's[4] photographic method, using a solution of chlorine in carbon tetrachloride instead of a chlorine gas filter. This modification allows a 1-cm. quartz cell to be used.

These methods are being applied to the quantitative separation of phosphorus-containing compounds in extracts from baker's yeast using bands instead of spots of concentrated extract applied to the starting line of the chromatogram with a very slow pipette[5]. By this method a commercial sample of adenosine triphosphate has been resolved into six constituents (adenosine triphosphate, adenosine diphosphate, adenylic acid, pyrophosphate, orthophosphate and a trace of an unknown ultra-violet-absorbing constituent), and analysed with good overall recoveries of total phosphorus and acid-labile phosphorus after cutting out the bands and eluting them with water by the capillary elution method of Dent[6]. The method is very suitable for the separation of traces of material from large amounts of interfering phosphates, and by its use glucose-1-phosphate equivalent to 6 μgm. of labile phosphorus was separated from about 300

Table 1. Solvent Mixtures

(1) 70 vol methanol : 30 vol. 2 *N* ammonia.
(2) 75 vol. acetone : 25 vol. 25 per cent w/v trichloroacetic acid.
(3) 65 vol acetone : 35 vol. 15 per cent w/v trichloroacetic acid.
(4) 60 vol acetone : 40 vol. 35 per cent w/v monochloroacetic acid.
(5) 70 vol acetone : 30 vol 50 per cent w/v monochloroacetic acid.
(6) 60 vol acetone : 40 vol. 35 per cent v/v formic acid.
(7) 50 vol. acetone · 50 vol. 30 per cent v/v acetic acid.

Table 2. Typical R_F Values

(No. 1 Whatman filter paper washed in 2 *N* hydrochloric acid and distilled water; solute applied as free acid or alkali salts)

Solvent mixture / Solute	1	2	3	4	5	6	7
Orthophosphate	0 31	0 61	0 75	0 67	0·58	0·70	0·73
Pyrophosphate	0 12	0 40	0·51	0·38	0·29	0·40	0·46
Glucose-1-phosphate	0 42	0·22	0·48	0·31	0·15	0·30	0·41
Ribose-5-phosphate	0·36	—	—	0 46	—	—	0·41
Fructose-6-phosphate	0·37	0 31	—	0 37	0 15	0·40	—
Fructose-1,6-diphosphate	0·31	0 39	0 67	0·37	0·26	0 42	—
Adenosine-5-phosphate	0·29	0 37	0·58	0·30	0·10	0 24	0·31
Adenosine diphosphate	0 15	0·10	0 27	0·22	—	0·11	0·28
Adenosine triphosphate	0 11	0·04	0·15	0 05	0	0·04	0·18
Cocarboxylase	0·24	0·11	—	—	—	0·28	0 38
Guanylic acid	0 28	0 20	—	—	—	—	—
Cytidylic acid	0 37	0 34	—	—	—	—	0 36
Uridylic acid	0 40	0 51	—	—	—	—	0 51
Diphosphopyridine nucleotide	0·12	0	0 08	0 02	0	0 02	0·10

µgm. of orthophosphate phosphorus in a trichloroacetic acid extract of resting yeast.

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Stepwise Degradation of the Peptides liberated in the Transformation of Ovalbumin to Plakalbumin

In the transformation of ovalbumin to plakalbumin by a proteinase from *Bacillus subtilis*, a small amount of material containing non-protein nitrogen is released, which has been separated into three fractions, designated[1] *A*, *B*, and *C*. Amino-acid analysis of these fractions suggests that *A* and *B* are peptides composed chiefly of glycine, valine, aspartic acid and alanine, in the ratios 1 : 1 : 1 : 3 and 1 : 1 : 1 : 1, respectively, while *C* appears to be alanylalanine. As pointed out before[1], it is reasonable to suppose that the three peptide fractions arise all from the same segment of the ovalbumin molecule, represented by *A*. Accordingly, *B* and *C* should be identical with parts of *A*. The present investigation furnishes some evidence for this scheme.

In an attempt to establish the structure of the three ovalbumin peptides, each fraction was subjected to a stepwise degradation process. This was accomplished by successive removal of the N-terminal amino-acids according to a procedure based largely on Edman's[2] phenyl isothiocyanate method and applicable for use with small quantities of higher peptides. 5–30 micromoles of peptide were allowed to react with phenyl isothiocyanate in 2 ml. of a water – dioxane mixture (aqueous ethanol and acetone also proved satisfactory) at *p*H 8·0 and 40° C. The course of the reaction, in which one hydrogen ion is liberated per ammonium group, was followed and recorded by means of a Jacobsen–Léonis autotitrator[3], as illustrated by the curves in Fig. 1. After completion of the reaction, the content of the reaction vessel was transferred to a graduated tube, and excess reagent and dioxane were removed by continuous extraction with cyclohexane. The aqueous phase, containing the phenylcarbamyl peptide, was evaporated to a volume of 1 ml., acidified with 5 *N* hydrochloric acid to *p*H 1, and left standing at 75° C. for 1½–15 hr., depending on the ease of cleavage of the carbamyl peptide, to yield the 3-phenyl-2-thiohydantoin derivative of the N-terminal amino-acid and the residual peptide or amino-acid. The yield of thiohydantoin, which was removed completely from the graduated tube by continuous extraction with ether, was checked by measurement of its ultra-violet absorption as described by the Fraenkel-Conrats[4]. Hydrolysis of the thiohydantoin by barium hydroxide[5] yielded the terminal amino-acid, which was identified by filter-paper chromatography. The residual peptide or amino-acid solution was returned to the reaction vessel, brought to *p*H 5·8 with 1 *N* sodium hydroxide and then to *p*H 8·0 with a measured volume of 0·1 *N* sodium hydroxide. The entire procedure was then repeated.

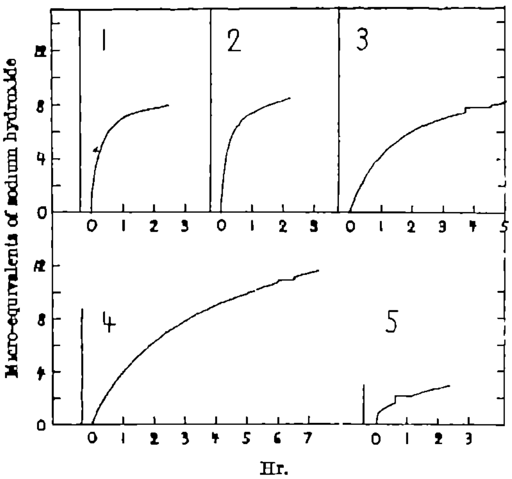

Fig. 1. Titration of terminal ammonium groups in the stepwise degradation of fraction *B*. Vertical lines in (4) and (5) titration from *p*H 5·8 to 8·0. Phenyl isothiocyanate added at zero time

By this method it could be confirmed that fraction *C* is alanylalanine, the first two degradation steps yielding equal quantities of alanine and the third step nothing. Similarly, fraction *B* could be identified as consisting, apart from an impurity containing glutamic acid (which may be a contamination from the bacterial enzyme preparation[6]), chiefly of alanylglycylvalylaspartic acid. This can be seen from the chromatogram reproduced in Fig. 2, in which the four component amino-acids appeared in the order indicated in the successive barium hydrolysates. The fifth run gave a blank, showing that one was dealing with a tetrapeptide. The titration curves in Fig. 1 indicate that during the entire degradation procedure there was little loss of peptide in the water phase, the amount of base consumed per ammonium group decreasing only slightly from one run to the next.

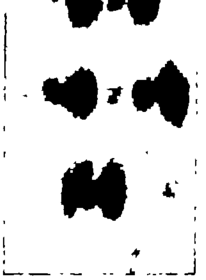

Fig. 2. Chromatogram of successively removed N-terminal amino-acids in fraction *B*. Whatman paper No. 1; phenol–water; descending chromatogram. Standards, from above to below: aspartic acid, glycine, alanine, valine. The spot in run 1 occupying a position between aspartic acid and glycine is due to glutamic acid

Stepwise degradation of fraction *A* yielded, beside unspecified amounts of glutamic acid[5], chiefly alanine as the first, and glycine as the second, amino-acid. In the third step valine and in the fourth step aspartic acid made their appearance. The chromatograms also showed spots due to glycine and valine, and particularly large spots due to alanine in the third and fourth steps. Analysis of the water phase following the second acid treatment revealed that alanylalanine had been liberated during this part of the procedure. By more drastic acid treatment most of, if not all, the remaining alanine could be split off as alanylalanine. Incubation of the original *A* fraction with carboxypeptidase resulted in the liberation of approximately one-third of the total alanine as free alanine. These observations indicate the presence of alanylalanine at the carboxyl end of fraction *A*, in all likelihood linked to the rest of the fraction through aspartic acid. In summary, analysis of fraction *A* to date indicates that it contains as a chief constituent the hexapeptide, alanylglycylvalylaspartylalanylalanine. It may also contain other peptides which may be products of the 'unspecific' breakdown of ovalbumin.

A detailed account of these experiments will appear in the *Comptes Rendus des Travaux du Laboratoire Carlsberg* (Série Chimique). We wish to express our gratitude to Prof. K. Linderstrøm-Lang for encouragement and suggestions throughout the course of this work.

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Preparation of Crystals containing the Plakalbumin-forming Enzyme from *Bacillus subtilis*

OVALBUMIN is transformed by a proteolytic enzyme preparation from *Bacillus subtilis* into another protein, plakalbumin[1]. During the transformation a small amount of peptides is liberated[2]. An attempt has been made to purify the enzyme responsible for this transformation.

The bacteria were grown in submerged culture with vigorous aeration in a medium containing peptone, glucose and a salt solution containing trace metals. When after *c.* 30 hr. the enzyme concentration had reached a maximum, the bacteria were removed by centrifugation, the proteins in the culture liquid precipitated by addition of sodium sulphate, and the crude enzyme dried in a vacuum. A 10 per cent solution of the crude enzyme was purified by addition of calcium chloride in excess to precipitate the sulphate ions and of one volume of acetone to precipitate the mucins. The enzyme was precipitated by increasing the acetone concentration to 75 vol. per cent, and the precipitate dissolved in a small amount of water. After evaporation of the acetone, pH was adjusted to *c.* 5·5. The solution was made *c.* 5 per cent with respect to sodium sulphate, kept at *c.* 30° C. with mechanical stirring, and eventually seeded with crystals of the enzyme. When crystallization had started, the concentration of sodium sulphate was slowly raised to about 12 per cent. The enzyme crystallized out as long, very thin needles (see photograph). It was dissolved in water and recrystallized by addition of sodium sulphate. The activity of the enzyme was followed during the purification by measuring its ability to clot milk.

Plakalbumin-forming enzyme, recrystallized. × 300

	Per cent of original nitrogen	Per cent of original activity	Activity per mgm. nitrogen	Activity per mgm. protein nitrogen
Solution of crude enzyme	(100)	(100)	5,550	
Precipitate 50–75 vol. per cent acetone	72	95	7,300	7,550
Dissolved crystals after :				
1. crystallization	64	84	7,300	7,450
2. "	59	76	7,100	7,300
3. "	55	71	7,130	7,350
4. "	49	64	7,200	7,450

During the purification, the plakalbumin-forming ability of the enzyme follows the milk-clotting activity within experimental error. The enzyme breaks down casein at almost the same rate as trypsin and about three times as fast as chymotrypsin. It has no amylase activity. Preliminary investigations in the electrophoresis apparatus show that about 95 per cent of the material moves as a symmetrical peak in an acetate buffer with sodium chloride pH 5·3, ionic strength 0·1. In the ultracentrifuge the material appears homogeneous with a sedimentation constant of *c.* 2·7 Svedberg units.

We wish to express our thanks to Prof. K. Linderstrøm-Lang for his interest in this investigation, and to Dr. H. C. Hagedorn who instigated the work.

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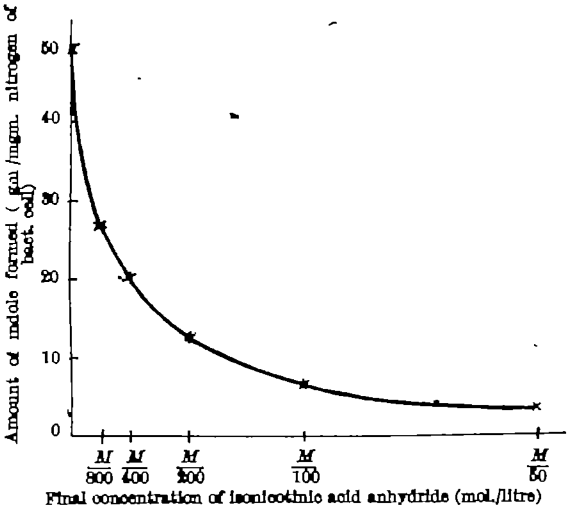
Competitive Action of Isonicotinic Acid Hydrazide and Vitamin B_6 in the Formation of Indole by *E. coli*

We have been seeking the mechanism to explain our observation that one of the substances which is contained in broth and is able to decrease the inhibitory effect of isonicotinic acid hydrazide on the growth of *E. coli* can, to some extent, be replaced by pyridoxine[1]. In further experiments, we have found that isonicotinic acid hydrazide considerably inhibits the formation by *E. coli* of indole, and that the activity of a suspension of *E. coli* treated with isonicotinic hydrazide recovers when the cells are in contact with pyridoxine.



Inhibitory activity of isonicotinic acid anhydride on the indole formation of *E. coli communior* (Exp. 1)

Typical results showing the inhibitory effect of isonicotinic acid hydrazide on the formation of indole by *E. coli communior* are given in the accompanying graph (Exp. 1), and the recovery effect due to pyridoxine is shown in Table 1 (Exp. 2). From the graph, it will be seen that the formation of indole by the washed suspension decreases considerably, generally in proportion to the amounts of isonicotinic acid hydrazide added; the rate of inhibition of isonicotinic acid hydrazide calculated from the results is given in Table 2.

The results in Tables 1 and 2 show that pyridoxine has a remarkable antagonistic action against the inhibitory effect on a cell suspension of isonicotinic acid hydrazide; for example, even 10^{-7} *M* (final concentration) of pyridoxine shows more than 50 per cent recovery effect.

In order to obtain the tryptophanase activity, the culture of *E. coli communior* (stock) was grown at 37° C. in broth containing 10 mgm./l. of DL-tryptophane for 18 hr. At the end of incubation, the organisms were centrifuged out of the growth medium, washed in saline three times and then made up into suspension in saline. The nitrogen content of the organisms per millimetre suspension was determined by the micro-Kjeldahl method as modified by Parnas.

Table 1 (Exp. 2). RECOVERY EFFECT OF PYRIDOXINE

Substrate. 0 4 ml. of *M*/160 DL-tryptophane in 3 4 ml. of reaction mixture. Reaction time. 10 minutes. Reaction temperature: 38° C.

Final concentration of INAH (*M*)	Final concentration of pyridoxine (*M*)	Indole formed (γgm./mgm. nitrogen of bact. cell)	Recovery effect (per cent)
10^{-2}	10^{-4}	27 6	69·3
10^{-2}	10^{-5}	27·1	67 4
10^{-2}	10^{-6}	26 9	66 8
10^{-2}	10^{-7}	24 2	56·6
10^{-2}	10^{-8}	12 5	11·5
10^{-2}	10^{-9}	10·0	2·2
10^{-2}	—	9 5	0·0
—	—	35·7	—

Table 2

Final concentration of isonicotinic acid hydrazide (mol./lit.)	Inhibitory rate (per cent)
0·02	92
0·01	86
0·005	74
0·0025	58
0·00125	45
0·0	—

As the preliminary experiments showed that contact for 30 min. was necessary for obtaining the complete action of isonicotinic acid hydrazide and of pyridoxine, suspensions of cells with the former or both of these substances respectively in phosphate buffer were incubated at 38° C. for 30 min. just before the determination of tryptophanase; the following quantities were used: in each test-tube, 0·5 ml. of washed suspension, 0·3 ml. of isonicotinic acid hydrazide solution, 1·9 ml. of *M*/15 phosphate buffer (*p*H 8·0), and in Experiment 2, 0·3 ml. of pyridoxine hydrochloride solution. The quantity of the liquid in each test-tube was made up to a volume of 3·0 ml. with distilled water.

In order to test the tryptophanase activity of these suspensions, the method of Wood *et al.*[2] with modifications was used throughout this work. The procedure is as follows: at the end of the contact, 0·4 ml. of *M*/160 DL-tryptophane was added to each test-tube and the reaction mixture was incubated at 38° C. for 10 min. The reaction was stopped by the addition of 0·2 ml. of 100 per cent trichloroacetic acid; and 2–5 ml. of toluene containing the indole extracted from the reaction mixture by shaking was mixed thoroughly with 5·0 ml. of Ehrlich's reagent (2 gm. paradimethyl-amido benzaldehyde, 40 ml. concentrated hydrochloric acid, 190 ml. of ethanol). After 10 min. reaction, 5·0 ml. of ethanol was added to dissolve the toluene and the red-coloured solution was used immediately for electrophotometric determination.

Since it is generally agreed that the coenzyme of the tryptophanase of *E. coli* is identical with pyridoxal phosphate[2], it is thus apparent from our results that isonicotinic acid hydrazide may act on the tryptophanase as an antimetabolite against the coenzyme, and that the considerable recovery effect of pyridoxine is due to the competitive action of the pyridoxal phosphate, which may be produced in the cell from pyridoxine added. These results point in the same direction as our experiments on the inhibitory action of isonicotinic acid hydrazide on the decarboxylation of amino-acids by *E. coli*[3]. Further research is now in progress. This work will be published in detail later.

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Effect of D(+)-Leucine on the Hydrolysis of Glycil-L-Leucine in Normal and Neoplastic Tissues

In a previous paper[1], describing the beginning of a series of investigations on the action of D-amino-acids on L-peptidasic activity, it was observed that the effect of D(+)-leucine on hydrolysis of glycil-L-leucine by raw extracts of bovine intestinal mucosa clearly differed according to the *p*H of the reaction and to the final concentration of the D-amino-acid. D(+)-Leucine inhibited hydrolysis of glycil-L-leucine at a *p*H near the neutral point; it had no influence at an alkaline *p*H (8·5), while at an acid *p*H (6·2) it activated the reaction slightly.

Subsequent research showed that, when raw extracts of normal and pathological non-neoplastic human tissues were used in place of bovine mucosa extracts, the same results were obtained. The study of the effects produced by D(+)-leucine on the hydrolysis of glycil-L-leucine in human neoplastic tissues is therefore of considerable interest.

The material used in the present research consisted of twenty-five neoplasms (eight adenocarcinomas of the breast, three carcinomas (scirrhus) of the breast, one carcinoma of the gluteal zone, six carcinomas of the uterine cervix, two lymphosarcomas, two scapular sarcomas, two carcinomas of the rectum and one carcinoma of the penis). In all these cases it was definitely observed that D(+)-leucine affected hydrolysis of glycil-L-leucine in an entirely different way from that when normal and pathological but non-neoplastic human tissues were used; that is, from *p*H 6·2 to *p*H 8·5 it exerts a very marked activating influence. Such influence does not alter noticeably on varying the concentration of the D-amino-acid from 0·04 to 0·01 *M*; while at still lower molarity the activating effect decreases gradually, and ceases at a final concentration lower than 0·001 *M*. Control experiments with D(+)-leucine and extract alone were regularly made and no modifications at all were observed. When L(−)-leucine is used in place of its antipode, inhibitory action is, naturally, noted.

The method for the preparation of raw enzymatic extracts and for the tests of activity is described elsewhere[2], hydrolysis was determined by the measurement of liberated carboxyl groups[3], and in some experiments the liberated amino-groups were also determined (Van Slyke). For all tests, the temperature was 38° C., 0·1 *M* veronal buffer was employed and the *p*H controlled by means of a Cambridge *p*H meter, and the substrate solution was 0·025 *M* in the final reaction mixture.

Effect of D(+)-Leucine (L) on Hydrolysis of Glycil-L-Leucine (GL) by Human Non-neoplastic and Neoplastic Tissues

Conc. of D(+)-leucine	Time (min.)	*K* GL	*K* GL+L	Hydrolysis (per cent) GL	Hydrolysis (per cent) GL+L	Tissue
0·04 *M*	15	0·00305	0·00832	10	25	breast cancer
	30	0·00287	0·00780	18	42	
	60	0·00290	0·00824	33	68	
0·04 *M*	10	0·00315	0·00280	7	5	normal skin
	30	0·00305	0·00201	19	13	
	60	0·00319	0·00227	35	25	
0·01 *M*	10	0·00155	0·00700	3·5	15	uterine cancer
	30	0·00152	0·00602	10	34	
	60	0·00156	0·00562	19	54	
0·01 *M*	10	0·0173	0·0173	33	33	uterus, chronic metritis
	20	0·0173	0·0173	59	59	
	40	0·0159	0·0159	77	77	
0·01 *M*	5	0·0181	0·0309	14	39	adeno-carcinoma
	15	0·0147	0·0303	39	65	
	30	0·0136	0·0294	61	85	

Some of the results are shown in the table, where the values for hydrolysis are expressed as the first-order velocity constant calculated as a decimal logarithm (*K*); the *p*H is 7·2, since at this value D(+)-leucine (final concentration, 0·04 *M*) has a distinct inhibitory influence when non-neoplastic tissues are used.

Hence it is clear that the activating influence of D(+)-leucine on the hydrolysis of glycil-L-leucine (at *p*H 7·2) in the case of neoplastic tissues is just the opposite to the inhibitory one observed in normal and pathological non-neoplastic tissues.

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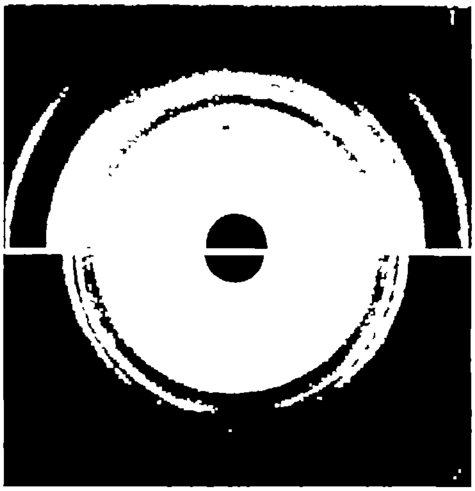
Isolation of Phosphothreonine from Bovine Casein

Lipmann has shown[1] that the phosphorus in casein is bound to serine, and this has been further confirmed by the isolation of crystalline phosphoserine in this Institute[2]; but it is also conceivable that a part of the phosphorus may be bound to threonine.

To investigate this, bovine casein was hydrolysed and a barium complex prepared, according to Lipmann. The barium was removed with a cation-exchanger ('Dowex 50'), and further purification was obtained by displacement on an anion-exchanger ('Dowex 2'), by the method of Partridge and Brimley[3]. For the final separation elution with 0·01 *N* hydrochloric acid from a 'Dowex 50' column was used. One of the fractions consisted, after evaporation, of lustrous stout prisms that yielded threonine after hydrolysis.

These prisms were compared with DL-phosphothreonine, synthesized according to Plimmer[4]. They had the same R_F value in paper chromatograms run with different solvents and the same melting point, 194° (decomp.). The crystals from the hydrolysate showed an optical rotation $[\alpha]_D^{24}$ − 7·37°, whereas the synthetic compound was inactive.



X-ray powder diffraction diagrams from (1) DL-phosphothreonine and (2) L-phosphothreonine

The X-ray powder diffraction patterns were identical. The molecular weight was 201·0 as calculated from X-ray diffraction data.

Analysis $C_4H_{10}O_6NP$ (199·1)				
Calculated	C 24·1	H 5·06	N 7·04	P 15·6
DL-Phosphothreonine	24·0	5·13	6·89	13·4
L-Phosphothreonine	24·9	5·19	7·03	14·0

The phosphorus was determined by Teorell's method[5]. The low figures seem to be due to difficulties in hydrolysing.

These facts seem to indicate that the phosphoric acid in casein is bound not only to serine, but also to threonine.

A full account of this work, which was sponsored by the Swedish Medical Research Council, will appear elsewhere.

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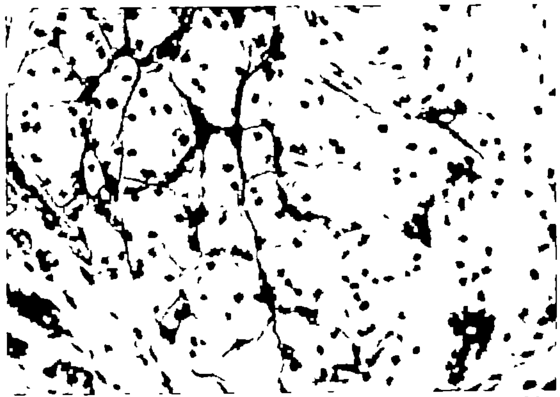
Survival of Adrenal Gland Homografts in the Rabbit's Skin

AN exception to the rule that tissue homografts in non-inbred mammals survive only for a few weeks has been observed in adrenal gland grafts transplanted from one adult rabbit to the skin of another. Such grafts live for many months, and appear to succumb finally to a type of disuse atrophy rather than to the usual homograft reaction.

Slices of adrenal gland including capsule, cortex and medulla, and weighing on the average about 25 mgm., were inserted into the fascial layer of the skin of the abdomen. At monthly intervals the grafts were exposed and measured and, beginning with the second month, tiny biopsy samples were taken. The grafts gradually diminish in size from the first month onwards.

Removal of one or both of the host's adrenal glands within five weeks of grafting was not followed by any noteworthy prolongation of the life of the graft or change in its histology. The chief determinant of the length of life of the graft appears to be the size of the original transplant; the results indicate that, in general, the bigger this is the longer will the graft survive. The biggest are still alive after seven months.

The medullary tissue did not survive, the grafts being composed of a capsule surrounding a mass of polyhedral cells which resembled enlarged zona fasciculata cells (see photograph). These cells gave positive reactions to tests for lipids, phospholipines, cholesterol and vitamin C, and there was a well-developed network of reticular fibres among them. They exhibited mitotic figures in a graft removed at two weeks, and in another removed at six weeks, after transplantation, but not in older grafts. Some of the signs of a homograft reaction, namely, infiltration of lymphocytes and plasma cells, and dilatation and congestion or destruction of the blood vessels, were observed in a few specimens, but they were usually weak or localized. The majority of grafts showed none of these signs.


Cells of an adrenal gland homograft after five months in the skin of a bilaterally adrenalectomized rabbit

The cells in most grafts undergo a slow process of degeneration. Their cytoplasm enlarges and frequently develops large fat droplets; the cell boundaries become indistinct and cells coalesce, so that multinucleate forms are common. Pyknotic and elongated nuclei are numerous in older grafts.

This degeneration of the homograft tissue is not surprising in normal or unilaterally adrenalectomized animals. But it also occurs in bilaterally adrenalectomized animals, and since these showed no distress after the disappearance of their grafts this suggests that accessory cortical tissue may take over the function of the glands. No cortical tissue was found on macroscopic examination of the sites of adrenalectomy at autopsy. The effect of later adrenalectomy and of implantation into the deeper parts of the body is now being tested.

The chief interest of the phenomenon lies in the apparent failure of the usual homograft reaction in these grafts and the indication that, contrary to the rule with other tissues, the larger the graft dosage the longer the survival. Submaxillary gland homografts transplanted to the same site and in the same dosage were found, when examined after two months, to be completely destroyed.

These findings are also of interest in relation to the reports of successful treatment of Addison's disease by means of adrenal gland homografts[1,2]. Lux, Higgins and Mann[3] reported survival up to twelve weeks of homografts of adrenal gland from new-born rabbits and guinea pigs when the grafts were first cultured in the presence of the host's serum and then transplanted into the groin. These grafts underwent a delayed, but ultimately strong, homograft reaction.

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Oxidation of Thiophosphate Insecticides in the Rat

THE problems encountered in assessing the toxicity of the organo-phosphorus insecticides towards mammals have been reviewed in a recent article by Aldridge and Barnes[1]. It was pointed out that compounds such as O-*p*-nitrophenyl O,O-diethyl thiophosphate (parathion, *E* 605) are considerably more potent *in vivo* as inhibitors of true cholinesterase than would be expected from their inhibitory activity *in vitro*; the summarized evidence indicated that thiophosphates of this type are transformed into another more active inhibitor *in vivo*. It has been shown that the inhibitory action of technical parathion on true cholinesterase *in vitro* is due mainly, if not entirely, to an impurity of the form O-*p*-nitrophenyl O,S-diethyl thiophosphate[2]. Thus it was conceivable that the increased potency of parathion *in vivo* could be due to the formation of this S-ethyl isomer, but recent evidence seems to suggest that isomerization may not be the complete answer to this problem[3]. In the course of investigations on the selective inhibition of ali-esterase (tributyrinase), we have obtained evidence indicating that the thiophosphate insecticides may be oxidized *in vivo* to their phosphate analogues.

This conclusion is based upon a comparison of the relative inhibitory potencies of various analogous organo-phosphorus compounds towards the true cholinesterase and ali-esterase of rat brain *in vitro* and *in vivo*. Paraoxon (III) inhibits the true cholinesterase of rat brain more readily than the ali-esterase, both *in vitro* and *in vivo*, whereas the S-ethyl isomer of parathion (II) inhibits both enzymes to about the same extent *in vitro* and *in vivo*. A preparation of parathion (I) with a chemical purity of about 99 per cent also inhibited both enzymes equally well *in vitro*; but its inhibitory potency was only 1 per cent of that of the isomer (see table). These findings provide additional evidence in favour of the hypothesis that the inhibitory activity of parathion *in vitro* is due to the presence of a small amount of the S-ethyl isomer as impurity[2]. However, when this parathion preparation was injected into adult male rats, the true cholinesterase of the brain was found to be considerably more inhibited than the ali-esterase, as is also the case when paraoxon is injected. We surmise from these results that the inhibitory activity of parathion *in vivo* must be due largely to paraoxon, formed by enzymic oxidation of —P=S to —P=O.

There was some doubt as to whether this conclusion was completely justifiable because of the fact that the inhibitory action of parathion on the cholinesterase of rat brain is of fairly short duration[4], whereas that of paraoxon seems to recede less rapidly. However, the above hypothesis is strongly supported by the results obtained in experiments with the compound *bis*-(O-*p*-nitrophenyl) O-methyl thiophosphate (IV)[5], its S-methyl isomer (V) and the analogous phosphate (VI)[5].

True cholinesterase and ali-esterase activities of rat brain homogenate were determined manometrically with 0·03 *M* acetyl-β-methylcholine and 0·2 per cent tributyrin suspension as respective substrates[1]. The esterase inhibition *in vitro* was measured after incubation of the rat brain homogenate with the inhibitor in a 0·025 *M* bicarbonate buffer for 30 min. before the substrate was added. All inhibitor preparations had a chemical purity of 95–100 per cent[5] with the exception of the S-ethyl compound (II), which was 70 per cent pure; the concentrations of inhibitor are necessarily expressed in the table as molar concentration of crude preparation. The esterase inhibition *in vivo* was determined in the brains of adult male rats after intraperitoneal injection of the inhibitor solution; * indicates the appearance of muscular fibrillation and other symptoms of true cholinesterase inhibition[6,7]; † indicates one or two fatalities in a group of five rats before the time when the surviving rats were sacrificed. Compound V was obtained by isomerization of IV for 36 hr. at 140° C.; melting point after recrystallization, 106°–107° C.

In vitro, the phosphate ester is a selective inhibitor of true cholinesterase, while both the O-methyl thiophosphate and its S-methyl isomer are selective inhibitors of ali-esterase (see table). Whereas the O-methyl thiophosphate exhibits only 1 per cent of the inhibitory potency of the S-methyl isomer *in vitro*, it is significantly more active than this isomer against the true cholinesterase *in vivo*. Moreover, both the O-methyl thiophosphate and the phosphate ester are selective inhibitors of true cholinesterase *in vivo*, and only the S-methyl isomer inhibits the ali-esterase more strongly than the cholinesterase (see table).

Finally, it was observed that the initial esterase inhibition caused by the S-methyl isomer had almost completely disappeared 24 hr. after the injection of this compound into the rats; the inhibitory and toxic actions of the analogous phosphate, in contrast, continue to increase slowly between 4 and 24 hr. after injection. The effects of *bis*-(O-*p*-nitrophenyl) O-methyl thiophosphate *in vivo* are qualitatively identical with those of the phosphate analogue, and do not resemble those of the S-methyl isomer (see table).

Apparently the inhibitory activity of the O-methyl thiophosphate derivative *in vitro* is due to a contaminating trace of the S-methyl isomer; but its inhibitory action in the rat is probably due

COMPARISON OF THE INHIBITORY ACTIONS OF ORGANO-PHOSPHORUS DERIVATIVES ON THE CHOLINESTERASE AND ALI-ESTERASE OF RAT BRAIN *in vitro* AND *in vivo*

Compound	Molar concentration producing 50 per cent inhibition *in vitro* of		Amount injected (mgm / 100 gm.)	Per cent inhibition of esterases *in vivo*			
	True cholinesterase	Ali-esterase		1 hr. later: True cholinesterase	1 hr. later: Ali-esterase		
(I) O-*p*-Nitrophenyl O,O-diethyl thiophosphate (parathion, *E* 605)	$2·5 \times 10^{-6}$	3×10^{-6}	0·6	86*	36		
(II) O-*p*-Nitrophenyl O,S-diethyl thiophosphate	$3·6 \times 10^{-7}$	4×10^{-7}	2·0	69	62		
(III) *p*-Nitrophenyl diethyl phosphate (paraoxon, *E* 600)	$0·1 \times 10^{-7}$	2×10^{-7}	0·15	78*	26		
				4 hr. later: True cholinesterase	4 hr. later: Ali-esterase	24 hr. later: True cholinesterase	24 hr. later: Ali-esterase
(IV) *Bis*-(O-*p*-Nitrophenyl) O-methyl thiophosphate	$c.\ 10 \times 10^{-4}$	$0·6 \times 10^{-4}$	10	72	56	92*†	75
(V) *Bis*-(O-*p*-Nitrophenyl) S-methyl thiophosphate	12×10^{-6}	$0·8 \times 10^{-6}$	20	40	78	16	30
(VI) *Bis*-(*p*-Nitrophenyl) methyl phosphate	$0·3 \times 10^{-7}$	3×10^{-7}	2	80*	62	93*†	79

almost exclusively to the formation of the phosphate analogue. The quantitative difference, that is, the reduced toxicity of the O-methyl thiophosphate as compared with the phosphate analogue, could be explained by the various factors involved in the absorption and destruction of the injected thiophosphate before it is transformed into this phosphate. On the other hand, the S-methyl isomer does not appear to undergo any isomerization or oxidation *in vivo* and thus has essentially the same action *in vivo* as *in vitro*.

Should the effects described above be reproducible in other species, it would appear that the well-known differences in relative toxicity of analogous phosphates and thiophosphates towards various forms of life must be due mainly to differences in the water and lipid solubility of these compounds[8], and secondarily to differences in the ability of various animal species to oxidize and destroy the thiophosphates. The toxicity of the organo-phosphorus insecticides towards mammals seems to be dependent only on the inhibition of true cholinesterase[1,4,7]. Some of these compounds may also cause an appreciable inhibition of the ali-esterase in brain; however, no toxic symptoms are observed when the ali-esterase is inhibited selectively by *bis*-(O-*p*-nitrophenyl) S-methyl thiophosphate.

A detailed report of the investigations on ali-esterase inhibition will be published elsewhere.

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Response to Vitamin B_{12} of Grazing Cobalt-deficient Lambs*

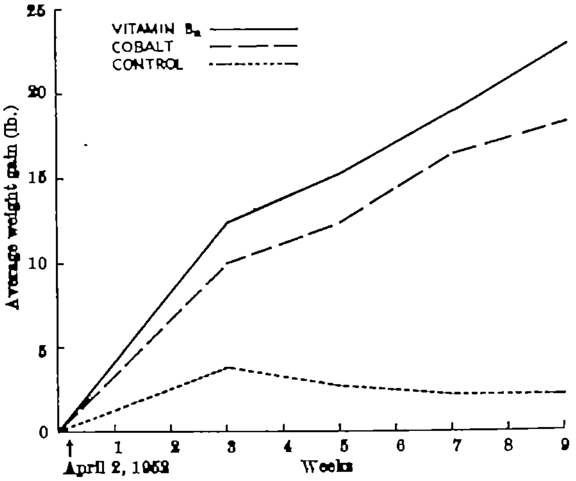
Smith and collaborators[1,2] have shown that vitamin B_{12} injected in sufficient quantity will alleviate the symptoms of cobalt deficiency in penned lambs fed a special low-cobalt ration.

Since cobalt deficiency in grazing lambs is not uncommon in New Zealand, it seemed desirable to test the curative action of vitamin B_{12} on unthrifty lambs grazing a pasture of low cobalt content. For this purpose suitable experimental conditions were available at the Winton Experimental Farm, Southland. Previous work[3] had shown that liver and pasture samples were low in cobalt content and unthrifty lambs had responded significantly to cobalt dosing.

In the present trial, Romney–Southdown crossbred lambs approximately 6½ months old were used. They had been confined to the same paddock since birth, and prior to the start of the experiment virtually all were showing signs of cobalt deficiency, as judged by small and erratic gains or actual losses in weight. Lambs were divided into three treatment groups as follows: (1) vitamin B_{12}-injected (4 lambs): 100 μgm. intramuscularly a lamb a week; (2) cobalt-dosed (19 lambs): 4 mgm. a lamb a week; (3) control (9 lambs).

Treatments commenced on April 2, 1952. All lambs were weighed at the start of the experiment, again three weeks later, and thereafter at fortnightly intervals until June 4. At the end of the nine-week experimental period, vitamin B_{12}-treated lambs had each received a total of 800 μgm. vitamin B_{12} and cobalt-dosed lambs each 32 mgm. cobalt.

Average gains in weight are set out in the accompanying graph. Responses to both vitamin B_{12} and cobalt are highly significant ($P < 0 \cdot 01$). Our figures suggest a more rapid response to vitamin B_{12} than to cobalt, but differences between the two groups do not attain significance.



These results show that, under the conditions of our experiment, grazing cobalt-deficient lambs respond at least equally as well to vitamin B_{12} as to cobalt. Australian workers[4] report a similar finding with adult merino ewes on low-cobalt pastures.

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* See also p. 791.

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Induction of a Spawning Reflex in Hypophysectomized Killifish

The observations reported below were made during the course of a preliminary series of experiments with purified fractions of pollack pituitary glands, a study which I am undertaking in collaboration with Dr. A. E. Wilhelmi, Department of Biochemistry, Emory University, with the support of a grant from the U.S. National Science Foundation.

The test fish were two-year-old male *Fundulus heteroclitus* (L.), hypophysectomized at least two months prior to the experiment to allow time for the testes to undergo complete regression. Intraperitoneal injections of 1 per cent saline suspensions were made at a standard dosage level of 100 μgm./gm. weight. Controls, which exhibited no response, received an equivalent volume of saline. Details of the effective fractions are reserved for later publication.

All fractions so far tested contain the melanophore-contracting hormone and pallor begins to develop 5–10 min. after injection. Shortly thereafter with certain fractions, on the average in 17 min., the fish become excited and begin to exhibit violent S-shaped spasms. Each spasm lasts from a few seconds to a minute or more. The fins are in rapid vibration or, more rarely, the fish becomes temporarily 'frozen' in a state of extreme flexure. A peak of activity is reached in about 30 min., after which there is a slow decline: but in the most potent fractions occasional spasms may be observed for as long as 1½–2 hr. The direction of flexure is either to the right or left with approximately equal frequency. The fish show no interest in each other but behave independently. Although the response is, in this respect, abnormal, there can be no doubt that the spasms are typical of the spawning behaviour of this species as described by Newman[1].

One completely hypophysectomized fish was injected thrice weekly for four weeks. At autopsy, nuptial colours were lacking and the testes were in total regression. Evidently the hormone responsible for the spawning reflex is not associated with stimulation of the regressed gonads. Nor can the spawning reflex be elicited by injections of methyl testosterone into hypophysectomized males.

Further experiments were made with pairs of unoperated fish, mostly well in advance of normal spawning. The response is exactly the same as in hypophysectomized fish and was elicited equally well in either sex. With the exception of one pair which were close to normal spawning, the development of spasms was not accompanied by emission of eggs or sperm, even after a second or third injection. Young fish, taken in their first spring, were as responsive as those with previous spawning experience.

In an attempt to identify the fraction responsible for the reflex, both normal and hypophysectomized fish were injected with a highly purified prolactin preparation. No response was elicited. Normal fish of both sexes were also injected with purified mammalian follicle-stimulating and luteinizing hormone (Armour and Co.). The follicle-stimulating hormone was inactive; but five out of six fish receiving the luteinizing hormone responded with characteristic spasms. The response appeared more slowly than with fish pituitary preparations, in 42–63 min., and it was less frequent. The luteinizing hormone was tested on a completely hypophysectomized fish and the response developed belatedly, in 77 min.

It is well known that injections of fish pituitary induce spawning in fish well in advance of the breeding season. Gerbilsky[2], an advocate of the neurocrine theory of the spawning hormone, has used intracranial injections for more rapid and effective results; in *Acipenser* the injected fish behaved in a tempestuous manner, leaping out of the water and often injuring themselves. Noble and his associates[3] induced brooding behaviour in the jewel fish, *Hemichromis*, with various pituitary preparations and also with injections of phenol; previous spawning experience was shown to be necessary, but the response could then be elicited even after castration, and it was further demonstrated that the nervous centres associated with the response were located in the corpus striatum. The findings reported in the present communication appear to confirm the theory that the spawning hormone of fish may stimulate sexual behaviour by a direct action on the nervous system. Furthermore, this hormone is apparently related to mammalian luteinizing hormone, which induces a similar response.

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Yale University.

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The 'Double Bang' of Supersonic Aircraft

Two explosive sounds in succession have sometimes been heard when aircraft in the vicinity exceeded the speed of sound. As I am not aware of any discussion of this phenomenon, I wish to direct attention to its explanation.

The condition for a shock to reach the stationary observer (in stationary air) can be stated simply with the aid of Huygens's wavelets: it occurs when the wavelets emanating from successive elements of the path of the source (the aircraft) superpose at the observer. This will happen when $-\mathrm{d}r/\mathrm{d}t = c$, where r is the (scalar) distance between aircraft and observer, and c is the speed of sound. Whatever the speed of the aircraft, no bang is heard by an observer with respect to whom $-\mathrm{d}r/\mathrm{d}t$ never exceeds the speed of sound. If it does exceed it, then there must be the point on the track where $-\mathrm{d}r/\mathrm{d}t$ first became equal to c; and, as a high speed of approach cannot be maintained indefinitely (at most until $r = 0$), there must be another point where $-\mathrm{d}r/\mathrm{d}t$ becomes again equal to c. Each of these two points is the origin of a bang for the particular observer, who would measure the direction and time accordingly.

The bang which is heard first is the one which was generated second, and it is expected to be usually the louder, having the closer origin. The second one to be heard may have its origin far away and hence be faint; but only if the aircraft has been flying nearly directly towards the observer for a long distance, or has been exceeding the speed of sound by a large margin. The most likely case at present appears to be a pair of similar bangs in quick succession.

The part of space in which the bangs can be heard is defined by a surface opening out in the forward direction from the point on the track where the aircraft first reached the speed of sound. An observer on this very surface would hear the two bangs merged into one.

The engine noise arrives at the observer in a complicated way: *before* the first and *after* the second bang, the noise is heard singly and in the time sequence of its generation; between the two bangs, there are three components of noise, one of which is reversed in time.

Note added on October 16. My attention has now been directed to a popular article in *Flight* of October 3 on this subject. That article contains no mention of the essential significance of the 'velocity of approach towards the observer' as distinct from the airspeed, and hence does not contain the main argument presented here.

T. GOLD

Trinity College,
Cambridge. Oct. 5.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 10

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Prof. C. A. Cotton: "Tectonic Relief".

University of London (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Dr. Henry E. Sigerist: "Landmarks in the History of Hygiene" (Heath Clark Lectures).* (Further Lectures on November 11, 12, 13 and 14.)

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. J. O. Wisdom: "A Theory of Psychosomatic Disorder".

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The Teaching of Illumination Engineering".

Pharmaceutical Society (at 17 Bloomsbury Square, London, W.C.1), at 7.30 p.m.—Dr. K. R. Capper: "The Extra Pharmacopoeia".

Chemical Society, Oxford Section (in the Physical Chemistry Laboratory, South Parks Road, Oxford), at 8.15 p.m.—Prof. G. E. Blackman: "Herbicides and Insecticides" (Alembic Club Lecture.) (All Fellows are invited.)

Tuesday, November 11

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. G. E. Blackman: "Factors Affecting the Selective Toxicity of Herbicides". (Further Lecture on November 18.)

University of London (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. C. A. Cotton: "Coastal Morphology and Classification".* (Further Lecture on November 13.)

Illuminating Engineering Society (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2) at 6 p.m.—Papers on "Factory Lighting".

Wednesday, November 12

Royal Sanitary Institute (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Mr. H. E. Bywater: "The Hygienic and Economic Utilization of Offal and By-Products of Food Animals" (Benjamin Ward Richardson Lecture).

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. E. G. Richardson: "The Science of Musical Instruments".

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Dr. S. F. Birch: "Sulphur Compounds in Petroleum".*

Royal Aeronautical Society (at Vickers-Armstrong, Ltd., Weybridge), at 6 p.m.—Sir A. H. Roy Fedden: "Rex Pierson—an Appreciation and the Lessons of his Work" (First R. K. Pierson Memorial Lecture).

Royal Statistical Society, Study Section (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Discussion on "The Census 1951—1% Results" (Speakers: Mr. Harry Henry, Mr. E. Grebenik, Dr. J. Baxter).

Society of Cosmetic Chemists of Great Britain (at the British Colour Council, 13 Portman Square, London, W.1)—Dr. Stoves: "Hair".

Thursday, November 13

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Mr. B. C. Brookes: "Words and their Definitions".*

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. R. H. Corkan and Dr. A. T. Doodson, F.R.S.: "Free Tidal Oscillations in a Rotating Square Sea"; Mr. J. Darbyshire: "The Generation of Waves by Wind".

Royal Institute of Chemistry, London and South-Eastern Counties Section (joint meeting with the University Chemical Society, in the Zoology Lecture Theatre, The University, Reading), at 8.15 p.m.—Dr. J. G. A. Griffiths: "Rockets and Chemistry".

Friday, November 14

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Mechanical Engineers (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. N. F. Mott, F.R.S.: "The Mechanism of Work-hardening in Metals" (Thomas Hawksley Lecture).

Institute of Physics, Industrial Spectroscopy Group (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Annual General Meeting; at 5.45 p.m.—Papers on "Vacuum Ultraviolet Spectroscopy".

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Dr. J. Carmichael: "Fine Chemicals in Veterinary Medicine".

Saturday, November 15

Biochemical Society (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 10.30 a.m.—Symposium on "Immunochemistry".

British Psychological Society (in the Eugenics Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. Sigmund Koch: "The Proper Functions of Theoretical Psychology".

Engineers' Study Group (in Room 6, 20 Buckingham Street, London, W.C.2), at 3.15 p.m.—Annual General Meeting.

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Dr. Ludwig Koch: "Songs of Wild Birds and How I Recorded Them".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Biochemist (basic grade) (with a B.Sc. degree, preferably with honours in biochemistry or chemistry, or an equivalent qualification)—The House Governor, General Hospital, Birmingham 4 (November 15).

Chemist (Senior Scientific Assistant) in the Central Laboratory, Chiswick, with responsibility for section concerned with wide variety of analytical and investigational work other than metals, fuels, lubricants and paints—The Staff Officer (F/EV 221), London Transport, 55 Broadway, London, S.W.1 (November 15).

Resident Assistant Lecturer in Agriculture at the Cumberland and Westmorland Farm School, Newton Rigg, Penrith, and for lecturing, demonstration and advisory work in the two counties—The Director of Education, 5 Portland Square, Carlisle (November 15).

Second Assistant Engineer (Chemist) (with first- or second-class honours degree in chemistry or associateship of the R.I.C., with emphasis on physical and inorganic chemistry) in the Generation Operation Branch at Bankside—The Director of Establishments, British Electricity Authority, British Electricity House, Winsley Street, London, W.1, quoting Ref. AE/297 (November 17).

Senior Tobacco Extension Officer (with a degree in agriculture, and wide experience in tobacco culture, particularly flue-cured Virginia, including curing, handling and marketing)—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (November 20).

Assistant Lecturer in Geology (with special qualifications in petrology and economic geology)—The Registrar, University College, Cathays Park, Cardiff (November 22).

Director of the Tasmanian Museum and Art Gallery—The Agent-General for Tasmania, 457 Strand, London, W.C.2 (November 29).

Assistant Lecturer (Grade III) in Physiology (Veterinary)—The Registrar and Secretary, The University, Bristol (November 30).

Lecturer in Economics at New England University College (University of Sydney), Armidale, N.S.W.—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (November 30).

Senior Masters (honours graduates) of Science, Mathematics, and Arts/Languages, at Welbeck Abbey, Worksop—The War Office (C.5), Whitehall, London, S.W.1 (November 30).

Senior Research Officer (with an honours degree in pure mathematics, with postgraduate or other training in mathematical statistics; research experience is essential) to be in charge of the Statistical Research Division, and a Research Officer (with an honours degree in psychology, preferably with mathematics and statistics as ancillary subjects) in the Industrial Research Team, to carry out research in the applied psychological field in industry, in the National Institute for Personnel Research, Johannesburg—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (November 30).

Lecturer in Physiology at University College, Dundee—The Secretary, The University, St. Andrews (December 1).

Research Fellowships in Economic History and Economic Statistics, Australian History, Law, Statistics, including Mathematical Statistics, Geography, International Relations, and Pacific History—The Administrative Officer in the U.K., Australian National University, 27 Russell Square, London, W.C.1 (December 1).

Chair of Mechanical Engineering and the Chair of Electrical Engineering, in the University of Roorkee, India—The High Commissioner of India (General Department), India House, Aldwych, London, W.C.2 (December 31).

Abstractor (a degree in engineering or physics is desirable) for duties consisting mainly of abstracting and summarizing technical and scientific papers in shipbuilding, marine engineering, naval architecture, general physics and engineering, and also dealing with technical inquiries relating to published material in these fields—The Secretary, British Shipbuilding Research Association, 5 Chesterfield Gardens, London, W.1.

Assistant, Grade B (with a university degree in science) in the Department of Chemistry—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

Assistant, Grade B (with honours degree in geology) in Geology—The Principal, Derby Technical College, Normanton Road, Derby.

Assistant Statistician to the Medical Research Council's Social Medicine Research Unit—Dr. J. N. Morris, Social Medicine Research Unit, Central Middlesex Hospital, Acton Lane, London, N.W.10.

Chief Hydrological Engineer in the Soil Conservation Section of the Ministry of Agriculture—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Chief Hydrological Engineer 404'.

Entomologist to carry out a survey of the tsetse areas of the Sudan and undertake research work—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist 2204'.

Graduate in Chemistry or Physics as Research Assistant in Chemical Engineering Department, to do research on flame propagation in gases—The Registrar, Imperial College of Science and Technology, South Kensington, London, S.W.7.

GRADUATE IN PHARMACY (with industrial experience) in the Department of Pharmacy—The Secretary, Royal Technical College, Glasgow.

LECTURER IN PHYSICAL CHEMISTRY—The Principal, Sir John Cass College, Jewry Street, London, E.C.3.

PHYSICIST (senior or basic grade) IN THE RADIOTHERAPY DEPARTMENT—The Group Secretary, Central Office, Nunnery Fields Hospital, Canterbury.

PHYSICIST (with honours degree) FOR WORK IN TECHNOLOGICAL DEPARTMENT involving investigations into friction and measurement and control of yarn tension—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

PROFESSOR OF ANALYTICAL CHEMISTRY—The Chairman, Department of Chemistry, University of Montreal, Montreal 26, Canada.

RESEARCH ASSISTANT PHYSICIST to undertake the development of a recording microspectrophotometer and the investigation of dichroism of biological crystallites—The Secretary to the Board, Royal Infirmary Branch, Bristol 2.

SENIOR EXPERIMENTAL OFFICER at the Ministry of Supply Trials Wing Outstation, Aberporth, South Wales, for duties mainly concerned with control of operation and maintenance of electronic instruments and supervision of technical work—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.401/52A.

SURVEYORS (university graduates with a degree, preferably with honours, in mathematics, physics, engineering, or geography, including geodesy) in the Colonial Survey Service and the Directorate of Colonial Surveys—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

East Malling Research Station. Annual Report (thirty-ninth Year), 1951. Pp. 208+20 plates. (East Malling: East Malling Research Station, 1952.) 12*s.* 6*d.* [177

General Register Office. Census 1951, Great Britain, One Per Cent Sample Tables. Part 1. Ages and Marital Condition, Occupations, Industries, Housing of Private Households. Pp. xix+159. 17*s.* 6*d.* net. The Registrar General's Estimates of the Population of England and Wales; Populations of each Administrative Area at 30th June 1951. Pp. 16. 6*d.* net. (London: H.M. Stationery Office, 1952.) [217

Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences. No. 638, Vol. 236: Mortality among Voles (*Microtus agrestis*) at Lake Vyrnwy, Montgomeryshire, in 1936–9. By D. Chitty. Pp. 505–552+plates 36–37. 13*s.* 6*d.* No. 639, Vol. 236. Development and Biology of the Larva of *Saccoglossus horsti* (Enteropneusta). By O. Burdon-Jones. Pp. 553–590. 9*s.* (London: Cambridge University Press, 1952.) [217

Directory of Free Lance Journalists, Artists and Photographers. Pp. 58. (London: National Union of Journalists, 1952.) [217

Annual Report on the Progress of Rubber Technology. Vol. 15, 1951. Edited by Dr. T. J. Drakeley. (Published for the Institution of the Rubber Industry.) Pp. vii+135. (Cambridge: W. Heffer and Sons, Ltd., 1952.) 21*s.* [217

Bibliography of Industrial Drying. Vol. 1. Pp. vi+288. Vol. 2. Pp. vii–x+301–520. Vol. 3. Pp. xi–xvi+531–802+xvii–xxxv. (London: Department of Scientific and Industrial Research, 1951.) 27*s.* 6*d.* [217

Treasure in Coal. Pp. 12. (London: Gas Council, 1952.) [237

Committee of Privy Council for Medical Research. Report of the Medical Research Council for the Year 1950–1951. (Cmd. 8584.) Pp. iv+214. (London: H.M. Stationery Office, 1952.) 6*s.* net. [237

Department of Scientific and Industrial Research. Road Research Laboratory. Road Note No. 14: Prevention of Wet-Weather Damage to Surface Dressings. Pp. 8. (London: H.M. Stationery Office, 1952.) 6*d.* net. [237

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Electrical Research Association. Technical Report L/T. 266. On the Vibrations of Long-chain Molecules, 1. By B. Szigeti. Pp. 12. 9*s.* Technical Report L/T 267: The Torsional Vibrations of Long-Chain Molecules, 2. By B. Szigeti. Pp. 10. 9*s.* (London: British Electrical and Allied Industries Research Association, 1951.) [237

University of Bristol. Annual Report of the Agricultural and Horticultural Research Station (the National Fruit and Cider Institute), Long Ashton, Bristol, 1951. Pp. 210+6 plates. (Bristol: The University, 1952.) [287

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Freshwater Biological Association. Twentieth Annual Report, for the Year ending 31st March 1952. Pp. 53. (Ambleside: Freshwater Biological Association, 1952.) 2*s.* 6*d.* [307

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Growth of Children: Sixty-six Boys and Girls each measured at Three Days, and at One, Two, Three, Four and Five Years of Age. By Prof. Alexander Low. Pp. v+64. (Aberdeen: The University, 1952.) 10*s.* [307

30th Report of Gresham's School Natural History Society, 1952. Pp. 16. (Holt: Gresham's School, 1952.) 1*s.* [307

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Dominion Museum Records in Entomology. Vol. 1, No. 9: Supplement to the Sub-Order Ouphophthalmi. By R. R. Forster. Pp. 177–212. (Wellington, N.Z.: Dominion Museum, 1952.) [237

Dominion Museum Records in Zoology. Vol. 1, Nos. 7, 8, 9, 10: Otoconcha and its Allies in New Zealand; New Species and Genera of New Zealand Land Snails, with a Revision of the Genus Cavellia; A Revision of the Molluscan Fauna of the Hurupi Beds, Southern Wairarapa; A Deep Water Molluscan Fauna from the Tasman Sea. By R. K. Dell. Pp. 57–108. (Wellington, N.Z.: Dominion Museum, 1952.) [237

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Proceedings of the California Academy of Sciences, Fourth Series. Vol. 27, Nos. 9, 10: Geology of the Continental Slope off Central California, by G. Dallas Hanna; Descriptive Petrography of Rocks dredged off the Coast of Central California, by Charles W. Chesterman. Pp. 325–374 (plates 7–19). Vol. 27, Nos. 11–15: A New Species of Foraminifera of the Genus *Discorbis* dredged off the Coast of California, by Clifford C. Church; Description of a New Pelecypod of the Genus *Lima* from Deep Water off Central California, by Leo George Hertlein; Shells from the Bird Guano of Southeast Farallon Island, California, with Description of a New Species of *Liotia*, by Allyn G. Smith; A Rare Species of Chiton from Pioneer Seamount off Central California, by A. G. Smith and G. D. Hanna; Some Decapod Crustacea dredged off the Coast of Central California, by Delbert G. Goodwin. Pp. 375–398 (plate 20). Vol. 27, No. 16: Annotated List of Fishes obtaine by the California Academy of Sciences during Six Cruises of the U.S.S. *Mulberry* conducted by the United States Navy off Central Californi in 1949 and 1950. By W. I. Follett. Pp. 399–432 (plates 21–26). (Sa Francisco: California Academy of Sciences, 1952.) [30

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A Catalogue of Books and Periodicals on Zoology, Botany an Geology. (No. 705.) Pp. 52. (London: Bernard Quaritch, Ltd., 1952.)

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INDUSTRIAL MANAGEMENT IN THE WELFARE STATE

IN its report for the year ending March 31, 1952, the Council of the British Institute of Management once again stressed the way uncertainty regarding future Government financial assistance handicaps the work of the Institute. The original five-year arrangement with the Government has now almost expired, and although the present Government has assured a deputation of its continued support of the purposes for which the Institute was established in 1948, the grant-in-aid of £50,000 eventually included in the Board of Trade estimates for 1952–53 is regarded as inadequate, notwithstanding the continuing growth of subscription income, to enable the Institute to carry out the full functions of a central institute of management. Since much of the Institute's work is of the nature of a public service to British industry as a whole, the Council makes a strong claim for a further and continuing contribution towards the cost of such service from public funds.

The completion of the merger with the Institute of Industrial Administration strengthens that claim, and it is also supported by the evidence in the reports of the Anglo-American Council on Productivity's teams on management accounting and on education for management. Elsewhere, the decisive contribution which management could make towards increasing productivity, and remedying the deficiency in Britain of men trained for management is widely recognized. It should be remembered, too, that when, in accordance with the recommendation of the Baillieu report six years ago the British Institute of Management was established, it was supported not only by Government funds but also by industry. The Council of the Institute believes that with even a fifty per cent increase in the present grant of £50,000 the Institute could meet the many and important demands now being made upon it.

What is possibly even more important is that the Institute should no longer be compelled to organize its work on a year-to-year basis. Such conditions are inimical to effective work in education and still more in research. The first fruits of the Institute's work in this latter field reinforce the claims of the Institute for the quite small sums which are required to place its work on an adequate and a permanent basis.

If the British Institute of Management's Field Research Group further develops its scrutiny of technical and managerial methods and skills and their adaptation to present requirements, it will be essential for the Institute to be assured of continued financial support. The value of a case study of an organization in its social environment as a complex indivisible unit has recently been demonstrated strikingly by the publication of a volume containing three such studies by J. F. Scott and R. P. Lynton. The Institute is not, of course, alone in making such investigations. Recent studies carried out, for example, by the Acton Society Trust, by the National Institute of Industrial Psychology or the Tavistock

Institute of Human Relations in association with the Human Factors Panel of the Committee on Industrial Productivity and by the Department of Social Science of the University of Liverpool, all emphasize the importance of such investigations and their bearing on productivity and the economic future of Great Britain.

The study of joint consultation in British industry published earlier this year (cf. *Nature*, 170, 254; 1952) noted a tendency for managers with high technical qualifications to pay insufficient attention to human factors in administration; nevertheless, it brought out the extent to which the whole problem of communication within industry is largely unsolved and that, while the responsibility for action and initiative may rest with management, all the faults do not lie on that side. New attitudes require to be developed on both sides. Dr. W. H. Scott's study* of human relations in three Merseyside firms largely corroborates the evidence obtained in the inquiry conducted earlier by the National Institute of Industrial Psychology's research team. This study, to which Sir George Schuster once again contributes a foreword, is an extension of work originally promoted by the Human Factors Panel. It provides further evidence that the working of a joint consultative system is extricably interwoven with, and conditioned by, the whole pattern of personal relations and informal structure in a particular firm, and by the pattern of deep-seated loyalties and suspicions which inevitably exist. No form of joint consultative machinery can accordingly fit every firm indiscriminately, and no system of joint consultation will work unless the total situation in the firm is right.

There is clear enough warning in Dr. Scott's book of the danger of attempting to create the right kind of co-operative spirit in industry by compulsory prescription of any standard form of joint consultative committee; but even more emphatically is that warning given by the Acton Society Trust's latest study, "The Worker's Point of View"†. This discussion of 'reporting back' based on a study in a coalfield gives a startling picture of the failure of the joint consultative machinery provided by statute, both to give employees an opportunity of having a say in the running of their firm or industry, and to supply them with sufficient background knowledge to ensure that their contribution is useful and relevant. In actual fact, so far from arousing a new sense of participation, the provision made under the Nationalization Acts has proved quite ineffective for both purposes. The dominant factor in the situation revealed by this study is not so much ignorance as the existence of an appalling range of positive misconception and misinformation. The very conditions in which joint consultation can function have still to be created.

To some extent this has already become apparent outside industry, through such incidents as the rejection by mine-workers of Italian workers. But the Acton Society Trust's study brings out clearly three factors, or rather attitudes, which dominate the whole situation: a persistent fear of the return of unemployment; a deep suspicion of all those in authority, who are thought to be idle or venal when not cruel or malicious; and a belief that the public regards the miner as an inferior type of human being and almost a social outcast. Joint consultation and the effective absorption of information are scarcely possible while such attitudes persist, and nothing less than an intensive programme of education and re-education on a national scale will serve. The practical problem is two-fold—whether from the point of view of joint consultation or morale; to provide more factual information, and to dispel these suspicions.

The Acton Society Trust does not suggest that there have been no failures to pass on effectively information which has been supplied; but it rightly insists on the necessity of restoring confidence in management—a point equally stressed in Dr. Scott's investigation. But it is the loss of human relationships in the nationalized industries that is responsible for much of the difficulty, and here, as appears more fully in Dr. Joseph Goldstein's study of the government of British trade unions*, the trade unions themselves must bear part of the responsibility. The question may fairly be raised whether, from the point of view of human relations, the whole administrative structure of some nationalized industries, such as the railways, is fundamentally wrong.

The picture revealed by the Acton Society Trust's study is disquieting, not simply from the picture of ignorance, misconception and misinformation which it reveals but still more because so often managements appear not to have thought out clearly either what employees should know or how to give them this information, and have made little attempt to put into effect a definite policy. Much trouble, it is true, has been due to failure on the part of members of consultative committees to pass on the information which has been given them. Even here, however the question may be raised whether management is entitled to think it has discharged its responsibilities when it has given information to these committees

That view is supported by Dr. Scott's study, which emphasizes the dependence of effective consultation not merely on the social relations existing in the factory but also on the extent to which management has taken the trouble to secure that the attitudes and behaviour of departmental managers and supervisor are in harmony with policy, and correlated with the employees' approval of both higher management and the general conditions existing in the firm. Like the earlier investigation of the National Institut of Industrial Psychology, his study emphasizes the way in which the pattern set by senior management, and in particular the higher executive, tends to be reflected throughout an organization. Moreover, both studie conclude that where management's leadership is paternal, employees tend to be concerned mainly with the personal advantages they can derive from joint consultation. They agree also that the status problems of representatives and the apathy of the rank and file are serious obstacles to successful joint consultation ; joint consultation tends to be more successful where it has been introduced by the modification of existing arrangements, such as management – shop steward procedures.

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* Industrial Leadership and Joint Consultation: a Study of Human Relations in Three Merseyside Firms. By Dr. W. H. Scott. Pp. xii+210. (Liverpool: University Press of Liverpool, 1952.) 12s. 6d.

† The Worker's Point of View: a Discussion of 'Reporting Back' based on a Study in a Coalfield. (Nationalised Industry Series, 11.) Pp. iv+32. (London: Acton Society Trust, 1952.) 2s.

* The Government of British Trade Unions: a Study of Apath and the Democratic Process in the Transport and General Worke Union. By Dr Joseph Goldstein. Pp. 300. (London: George Alle and Unwin, Ltd., 1952.) 25s net.

Sir George Schuster, in his foreword to Dr. Scott's book, expresses his belief that university departments are specially fitted to conduct the type of research in this field which, both by its methods and personnel, inspires the confidence essential for enlisting the active interest and collaboration of those concerned. That belief is substantiated by the approach to this study indicated by Dr. Scott, and by the account he gives of the methods used. No claim is advanced that the results described are more than preliminary, or that they show more than the interdependence of the various sectors of social relationships in an industrial organization and the very limited contribution which the introduction of formal joint consultation can make to the improvement of industrial relations. Nevertheless, they do something more than stress the cardinal importance of real leadership in general. The problems which further work should seek to clarify in this complex situation are indicated. The characteristics of the behaviour of a variety of leaders, and the associated attitudes and behaviour of the subordinates for whom they are responsible, at various levels in the everyday industrial situation, require description. Again, while morale and productivity may be less closely linked than has often been suggested, the important outstanding problem here is to determine whether there is a particular type of social structure within which both high morale and high productivity co-exist.

We are, in fact, rapidly increasing our knowledge of the ways in which change may be achieved, and this only increases the importance of developing our systematic knowledge of the directions in which change should proceed. Dr. Scott rightly urges that a fuller understanding of the nature of effective leadership, and of the factors which mould the behaviour of leaders, is needed if our increasing knowledge of the procedures which will facilitate change is to be used to the best advantage. But those procedures will only be used with confidence as the directions which change should take become clearly defined.

Accordingly, studies concerning the community and the cultural milieu of leaders are specially important, and this is emphasized at one particular point where these studies of Dr. Scott, the National Institute of Industrial Psychology and the Acton Society Trust touch Dr. Goldstein's study of British trade unions. The two former remark on the way in which a good trade union – management relationship facilitated joint consultation, and Dr. Scott, recognizing further the complication which inter-union rivalry can introduce, notes that the attempt to solve such problems will require an analysis of the structure and functioning of the trade union movement such as Dr. Goldstein has, in part, attempted. Quite as explicitly, the Acton Society Trust recognizes that in this matter of communications and leadership the sole responsibility does not rest on management : there is the further more specific question of immediate interest to the unions themselves of how far industrial democracy can be made a reality except on a basis of good communications.

To this question Dr. Goldstein's story of apathy and the democratic process in the Transport and General Workers Union gives a very perturbing answer. His study shows that the lack of interest of the rank-and-file of the workers revealed by those studies of leadership and joint consultation in specific firms is paralleled in one of the largest trade unions of Great Britain. At the same time, he demonstrates beyond question the way in which both the method of conveying public information and the determination of what information is relevant are matters of vital and direct concern to the unions as well as to industry.

The unrealistic view of industrial democracy prevalent in the Union studied by Dr. Goldstein is probably the most disturbing feature of his book. The domination of the Union by a small group which may be quite unrepresentative has dangers which are obvious, though within the Union they appear not to be realized. To some extent that position is due to the very high proportion of members who are automatically deprived of the opportunity of holding any office by a rule which makes office conditional on membership in good standing for at least two years.

Dr. Goldstein's study lends support to the view that, while the rules and constitution of this Union make it in theory fully democratic, the apathy of the ordinary workers has converted it into an oligarchy liable to be captured and used for purposes alien to the wishes of the majority, notwithstanding that members are, in general, alert and inquisitive persons. 'Branch' activities have failed to develop within the membership the social skills that are best expressed in an individual's capacity to receive communications from others and to respond to their attitudes and ideas, so as to promote well-informed participation in the common tasks of the democratic co-operation of the Union.

Nothing could better express the connexion between the management studies already discussed and the trade unions than this conclusion of Dr. Goldstein. He recognizes that the Union has many great achievements to its credit, and that it has trained many leaders who have served the community well. What is lacking is that tradition of democracy, which only everyday experience, custom and practice can build within the Union, and Dr. Goldstein maintains that it is the responsibility of the Union to widen the scope of its appeal to the rank-and-file beyond the horizon of mere wage increases or the improvement of conditions at a particular factory.

Part of the importance of this study lies in its revelation of the plain fact that the Union has failed to secure the active interest of most of its members. To that extent the Union faces the same problem as industrial management faces in joint consultation, and the response of the Unions to that challenge cannot be a matter of indifference to industry or to the nation as a whole. The self-contained attitude of at any rate some trade unions is a barrier to the development of wider loyalties in keeping with the need of the times. That is not stated explicitly by Dr. Goldstein, but a short-sighted insistence on the maintenance of vested power is likely to be the biggest obstacle to the trade unions accepting their responsibility of training the individual, through democratic participation, to adapt himself intelligently to the ever-changing personal relationships created by the demands of democracy in a highly industrialized economy.

If the trade unions do not respond to that challenge, democracy itself is endangered, for in the long run they alone can supply the tradition of democracy which is required for the growth of industrial democracy. If they accept the challenge, they will, as all these studies show, be faced with problems of communication, consultation and co-operation essentially similar to those which management faces in industry. In that lies the final reason for continued and adequate support by the Government of the British Institute of Management. It is not simply that the Institute is already making valuable investigations in this field—and that Messrs. J. F. Scott and R. P. Lynton provide a substantial basis for confidence in this question of securing co-operation and loyalty. It is rather that the British Institute of Management, as an independent body, with which trade unions are already associated, as well as industry, is doing unique work. It provides opportunities for managers and trade union leaders to meet in an atmosphere free from negotiation, and to explore informally many problems that are of common interest. In consultation with the trade union advisory committee, it is considering the desirability of including the field of trade union structure and working as a part of management training. Only such an independent body, the staff and methods of which command confidence, is in a position to provide whatever disinterested advice the trade unions require when they address themselves to the task of adapting their organization to meet the new demands and problems of the social welfare State. No more foolish economy could well be imagined than to jeopardize the efficient working of a body which serves such well-attested needs.

PRESENT POSITION OF METEOROLOGY

Compendium of Meteorology

Edited by Thomas F. Malone. Pp. ix+1334. (Boston, Mass.: American Meteorological Society, 1951.) 12 dollars.

THE preface of the "Compendium of Meteorology" states that the purpose of the book is to take stock of the present position of meteorology, to summarize the knowledge won by research in recent years, and to indicate lines for future study and research. The "Compendium", in fact, gives a broad survey of the state of knowledge in 1950 of physical and dynamical meteorology, of methods of weather forecasting, and of some aspects of climatology, applied meteorology and meteorological instrumentation.

The book has been compiled primarily for the professional meteorologist and other specialists in atmospheric physics. It must be made clear for the benefit of any who may be misled by the title that it does not include a collection of climatological data, physical tables, or tables for meteorological computers. It is not, on the whole, a text-book for new students of meteorology. Some articles cover the whole of their particular subject in a way very useful to readers with little previous knowledge; but many articles are very compressed, cover relatively recent developments only, and assume a thorough acquaintance with the bases of the subject.

There are a hundred and eight articles written by a hundred and two authors assembled into twenty-five sections. A few articles are by two or more authors. Seventy-seven of the authors are now working in the United States, though many of these, such as J. Bjerknes, B. Haurwitz and H. G. Booker, are of European origin. Eleven authors are now working in Britain. The great majority of authors are internationally known experts in their respective fields. The majority of the articles conclude with a list of problems on which research is most urgently needed and with extensive bibliographies.

The titles of the sections are, with brief notes, as follows: composition of the atmosphere (one article, chemical composition); radiation (three articles); meteorological optics (three articles, includes physics of visibility); atmospheric electricity (six articles); cloud physics (seven articles, includes artificial stimulation of precipitation); the upper atmosphere (twelve articles, atmosphere above the tropopause); cosmical meteorology (two articles, relations between solar phenomena and terrestrial weather changes); dynamics of the atmosphere (ten articles, includes meteorological thermodynamics, turbulence, and atmospheric tides); general circulation (three articles, summary of observations as well as theories); mechanics of pressure systems (six articles, pressure temperature and wind structure of depressions and anticyclones); local circulations (four articles, sea breezes, orographic effects on wind, air currents of thunderclouds); observations and analysis (three articles, distribution of observing stations, methods of plotting and analysing weather charts); weather forecasting (nine articles, short- and long-period forecasting, vertification of forecasts); tropical meteorology (four articles); polar meteorology (three articles, one on the Antarctic is very comprehensive on the aerological side); climatology (six articles, applications of meteorological information in planning, past climates, microclimatology); hydrometeorology (two articles, application of rainfall data in water supply and control of river flow); marine meteorology (four articles, exchange of energy between air and sea, ocean waves); biological and chemical meteorology (three articles, distribution of biological organisms by the atmosphere, human bioclimatology, measurement of atmospheric composition and other chemical problems); atmospheric pollution (one article); clouds, fog, and aircraft icing (five articles); meteorological instruments (two articles, almost exclusively on instruments for upper-air observation); laboratory investigations (three articles, use of models in meteorological research); radio meteorology (four articles, radar cloud echoes, refraction of high-frequency electromagnetic waves, use of location of atmospherics in weather forecasting); and microseisms (two articles, causes of microseisms and their application in forecasting).

The book shows that, as is natural, the greatest progress has been made in those parts of meteorology in which experiment is possible. Experiments in cloud physics, stimulated by the scientific desire to understand the processes of condensation of water vapour and formation of precipitation, the attraction of artificial precipitation and artificial cloud dispersal, and the need to minimize ice accretion on aircraft have led to great progress in that subject. Development in radio apparatus has given the meteorologist much better instruments than before 1939 for examining cloud structure and measuring pressure, wind and temperature in the free atmosphere.

Though techniques have improved and the number of stations increased, we learn that the accuracy of observation of some elements is not high enough for numerical forecasting and that over much of the equatorial regions and southern hemisphere stations are too sparse for scientific needs. Disappointment at the failure of the increase in the amount of information to provide more accurate forecasts of general weather is strongly expressed. The writers on synoptic meteorology and the general circulation are clear that more effort needs to be devoted to study of the circulation as a whole and to basic research in meteorological physics, at the expense of study of local circulations and development of empirical forecasting techniques.

The articles on meteorological dynamics and thermodynamics provide excellent summaries of these subjects and show very clearly their immense difficulties. The differential equations can only be solved for simplified states of steady motion or for first-order perturbations from those states, and the observed effects are given in the equations as the relatively small differences between two large terms the values of which are not known with sufficient accuracy for calculation of the differences. In his article on numerical prediction J. G. Charney is hopeful about allowing for radiation and condensation of water vapour but pessimistic about the turbulent transfer of heat and momentum.

At the end of his article on the forecast problem, H. C. Willett calls for the establishment of an international centre for global meteorological research. In this connexion it is of interest to see that the first number (April 1952) of the *Bulletin of the World Meteorological Organization* shows that attention is being given to this proposal. One of the features of the developments of the past fourteen years has been the growing realization of the value of meteorological knowledge in civil and military planning and in the control of industrial and agricultural processes. The articles by C. S. Durst, H. E. Landsberg and W. C. Jacobs, R. Geiger and E. W. Hewson on these matters deserve study by planners, engineers and agriculturists as well as meteorologists.

Considered as a picture of developments since 1939 the book is very complete, and there seem to be few omissions. More might have been said on condensation trails in the articles on cloud physics; and the subject of turbulence in clear air at great heights, to which much effort has been devoted during the past five years, is not mentioned. Very few misprints have been noted. The type and illustrations are very clear and the binding good. The editors have evidently taken much care to ensure uniformity of notation in the mathematical articles. The index contains about twelve hundred entries and seems very complete.

Meteorologists and all to whom meteorological knowledge is important will be grateful to the American Meteorological Society and the Geophysics Research Division of the United States Air Force, which supported the preparation in financial and other ways, for the production of this magnificent book.

THE WORLD OF TOUCH

Psychology and Art of the Blind

By Prof. G. Révész. Translated from the German by Dr. H. A. Wolff. Pp. xxiv+338. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1950.) 42*s*. net.

As the title of Prof. G. Révész's book seems to suggest, there are here really two books combined into one. The first deals with the fundamental theory of haptics ("the impressions conveyed by the tactile and kinematic sense"); the second deals with the æsthetic experience in haptic perception and with the creative activity of the blind. The work as a whole opens up a field of investigation for haptics comparable in its way with the fields of optics and acoustics. Besides being an important original contribution to psychology, it will doubtless be of considerable interest to the student of æsthetics. Erudite, clear and critical, it carries the mark of the mature scholar.

The method employed is chiefly that of searching phenomenological analysis, supplemented where appropriate by experiment. The experiments are not of the 'stream-lined' variety favoured by many of the American psychologists. They are ingeniously simple and usually conclusive. The Continental tradition of phenomenology has never taken root in Britain, and among psychologists in the United States, with very few exceptions, the very word 'phenomenologist' is almost a term of abuse. Yet, on studying such a work as this, one cannot help feeling that psychology in these countries has been impoverished as a result. Only two of the eighty references cited by Prof. Révész are to American sources; and in a well-known symposium on perception (edited by Blake and Ramsey), published in the United States in 1951, more than five hundred references are cited; but Prof. Révész does not appear among them, although he has devoted a large proportion of a long and distinguished career to research on perception. These signs are disturbing.

One of the main conclusions reached by Prof. Révész involves a rejection of the alleged universal applicability of *Gestalt* principles to all modes of perception. It had been more or less tacitly assumed that the principles that are probably valid for vision hold also for touch, although the world of touch has been left almost unexplored by the *Gestalt* theorists. Prof. Révész argues that haptic and optic space are autonomous, and that the first is just as real psychologically as the second. The world of those born blind is just as spatial as the world of the sighted but in a phenomenologically different way. In haptic space we proceed from structure to form; in visual space we proceed from form to structure. Apprehension of form means the appreciation of a unity of elements fused in a total impression. Apprehension of structure means consciously acquiring knowledge of the spatial and temporal relations of the perceived object. Prof. Révész derives a number of principles which he believes govern haptic perception in a distinctive way.

Much of the second part of the book is taken up with a careful study of the life-histories and artistic achievements of a number of blind sculptors. Here one must pay a tribute to the immense effort expended by the author in collecting and checking his data. He concludes that the æsthetic 'function' of the haptic sense is very limited. The blind are unable to apprehend objects as individual entities because haptic perception merely gives type images devoid of individuality. This may explain why they have no desire to finger objects of art or to learn details of their form and structure.

The foregoing indicates the kind of issue raised by Prof. Révész. The reader interested in almost any aspect of human perception or in the nature of æsthetic experience is bound to learn a great deal from his book. He had also better prepare himself to unlearn, because he will encounter a challenge to many of his preconceptions.

JOHN COHEN

TEXT-BOOK OF SILVICULTURAL SYSTEMS

Silvicultural Systems

By Dr. R. S. Troup. (Oxford Manuals of Forestry.) Second edition, edited by E. W. Jones. Pp. xv+216+43 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 25s. net.

TROUP'S "Silvicultural Systems", published in 1928, has long been recognized both as one of the best forestry text-books in the English language and the best survey in any language of the subject with which it deals. Changes in the methods of handling forests, however desirable, can only be a very slow process, as variation in future treatment is unavoidably largely circumscribed by what has been done in the past. A consequence of this fact is that although changed practices inevitably become necessary with increase of experience and the progress of knowledge, a book such as this does not quickly become out of date. It is therefore not surprising that even after twenty-four years the editor of the new edition finds that he can accept almost unchanged the greater part of the text, and that, apart from a few relatively minor amendments, changes in view and in practice can mostly be dealt with in an additional final chapter. Dr. E. W. Jones has among British foresters an unrivalled knowledge of the silviculture and silvicultural practices of western Europe, derived from repeated visits, particularly to France and Switzerland, and he has also first-hand knowledge of some of the silvicultural problems of tropical forests. As, also, he was on Troup's staff teaching silviculture and carrying out research in the subject, he was obviously in an exceptionally good position to bring Troup's book in line with current thought and practice.

In his preface, Dr. Jones enumerates the main changes he has made, and, except for modifying Troup's rather unqualified acceptance of the view that the selection system with all-aged crops gives timber inferior to that obtained with the more or less uniform (even-aged) crops, it is clear that his original contribution is concentrated in the new Chapter 20, "Developments of the Last Twenty Years". This is, indeed, a masterly and valuable summary of recent trends of thought in this field. Dr. Jones, man of science that he is, is very careful to keep in view the economic and practical considerations that must always play a large part in choosing between possible alternatives, and I only disagree with him in his reluctance to accept the view that supervision of uneven-aged forest is more difficult than that of more or less even-aged forests worked under the other systems; above all, when the technical standard of the staff is not first-class.

This chapter brings out the greatly increased importance now attached to the maintenance of soil fertility, leading to a growing preference for less regularity both in age and size, and in species, and to the maintenance of the canopy, avoiding clear or very heavy fellings at all times. I miss at this point an assessment of the alleged merits of periodically admitting light and warmth to the soil, as there are certain conditions where the claim is made that undesirable accumulation of raw humus occurs without it; there are also conditions in the tropics where, with appropriate treatment, any damage that may ensue from such exposure may be more than compensated, both economically and silviculturally, by the quick establishment of a better new crop.

The second important point made is that there is now a demand for more freedom of action to adapt current work in the forest to economic changes, the nature and direction of which cannot be predicted. The feeling is very general that any operation which ties the hands of the forest manager for a long period is to be avoided: this is just one more of the reasons that is giving a bias in favour of woods of mixed ages and species. It might perhaps also have been noted how generally the stress has shifted from getting each area unit of a forest into a form fitting into a preconceived pattern under a silvicultural system, to getting it into a condition in which it is producing the maximum growth in quantity and quality. Attention is very rightly directed to the new factor of forest genetics to be kept in mind.

The five pages devoted to natural regeneration in tropical forests (pp. 200–4), together with p. 207 on the enrichment of tropical forest and scrub, while perhaps not entirely up to date, give a very fair idea of the position. The merits and demerits of clear felling with artificial regeneration, notably with agricultural crops ('taungya') as a method of quickly bringing a mainly unproductive forest into more or less full production, will appear to many to be of sufficient importance for fuller discussion; such drastic measures might quite well only be necessary once, when the forest is first brought under intensive working.

Dr. Jones has done forestry another considerable service in undertaking this revision, and it can confidently be predicted that the new edition will meet most requirements for another twenty years.

H. G. CHAMPION

Chemical Kinetics

By Prof. Keith J. Laidler. (International Chemical Series.) Pp. ix+408. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 47*s*.

THERE has been a real need for a modern and intelligible book on chemical kinetics, and the present volume seems to provide such a book. It includes what may be called the classical material, in which it is pleasing to find that the contributions of those who laid the foundations of the subject are adequately recognized. The style is clear and concise, so that a large amount of information is presented in a readable form. Adequate references to literature are given, not confined to American publications.

All the important topics are covered, and special mention may be made of the clear accounts of the theory of absolute reaction-rates, which many students find difficult, and of chain reactions. Photochemical processes are included, and there is a good summary of polymerization. The experimental methods are briefly explained. It might have been mentioned on p. 34 that 'Pyrex' glass often gives anomalous results; the point is brought out later, but it could have been emphasized, since some apparent contradictions in results are due to this fact, as is mentioned on p. 52. There are useful short tables of results, and a selection of problems at the end of each chapter will be useful to students and teachers.

The chapter on catalysis is to some extent rather confused by the contradictory results of different workers, and in such cases it might have been better in an elementary work to wait until the subject is a little more clarified in such parts. They are more suited to a report than a text-book. All the same, it may be hoped that students beginning research may be stimulated by such contradictions to undertake work in the field. The book is one which can be warmly recommended as giving a modern and adequate account of its subject within its standard.

J. R. P.

Substances naturelles de synthèse

Préparations et méthodes de laboratoire. Collection publiée sous la direction de Dr. Léon Velluz. Vol. 3. Par J. Mathieu, P. Poirier, A. Petit et Dr. L. Velluz. Pp. 156. (Paris: Masson et Cie., 1951.) 1,750 francs.

THE third volume of this series follows the same plan as the two previous volumes (see *Nature*, 169, 169; 1952). It gives details, taken from current chemical literature, for the small-scale laboratory preparation of the following compounds: *dl*-glutamic acid from methyl acrylate and sodio ethyl acetamidomalonate (Snyder, Stockleton and Lewis, *J. Amer. Chem. Soc.*, 1945); *dl*-3:4-dihydroxyphenylalanine from piperonal (Barry, Mattocks and Hartung, *J. Amer. Chem. Soc.*, 1948); œstradiol from the acetate of dehydroandrosterone (Wilds and Djerassi, *J. Amer. Chem. Soc.*, 1946); *dl*-ornithine from acrylonitrile and ethyl acetamidomalonate (Albertson and Archer, *J. Amer. Chem. Soc.*, 1945); and thiamin (vitamin B$_1$) (Gravin, *J. Chim. App. U.R.S.S.*, 1943). There are many additional notes on the preparation of intermediates, and on a variety of topics connected with the syntheses, including the Michael reaction, aliphatic nitroso compounds, bromination of 3-ketosteroids, syntheses of equilenin and œstrone, the Stobbe reaction, cyanoethylation, the synthesis of pyrimidines and thiazoles, the preparation of alcohols from amines, and oxythiamine.

Two sections deal at some length with the preparation of thiazoles and benzthiazoles, and with the synthesis of α-amino-acids. These articles tabulate many thiazoles and amino-acids, with their methods of preparation and the relevant references. There is finally a short article on the determination of melting points, and the book is completed by a table of contents, and author and compound indexes to the experimental sections.

W. Baker

Treatise on Powder Metallurgy

By Dr. Claus G. Goetzel. Vol. 3: Classified and Annotated Bibliography. Pp. xxiv+899. (New York: Interscience Publishers, Inc., 1952.) 22 dollars.

THIS is the third, and last, volume of Dr. C. G. Goetzel's "Treatise" (see *Nature*, 168, 133; 1951), and its appearance crowns a magnificent achievement. It consists of a classified and annotated bibliography and comprises, with indexes, etc., 899 pages. After a short preface, with acknowledgments and a section on the use of the bibliography, there is a full contents table giving the sub-divisions of chapters and sections. The bibliography follows the same order and divisions of subject as that in the preceding volumes. The literature survey comprises 5,535 separate references, each accompanied by a short annotation indicating the main subject and sufficient to indicate the necessity or otherwise of further study. References are complete to January 1, 1950, and careful search has failed to disclose any important gap.

The patent index cites 6,330 patents, including American and British, and many French, German and other Continental countries. There is a complete subject index, and the very full name index differentiates between literature and patents by using Arabic numerals for the former and italic numerals for the latter.

Now that the complete treatise on powder metallurgy is available, it is possible to appreciate the magnitude of Dr. Goetzel's work and to assess, in part at least, the nature of the contribution he has made to all present and future workers in this field. There can be no question that this "Treatise" will provide the standard work on the subject for many years to come and will be indispensable in every reference library on metallurgy.

H. W. Greenwood

Preparation of Organic Intermediates

By Prof. David Allen Shirley. Pp. x+328. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1951.) 48*s*. net.

ALTHOUGH the range of organic chemicals offered by chemical manufacturers is ever increasing, more often than not a certain intermediate which is needed for a synthesis is not available, and the laboratory worker has to resort to its preparation. Usually, he first refers to "Organic Syntheses" to see whether preparative details are given in one of the several volumes of the series. If not, he has to search the original literature and often make a judicious selection. This book contains specific preparative information on more than five hundred useful organic compounds. The preparations listed are all taken directly from the literature, but the author is to be congratulated on the selection of compounds included and the preparative methods adopted. The criteria which determined his choice of intermediates were as follows: the compounds are not available commercially or, if available, are relatively expensive; they are useful intermediates for the synthesis of other chemicals, or their method of preparation serves as an example of a generally useful type of organic reaction; the starting materials are commonly available (in the United States) or, if not, their preparation is described in "Organic Syntheses" or elsewhere in the book.

All the preparations are on a convenient and useful laboratory scale. The inclusion of some catalyst preparations and certain precautionary notices concerning hazards are commendable features. In addition to a molecular formula and general index, there is a "type of reaction" index which is valuable and which serves to indicate the wide range of reactions covered.

This book is a worthy companion volume to "Organic Syntheses". J. IDRIS JONES

Artificial Fibres

By R. W. Moncrieff. Pp. x+313. (London: National Trade Press, Ltd., 1950.) 25*s*. net.

FIBRES from groundnuts, others from seaweed, fibres long known such as those from the cuprammonium process, celanese and viscose, others more modern such as nylon, 'Terylene', and vicara, lesser-known ones such as those made from glass or from polythene; fibres manufactured, spun, woven, stretched, regenerated, dyed, their strength tested; fibres examined, analysed, identified and their molecular structure investigated; staple fibres, lustrous fibres, anti-crease fibres; all are described or discussed by the author—himself a master craftsman—in this interesting and informative book.

Besides being clearly and singularly well written, the book is made additionally attractive by its 112 illustrations, many of which are in half-tone. The thirty-one chapters are grouped to make five parts severally headed as follows: the structure and properties of fibres; regenerated cellulosic and alginic fibres; regenerated protein fibres; synthetic fibres; and processing. The greater part of the text will be easily understood and enjoyed by the ordinary reader. The sections appealing only to the expert are well done and supported by abundant references to the literature. A perusal fully bears out the publisher's claim that the book affords a thorough up-to-date survey of modern synthetic fibres, and it should appeal to all in any way concerned with these new and promising materials.

The Hardness of Metals

By D. Tabor. (Monographs on the Physics and Chemistry of Materials.) Pp. ix+176. (Oxford: Clarendon Press; London: Oxford University Press, 1951.) 15*s*. net.

STANDARD text-books satisfactorily describe the various techniques of hardness testing and critically discuss their relative advantages and disadvantages in practice. They do not, however, provide any clear understanding of what is meant by 'hardness'; nor do they explain the hardness behaviour of metals in terms of any of the well-understood physical properties. The omission is rectified by the book under review. Over a period of several years the author has studied the problems of contact between solid surfaces and, finding the existing theory of deformation by indenters quite inadequate, he has proceeded to build up a satisfactory treatment in terms of the formal theory of plasticity using only very simple mathematical methods. No reader can fail to be impressed by the thorough way in which this has been done, for light is thrown on almost every aspect of hardness behaviour. Meyer's Law is derived from the stress–strain curve; the relationship between Brinell hardness and ultimate tensile strength is explained, and many empirical relationships deduced from practical experience are given a physical basis.

Dynamic or rebound hardness and the factors determining the area of contact between solids are discussed in the final two chapters.

This book is clearly written and illustrated and can be warmly recommended to all those who are interested in the hardness of metals. It is without doubt the most important work on the subject to have appeared for many years.

A. G. QUARRELL

The Old Place

By C. C. Vyvyan. Pp. 190. (London: Museum Press, n.d.) 15*s*. net.

IN an age of ever-increasing statistics and sociological studies there is a danger that the history of our times may become intelligible only to those of our successors who have familiarized themselves with the requisite techniques. Yet shades of emphasis and the nuances of everyday life are still difficult to express mathematically and need the eye and expressive powers of the artist before they can be transmitted to others elsewhere. In "The Old Place", Miss C. C. Vyvyan would be the last to claim that she had written a precise account of what the Second World War had meant to those who lived in large country homes. She could claim to have recorded faithfully her part in the struggle to 'keep up' at least some of the standards of one fine old country house, and especially its garden. This simple account of a determined and not unsuccessful effort to restore the house and garden to a state of beauty after years of requisition by military and other authorities is one which was worth the telling; it deserves readers, now and hereafter.

The British Pharmaceutical Codex, 1949

Supplement 1952. (Published by direction of the Council of the Pharmaceutical Society of Great Britain.) Pp. xii+148. (London: Pharmaceutical Press, 1952.) 25*s*. net.

THE continual appearance of new drugs makes it difficult to keep the books of reference up to date. The "British Pharmacopœia" of 1948 was followed by an addendum in 1951, and the "Codex" of 1949 is followed by a supplement in 1952. This supplement contains new general monographs, dealing with twenty-two drugs now officially described for the first time in Great Britain, and fourteen drugs already described in the addendum to the British Pharmacopœia. There are also fourteen old monographs which have been amended because the drugs appeared in the addendum.

The new drugs include amidone, aureomycin, cyanocobalamin (vitamin B_{12}), dapsone, decamethonium, diethylcarbamazine (Hetrazan), gallamine (Flaxedil), gammabenzene, lucanthone (Miracil *D*), mephenesin, solapsone (Sulphetrone) and troxidone (Tridione). It is good to have official standards and names for all these drugs, and reliable paragraphs on their actions and uses. The Codex Revision Committee is to be congratulated.

REACTIVITY OF FREE RADICALS

FARADAY SOCIETY DISCUSSION IN TORONTO

THE first full meeting of the Faraday Society held outside the United Kingdom took place in Toronto during September 8–9. Owing to the generosity and hospitality of Canadian chemists, a strong party of British chemists was able to participate in the meeting and to see something at first hand of Canadian achievements in chemistry during visits to university, government and industrial laboratories. The subject of the discussion, "The Reactivity of Free Radicals", was deliberately chosen to focus attention on the more quantitative aspects of the chemistry of free radicals. The Faraday Society has already held a number of discussions directly concerned with radicals and having a considerable bearing on such specialized subjects as oxidation, polymerization and related phenomena. In 1947 the discussion on labile molecules marked the opening of the quantitative phase. Here the principles of determining the absolute reactivity of radicals became apparent, and the complete chemistry, as well as the kinetics of reactions, began to develop. In five years extremely rapid progress has been made, and the present discussion covered the whole field, with the exception of the chemistry of polymer radicals, so that it was possible to appreciate from the papers the present position of what used to be a rather nebulous and highly controversial part of physical chemistry. The character of the discussion naturally took special notice of the important developments in Canada in this field; in fact, it was particularly appropriate that the discussion might in this way pay a tribute to the progress of Canadian physical chemistry. The Canadian interest centred mainly on gas phase reactions, while the British contributions were more concerned with liquid phase phenomena. Some measure of Canadian achievement may be found from the fact that half the papers originated from the western side of the Atlantic.

Perhaps the more striking feature of the papers presented to the meeting is the variety of methods that can be brought to bear on the problem of radical reactivity. The conventional kinetic approach, namely, the effect of measurable variables like concentration, temperature and intensity of light on the rate of reaction, has been supplemented by quite independent methods, so that the rather tentative conclusions about mechanism devised from kinetics may be much more firmly established and the reality of the existence of radicals proved beyond all doubt.

One of the most striking new methods is flash photolysis (R. G. W. Norrish and G. Porter). Here an intense flash of radiation of short duration is projected into a reaction system, and, if radicals are formed, their concentration is so remarkably high that their ultra-violet absorption spectra may be recorded, with the great advantage of certain identification. Furthermore, the variation of concentration with time may be followed by suitable modification of the apparatus so that velocity coefficients can be determined in the most direct manner possible. For example (G. Herzberg and D. A. Ramsay), it has been known for some time that ammonia undergoes primary photolysis to hydrogen atoms and, it is suspected, amine radicals. Now, with flash photolysis, the existence of the amine radical shows up in its absorption spectrum. Further confirmatory evidence comes from observations on ammonia labelled with nitrogen-14. With the identification of the spectrum of NH_2, the so-called α-bands of ammonia which appear in discharges through ammonia, in ammonia flames and even in comets, can now be ascribed to a well-defined amine-emitter. The flash photolysis method is particularly useful in the study of explosions, for a photochemically active flash is so short in duration that the heating of the system occurs adiabatically and may easily reach and exceed the ignition temperature of an explosive mixture. Thus a new and controllable means of initiating explosions becomes available; but far more important is the fact that the nature of some of the radicals and the variation of their concentration with time may be followed throughout the short period of reaction. For example, with acetylene–oxygen mixtures sensitized by nitrogen dioxide, OH, CN, C_2 and CH radicals can all be observed simultaneously, and controversy as to the nature of these active intermediates at once stilled. Another application of the method makes it practicable to study photochemical reactions that do not ordinarily take place. If chlorine and oxygen are illuminated nothing happens, but by flash irradiation the hypochlorite radical can be observed and its reactions readily followed (G. Porter and F. J. Wright).

Another equally valuable but difficult technique consists in introducing a representative sample of a reacting mixture into the ionization chamber of a mass spectrometer and detecting any radicals present, owing to the fact that the ionization potentials are smaller than those of the molecules from which they were derived. The appearance potential, mass number, and the magnitude of the positive-ion current in sufficiently simple systems serves to identify the radicals. The first experiments with this method were essentially qualitative in nature, but now quantitative information about the efficiency of radical production is becoming available (F. P. Lossing, K. U. Ingold and A. W. Tickner). For example, in the primary decomposition of ethylene oxide each molecule gives rise to 0·6 methyl radicals, and with propylene the figure is down to 0·36. This promises well for the elucidation of the primary step in thermal transformations and therefore supplements the evidence from purely kinetic sources.

Although new methods yield new information about radical reactivities, there is much to be done by the older methods, provided sufficiently simple systems are investigated. For example, in the attack by methyl radicals on hydrogen molecules, experiments with all the deuterated varieties of the entities concerned show that the nature of the molecule rather than that of the radical determines reactivity (T. G. Majury and E. W. R. Steacie). Again, the production of atomic hydrogen by means of a hot tungsten filament in a flow system has resulted in a much clearer picture of the mechanism of attack on the ethane molecule. There seems to be little doubt that dehydrogenation is the first step, followed by the interaction of atomic hydrogen with the ethyl radical to yield two methyl radicals, the reaction being completed by the hydrogenation of the methyl radicals (M. R. Berlie and D. J. Le Roy). Another convenient way of generating atomic hydrogen consists in the photodecomposition of hydrogen sulphide thus :

$$h\nu + H_2S = H + SH.$$

The hydrogen atoms either decompose another molecule of hydrogen sulphide or interact with an olefine added to the system. By this competitive method the relative reactivities may be obtained. With paraffins the hydrogen atoms merely abstract hydrogen atoms, but by using deuterium sulphide the ratio HD/D_2 that is found gives a measure of the competition of the process involved (B. de B. Darwent and R. Roberts).

In the photolysis of complex polyatomic molecules like biacetyl, there is plenty of evidence of initial fission into acetyl radicals. Complications immediately arise when such radicals not only undergo further decomposition but, in addition, attack biacetyl. Precise quantum-yield measurements coupled with complete analysis of the reaction products can go a long way to obtaining the sequence of radical reactions involved. Such an analysis is normally extremely tedious, but by mass spectrometry the quantum yields for the production of all the molecules are readily measured so that a much more reliable scheme may be constructed (F. E. Blacet and W. Bell). When radicals from ketones (for example, diethyl ketone) are liberated in the presence of oxygen, the character of the reaction changes completely because of the rapidity with which oxygen adds on to the ethyl radical. Even at room temperature short chains are propagated in such a mixture. Instead of the radical yielding carbon monoxide, the final product of attack is carbon dioxide (A. Finkelstein and W. A. Noyes, jun.). Sometimes it is possible to choose a molecule for photochemical studies in such a way that only one of the radicals produced is sufficiently reactive to require study. Trifluoromethyl iodide is a case in point. The iodine atom can be photolysed off in the gas phase, leaving the trifluoromethyl (CF_3) radical for study. Measurement of quantum yield gives the surprisingly low value of 0·02–0·13, which apparently is mainly due to a fast back-reaction between the two entities concerned which can be suppressed to some extent if the trifluoromethyl radical reacts with an added molecule sufficiently rapidly (J. R. Dacey).

The nature of active nitrogen has been the cause of violent debate for forty years. In this discussion it has been admitted as a free radical mainly on the basis that it will attack olefines and hydrocarbons—the olefines faster than the paraffins, hydrocyanic acid being the main product. This leads to the strong suspicion that atomic nitrogen is the source of the activity, and this is supported by the fact that absorption lines in the vacuum ultra-violet spectrum due to atomic nitrogen can be identified (C. A. Winkler and H. I. Schiff). The long-continued glow is, however, difficult to understand on this assumption, since the atoms ought to disappear quite quickly even in pure nitrogen. Another kind of discharge, in water vapour in a flow system, can give rise to production of up to 50 per cent hydrogen peroxide in a liquid-air trap, thus demonstrating that hydroxyl radicals combine at low temperatures. When the contents of such a trap are warmed, first hydrogen and then oxygen is evolved, and water and hydrogen peroxide remain. How these gases are held in the cooled material is a matter not yet satisfactorily settled (P. A. Giguère, E. A. Secco and R. S. Eaton).

Nitric oxide has long been used as a retarder of gas-phase radical reactions in order to estimate chain-lengths. Under suitable conditions nitric oxide is a supporter of the combustion, in flames, of hydrogen, ammonia and hydrocarbons (G. K. Adams, W. G. Parker and H. G. Wolfhard). Although the results are preliminary, these studies open up another unexplored field of radical chemistry. Another inhibitor of chain reactions—lead tetraethyl—is now supposed to act through the medium of lead oxide (G. H. N. Chamberlain, D. E. Hoare and A. D. Walsh).

The discussion on processes in the liquid phase revealed a similar broad approach to the reactivity of radicals. There is as yet very little evidence about the behaviour of the same radical in both the liquid and gas phases, and thus a direct connecting link is missing. At present, the kinetics of liquid-phase radical reactions are treated as if they were gas-phase reactions in regard to the dynamics of collisions. On the whole, the analogy with gases works well enough but occasionally difficulties appear which demonstrate that the analogy breaks down. Much of the information about liquid-phase radical chemistry is derived from studies in addition-polymerization, but this topic was excluded to make room for a discussion of other radical reactions. Photosensitizers are extensively used to initiate radical reactions, and the elucidation of mechanisms is important. Therefore studies on the photo-oxidation of anthracene (E. J. Bowen and Miss K. K. Rohatgi) and of the photochemistry of anthracene dissolved in carbon tetrachloride yield a great deal of information concerning the interaction of electronically excited molecules with reactive substrates. The dehydrogenation of aldehydes is an essential step in the oxidation of these molecules. The resultant radicals do not in general undergo decarbonylation. Similar dehydrogenation may be brought about by the radical $Me_2C(CN)$, but not efficiently. Thiols, however, enormously increase the rate of dehydrogenation and are regenerated in a cyclic process, so much so that the aldehydes are readily decarbonylated to the corresponding hydrocarbons (W. A. Waters and K. E. J. Barrett).

The decomposition of hydroperoxide provides another means of generating radicals. Normally, such a decomposition is a unimolecular process ; but thi does not always happen, for the reaction in certain circumstances becomes bimolecular, kinetically, though radicals still form a primary product of decomposition (L. Bateman, Mrs. H. Hughes and A. L. Morris). In the presence of certain oxidizable substances hydroperoxides can be induced to decompose very much more rapidly than on their own. This is industrially important, for it enables polymerization to be carried out at lower temperatures. Poly-ethylene polyamine of the general formula $H_2N(C_2H_4NH)_xH$ are particularly effective if they are associated with ferrou iron as a complex (R. J. Orr and H. L. Williams). Many such organic reactions are apparently simple stoichiometrically, but the mechanism is very much more complex. Such an example is the direct addition of trichlorobromomethane to vinyl acetate or cyclohexene. Kinetic methods, however, make it possible to analyse the mechanism completely and to get quantitative data about the reactivity of trichloromethyl radicals and derived radicals such a $CCl_3.CH_2.CH(OCOCH_3)$, which data have important application in many related fields (H. W. Melville, J. C. Robb and R. C. Tutton).

It has been known for many years that heavy metal ions which are present even in small traces can accelerate radical reactions like oxidation. These heavy metal ions, such as cobalt, act as true catalysts by means of electron transfer reactions with hydroperoxides, for example, giving rise to radicals which then initiate reactions. A typical reaction is $M^{2+} + R\text{OOH} \rightarrow M^{3+} + R\text{O}\cdot + \text{OH}^-$. If M is cobalt, then Co^{3+} is so powerful an oxidizing agent that it decomposes water as $\text{Co}^{3+} + \text{OH}^- \rightarrow \text{Co}^{2+} + \text{OH}\cdot$. Actual reactions are usually much more complex, but kinetic methods are leading to a complete elucidation in some cases (C. E. H. Bawn). With another related system—ferrous iron and hydrogen peroxide—benzene may be readily oxidized at room temperature with the production of phenol and diphenyl resulting from the dimerization of phenyl radicals produced by the dehydrogenation of benzene with hydroxyl radicals. Again, the precise mechanism yields to kinetic analysis (J. H. Baxendale and J. Magee). Sometimes it is not possible to perform a complete analysis, as, for example, in the attack of a phenyl radical on a variety of substituted benzene derivatives. However, it is possible to get relative rates of attack. In this system there is, fortunately, some guidance from the quantum-mechanical theory of aromatic structures (D. H. Hey and G. H. Williams). This guidance is lacking in the interpretation of most radical reactions. In fact, this lack of theory in radical reactions is a serious barrier to further progress. There is an increasing and exact body of experimental data available, and there is as yet very little in the way of fundamental explanation of even relative reactivities, apart altogether from absolute reactivities.

In many radical reactions large radicals are produced which may break up thermally before the next reaction-step takes place. Decarbonylation, referred to above, is an example, whereas degradation of hydrocarbon radicals and polymer radicals is well known. The methods of dealing with yet another complication were also considered in the discussion (F. S. Dainton and K. J. Ivin). More complicated still are those systems in which heterogeneity exists at first or is produced during the course of a reaction. This can happen in some oxidations and in polymerizations such as styrene and maleic anhydride, and leads to a state of affairs where homogeneous reaction treatment is not adequate to cope with the situation (C. H. Bamford and W. G. Barb).

H. W. MELVILLE

THE HUMAN BLOOD GROUPS

By DR. F. STRATTON

Director of the Regional Blood Transfusion Centre, Manchester

THE Medical Research Council has issued a revision[1] of its Memorandum No. 19, on "*Rh* Blood Groups and their Clinical Effects". Some of the sections have been considerably revised but others have only minor alterations.

The *Rh* system has been one of considerable interest and stands, as it were, at the crossroads between the older *ABO* and *MN* blood groups and those that have been discovered more recently. With the investigation of the *Rh* system the complexity of the human blood groups was realized, and the significance of their clinical effects more appreciated and understood.

Blood group systems	Year of discovery	Erythrocyte antigens	Principal types	Frequency of principal types (per cent)	Known anti-bodies
ABO	1900 1911	$A_1A_2\,B$	$A_1B\;A_2B$	3	anti-A
			$A_1\;\;A_2$	40	anti-A_1
			B	8·5	anti-B
			O	48·5	
MN *S s*	1927 1947	$MN\;Ss$	MS	20	anti-M
			MNS	28	anti-N
			Ms	8	anti-S
			MNs	22	anti-s
			NS	7	
			Ns	15	
P	1927	P	P-pos.	77	anti-P
			P-neg.	23	
Rh	1940/5	$CcDdEeC^w$	cde/cde	15	anti-D
			cDE/cDE	2	anti-C
			CDe/CDe	17	anti-E
			cDE/cde	11	anti-c
			CDe/cde	32	anti-e
			CDe/cDE	12	anti-C^w
			cDe/cde	2	
Lutheran	1945	Lu^a	$Lu(a+)$	8	anti-Lu^a
			$Lu(a-)$	92	
Kell	1946	$K\;k$	KK	0·2	anti-K
			Kk	10	anti-k
			kk	90	
Lewis	1946	$Le^a\;Le^b$	$Le(a+b-)$	22	anti-Le^a
			$Le(a-b+)$	70	anti-Le^b
			$Le(a-b-)$	8	
Duffy	1950	$Fy^a\;Fy^b$	$Fy^aFy^a\;Fy^aFy^b$	66	anti-Fy^a
			Fy^bFy^b	34	anti-Fy^b
Kidd	1951	Jk^a	$Jk(a+)$	77	anti-Jk^a
			$Jk(a-)$	23	

The accompanying table shows the commoner human blood groups, with English frequencies[2]. The *ABO* frequencies are Manchester ones. Including the *Rh* system, six of the series have been discovered during the past ten years.

Blood groups are due to the presence of antigens on the surface of the red blood cells. These erythrocyte antigens when injected into man or animals produce, sometimes in one, sometimes in both, a specific antibody. This antibody is used for the detection of the blood group, and, therefore, the determination of a new blood group antigen depends upon the finding of a particular antibody and the establishment of the fact that it determines a new antigen present on the surface of the red cell.

The blood groups listed in the table are the commoner ones, but others have been found which have been aptly labelled by Levine[3] as 'private' blood groups, that is, the positive or negative reactions are found only within a particular family, such as the *Miltenberger* group which he described and the *Levay* group of Callender and Race[4]. Another antigen is the Tj^a antigen of Levine[3], which is so far known to be absent only from the red blood cells of persons whose sera contain the antibody, or from their immediate relatives.

The antibodies which are used for the typing of blood groups are either human or animal in origin. The human antibodies may be regularly occurring ones, such as anti-A and anti-B antibodies, with which Landsteiner[5] first discovered the *ABO* groups at the beginning of this century. These are the only regularly occurring blood group antibodies in human blood. Other blood group antibodies do occur naturally in human serum, that is, not as a result of immunization; but their occurrence is irregular and their presence atypical. Such antibodies are the anti-P which detects the P blood group, and the *Lewis* series of antibodies which detect the antigens of the complicated *Lewis* blood group system. Immune human antibodies have lately been used for the discovery of the more recent blood groups; for example, the *S* sub-groups of the *MN* system and the *Kell*, *Duffy* and *Kidd* groups. These immune antibodies have resulted either from repeated immunization due to blood transfusion, or to the iso-immunization which occurs sometimes during pregnancy, or to a combination of both these factors.

Animal antibodies have been used for a long time for *MN* typing, and the *Rh* system itself was first discovered by Landsteiner and Wiener[6] using animal anti-*Rh* serum. Nowadays, however, with the exception of the *MN* groups, most blood grouping is done using natural or immune human antisera.

The great increase in the discovery of human blood groups in the past few years has been due partly to the occurrence of greater chances of immunization (in the main caused by the increase in blood transfusion therapy) as well as to the realization that pregnancy may cause iso-immunization, and partially to technical advances. Had no technical advances been made, it is quite possible that many of the newer blood groups would not have been discovered, since, in spite of the presence of the antibodies, these would have remained undetected. This may well mean that there are other blood group antigens present on human erythrocytes which may be detectable when suitable technical methods are available. It is probable, too, that more attention will be given to the study of the antibodies themselves, since it is the ability to recognize the antigen – antibody reaction on which substantially depends the recognition of new blood groups. Many different antibodies do not necessarily mean many different heritable agglutinogens.

Another interesting study has been that of the frequency of the various blood groups in the different races of man. It was known previously that the *ABO* and *MN* groups occurred in the different races of man with slightly different frequencies, but when the newer blood groups were examined it was found that these were widely different. Negroes probably have greater differences from the White than many other races; for example, in the *Rh* system one type (*cDe*/*cde*, Rh_0r) has a frequency of about 2 per cent in the English population but about 46 per cent in the Negro population[7]. Again, in the Chinese[7], *Rh*-negative persons are almost unknown, whereas in England they number about 17 per cent of the population; similarly, in studies of South American Indians[8], the *Duffy* blood group is always found to be negative, whereas in White populations 65 per cent are *Duffy*-positive. In North-West Pakistan, 91 per cent of the population are *Duffy*-positive[9].

These are very remarkable differences, but other interesting things have been discovered. It has always been realized that the *Rh* system was one of great intricacy; but for some time it had been thought that the *ABO* and *MN* groups were, compared with this, relatively simple ones. Study of these groups in the different races of man, however, has revealed that they are more complex. In the *MN* groups the *S* sub-groups were found in 1947; Landsteiner, Strutton and Chase[10] originally described a different type of *M* in Negroes, and Ikin and Mourant[11] have described another variety of *M* which is probably different from the former. In the *ABO* groups it has been found that certain group *O* Indians have, in their sera, an antibody which had always previously been considered to be of an anti-*O* variety[12]. This obviously does not fit our present ideas, and reveals further blood group characters within the *ABO* groups. Thus we see that whereas previously the complexity of the human blood groups was realized from serological and genetical studies, latterly their complexity has been further revealed by studies of the blood groups in the different races of man.

Soon after the discovery of the human blood groups, it was found that they were inherited and that the erythrocyte antigens were determined by allelomorphic genes. The inheritance was according to the Mendelian laws. Blood typing is generally possible; but genotyping may be possible only in certain cases. Genotyping is desirable since it is more accurate, and it is often necessary to know whether a person is homozygous or heterozygous with respect to a particular agglutinogen. If this is to be known, it is not only necessary to have the antibody of the particular blood group agglutinogen but also the antibody of its allele or, if the system is complex, the numerous antibodies of the system. Blood typing is sometimes actual genotyping—for example, in the *MN* system—in contradiction to the *ABO* groups where typing is not genotyping. In some of the more recently discovered groups, such as the *Kell* and *Duffy* systems, it was at first possible to group a person as *Kell*-positive or *Kell*-negative, or *Duffy*-positive or *Duffy*-negative; but later, other antibodies have been discovered to their alleles, the one in the *Kell* system being referred to as an 'anti-*k*' antibody, and that in the *Duffy* system as an 'anti-Fy^b' antibody, and consequently in these systems nowadays it is possible to genotype people. Similarly, in the *Rh* system, a large amount of genotyping can now be done.

Most blood groups are inherited independently of one another; but more recently it has been suggested that the *Lewis* group is linked with the *Lutheran* group[13].

Intensive studies have been carried out to try to associate blood groups with diseases. Iso-immunization of pregnancy is known to occur and may produce hæmolytic disease of the newborn. In these cases, the commonest responsible blood group is the *Rh* one. Linkage between blood groups and human characters has been studied many times, but no definite case of linkage has been established, although Penrose[14] has suggested a possible linkage between bright red hair and the *ABO* groups.

Blood groups are of especial interest in the study of human genetics because they are normal physiological characters, and as such are a feature of the whole population; moreover, from a genetical point of view, they are clear-cut characters, readily charted and scored; they are unaffected by environment. Their manner of inheritance is largely simple, the determinant genes being associated with one pair of chromosomes. They are, therefore, of great value in the study of human genetics, their wide distribution and complete penetrance always making them applicable, unlike other traits. It must be remembered, however, that the presence of the individual is required for such examination and studies; these therefore, are restricted to three or four generations and the possibility of illegitimacy must always be borne in mind. Nevertheless, the blood groups form a base-line from which to work, and it is desirable that human genetical studies should always be accompanied by a study of the blood groups, if this is possible.

Twinning is of considerable interest to human geneticists, and blood groups have been especially helpful in such cases. With the number of blood groups now known, if the twins are like-sexed, it is possible to calculate the chances of monozygosity[3]. The present writer has found it particularly useful in the study of a series of twins in which one child suffered from a congenital abnormality which the other did not possess; in a number of these cases the blood groups tended to show that the twins were monozygous.

Blood groups, of course, are of interest to the physician because of their importance in blood transfusion therapy, and they have also been used in cases of disputed parentage and in medico-legal work. In the case of disputed parentage, the *ABO*, *MN* and *Rh* groups are the ones that are used, because in these blood groups large numbers of family studies have been undertaken and their mode of inheritance is clearly defined and beyond doubt.

Landsteiner once said that blood groups would some day become as valuable as finger prints in the recognition of the individual. There is no doubt that recent studies have more and more established the individuality of the blood. There are now 300,000 blood-group combinations; some of these are extremely rare and occur very infrequently in the population. It is probable that more blood groups remain to be discovered; therefore, the study of human blood groups is one that assists in establishing the individuality of man, and the revised Medical Research Council publication is a valuable contribution on the subject.

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ENERGETICS OF SENSORY EFFECTS

AT the recent meeting of the British Association in Belfast, Section I (Physiology) arranged a session entitled "Energy into Nerve Impulses". The first paper was by Prof. E. D. Adrian, president of the Royal Society, who spoke on the sense of smell. He said there is much evidence that the olfactory organ in man is far less sensitive than the larger organs in dogs or sharks and the much smaller organs in moths and insects. It is likely that this difference in sensitivity is due more to a greater power of discriminating scents than to a lower absolute threshold at the end organs. Prof. Adrian then turned to the results he has obtained by recording, with a fine electrode in the olfactory bulb, the nervous discharges which occur in the mitral cells of the rabbit, while the nose is subjected to a known concentration of a suitable substance. With most smells excitation is confined to each inspiration, and it is also found that the concentration which is just perceptible to the human nose differs very little from that just capable of producing an olfactory discharge in the rabbit. Nervous discharges recorded in this way show a number of features by which the discharge may be distinguished as due to a particular smell. The differences in the olfactory discharge are of two kinds, depending on differences in the excitability of the different receptors and of different regions of the organ to different materials; and on differences in the time course of the discharge, the latency, duration and rate of rise and fall in the frequency of the impulses.

Prof. Adrian first considered the different sensitivities of individual units. It is possible to distinguish one unit from its neighbours by careful placing of the electrode, and it is nearly always possible to find a substance which will excite this single unit at a concentration too low to excite the others. Thus, in one preparation the single unit responded to acetone in a concentration at which no other unit did, and to a concentration of amyl acetate which excited other units, while it was unaffected by pentane in a concentration that excited the others. The substances tested could be classed in two groups—water soluble and lipoid soluble. Units responding to one group rarely responded to the other, and there is also a regional distribution, the anterior parts of the organ responding mainly to the water-soluble group and the posterior part to the lipoid-soluble group. The latency of the response to the water-soluble group is always less than 0·025 sec., while with substances insoluble in water it is longer than 0·05 sec. The substances which excite after a short latency produce a short discharge, and vice versa. Prof. Adrian concluded by saying that some of these differences may depend on the gross structure of the organ, and he suggested that the specific sensitivities of the receptors might be related to the length of the terminal part of the cell, which varies. He thought it unlikely that olfactory discrimination depends on a limited number of distinct receptor types.

Dr. Hallowell Davis, director of research of the Central Institute for the Deaf, St. Louis, Mo., then discussed the problem of how mechanical energy is converted into nerve impulses in the inner ear. The sensitivity of the cochlea is so great that the movement of the basilar membrane at threshold is probably less than the diameter of a hydrogen atom, and the amount of energy is of the same order of magnitude as the energy of thermal agitation of the molecules. If the cochlea were a transducer, this energy would have to be converted extremely efficiently, and the nervous tissue involved would need to be on the verge of spontaneous discharge. Dr. Davis described the results of recent experiments and put forward a new hypothesis that explains the action of the cochlea as an electronic valve mechanism rather than a transducer. The cochlea microphonic has been suggested as the immediate stimulus to the terminals of the auditory nerve, but at one time it seemed difficult to reconcile this hypothesis with the long latency that had been observed between the peaks of the microphonic and the impulses. This difficulty no longer exists, however, because the summating potential which Davis and his collaborators previously believed to be a local potential in the receptor cells has now been shown by Davis and Tasaki to be an action potential in the nerve fibre in the neighbourhood of the hair cells. This shows that the latency in the initiation of the impulses is very short, and Dr. Davis stated that he now accepts the hypothesis that the cochlea microphonic is the immediate stimulus to the auditory nerve fibre.

There has been indirect evidence that the cochlea microphonic is associated with the hair cells of the organ of Corti, and very recent explorations of the cochlea, independently by Békésy at Harvard and by Tasaki at the Central Institute for the Deaf, have strongly supported this conclusion. The source (or sink) for the cochlea microphonics seems to be the hair-bearing end of the hair cells. This is where the hairs are embedded in the tectorial membrane, and Békésy has shown that it is radial movements of the tectorial membrane across the organ of Corti that are most effective in producing the cochlea microphonics. He has also shown that, if the tectorial membrane is displaced and held in its new position, the microphonic continues as a D.C. potential without further addition of mechanical energy. This provides direct evidence that the mechanism must be of an electronic valve and not of a transducer type. Békésy has found that the endolymph in the scala media is about 80 mV. positive to that in the other scalæ, and that the electrical resistance of the walls of the scala media is high. Dr. Davis put forward the hypothesis that the cochlea microphonic is due to changes in the current flowing from the scala media to the scala tympani, due to changes in the electrical resistance of the hair cells in the region of the hairs, and that this change of resistance is due to, and directly related to, the position of the hairs. He suggested that the source of energy that maintains the potential in the scala media may be in the stria vascularis.

The next paper was on "Light-Quanta into Nerve Impulses", and was given by Dr. M. H. Pirenne, of the Physiology Department, University of Aberdeen. Light falling into the eye causes nervous excitation in the retina and optic nerve, and it is generally accepted that a photochemical change in the retinal receptors is the first step in this process. The retinal receptors, the rods and cones, contain substances (such as visual purple in the rods) which absorb part of the incident light and undergo physicochemical changes in consequence. It is these changes that lead to nerve excitation. Light can only be absorbed in quanta, and fractions of quanta cannot be absorbed (the energy of a quantum is about 4×10^{-12} erg for $\lambda = 0 \cdot 51\,\mu$). Experimental measurement indicates that under the best conditions a rod can become excited when it has absorbed one quantum only. The light sensitivity of the rod, therefore, reaches the absolute physical limit. To enable a human subject to see a dim flash of light, however, a few neighbouring rods must be excited within a short time-interval. Thus, while a rod reacts to one quantum, the organism as a whole requires more than one quantum to give a visual response. One quantum is absorbed by one molecule and reacts with that molecule alone. There must therefore be some mechanism which can amplify such a one-molecule disturbance into a stimulus adequate to set up an impulse.

Dr. Pirenne then turned to the visibility of large, continuously exposed fields, a problem in which he has been interested recently. The threshold for such a field is of the order of 10^{-6} candle/sq. m. At threshold the retina receives extremely little light energy—on the average one quantum is absorbed every 0·1 sec. per 100,000 rods. One-tenth of a second is roughly the time during which the retina can summate the action of light. Physical fluctuations give some parts of the retina more, and others less, than this average, so there may be a group or groups of rods in the retina that are excited within the summation time. These figures show that, in order to make every rod absorb about ten quanta every tenth of a second, we must use intensities equal to about a million times the threshold intensity for a large field. If the central cones are as sensitive as rods, then the same will apply in the fovea, but, if the cones are less sensitive, then even more light will be required. Thus, a single cone cannot be activated with intensities below 0·1 or 0·01 candle/sq. m., simply because at such intensities they generally absorb no light at all. Thus, quantum phenomena probably play as important a part in cone as in rod vision. It can be shown, for example, that in the range from threshold to about 10^3 threshold intensity, the finest details just visible at each intensity are almost as fine as they could be. Visual acuity and retinal sensitivity in this range are linked together, almost reaching the limit set by the quantum properties of light.

In the last paper, on the "Initiation of Impulses at some Sensory Endings", Dr. J. A. B. Gray, of the National Institute for Medical Research, confined himself to considering mechanically stimulated receptors. Certain conditions must be fulfilled before an impulse is initiated at a sensory receptor. A certain minimum amount of energy must be provided; but, as most of this energy is absorbed by inexcitable structures, it is easier to talk in terms of compression or extension of the receptor. A Pacinian corpuscle which can be freed from its surrounding tissues can be excited by compression movements of less than $0 \cdot 5\,\mu$. With some receptors, including the Pacinian corpuscle, the stimulating movement must also have a minimum velocity, and in this receptor a threshold movement must be complete in about 1 msec.—that is, a velocity of about 0·5 mm./sec.

A minimum velocity is not a necessary condition of excitation for all receptors; Landgren has shown that some receptors in artery walls respond however slowly the pressure rises to its final value. Impulses can sometimes be excited as frequently as a thousand a second from Pacinian corpuscles. A stimulus which satisfies these minimal conditions excites an impulse after a short interval. In the Pacinian corpuscle this interval is about 1·5 msec. when the stimulus only just reaches threshold, but it is reduced to about 0·5 msec. if the stimulus is large. During this interval, the excitability of the ending is steadily increasing, a fact which is shown by giving a Pacinian corpuscle a mechanical stimulus too small to excite and testing its excitability with a short electrical pulse at intervals after the mechanical stimulus. The excitability increases up to the time at which a threshold mechanical stimulus would have initiated an impulse, and then declines. These excitability changes are probably caused by a local potential change that has been observed by Alvarez-Buylla and Ramirez de Arellano. This potential change, unlike the impulse, is confined to the ending, and its size is directly related to the size of the stimulus. Local potentials were first seen in sense endings by Katz, who recorded them from a stretch receptor from a muscle. The potentials from this receptor showed two components: an early peak the amplitude of which was related to the velocity of the stimulus, and a part which was related to the amplitude of the stretch and remained as long as the stretch was applied. This local potential is probably the immediate cause of the impulse. The mechanism by which the mechanical stimulus produces the local potential is not known, but it seems likely that the mechanical stimulus allows the electrical energy stored in the nerve cell to be released. Stretching a single node of Ranvier does not produce changes comparable to stimulating a sensory receptor. However, a suggestion that there may be specialization of the membrane of sensory terminals comes from evidence that acetylcholine may stimulate sense endings, though this substance seems to play no part in their normal function.

In the discussion that followed, Prof. Adrian was asked whether the adaptation to a smell that is commonly experienced is due to fatigue of the receptor. He replied that an impulse discharge can be recorded for long periods and that the adaptation is presumably central. Dr. Detlev W. Bronk referred to the importance of the chemical environment of nerves and the oscillatory phenomena seen with lack of calcium. Under these conditions impulses occur at intervals which are multiples of a fundamental interval; he said that Dr. Scott had observed similar rhythmical discharges from Pacinian corpuscles. Prof. W. Burns asked Dr. Davis whether the threshold of the auditory receptors could be altered by polarizing currents, to which the latter replied that they can be either raised or lowered according to the polarity of the current. J. A. B. GRAY

OBITUARIES

Dr. W. E. Gye, F.R.S.

W. E. GYE, internationally known as an exponent of the virus hypothesis of cancer, died in Perth, Western Australia, on October 13.

W. E. Bullock, who later changed his name to Gye, was born in the Derbyshire village of Beeston on August 11, 1884. The son of a railway signalman, he tried a number of occupations before becoming a 'pupil teacher'. Later, he obtained a scholarship tenable at University College, Nottingham, and gained the London B.Sc. in chemistry. After spending a year teaching in Birmingham, he began the study of medicine with the financial aid of a friend. During his student days Gye lived simply, found gainful employment during the vacations and repaid the assistance which he had insisted on regarding as a loan. He graduated in Edinburgh in 1913 (Gold Medal) and joined the staff of the Imperial Cancer Research Fund under Bashford and Murray. He served in the R.A.M.C. in charge of a field ambulance in France and Italy during the First World War, and on his return carried out investigations on anaerobic infections with W. Cramer.

Gye and Cramer studied the influences of chemical substances, calcium salts and silica, for example, in producing 'defence rupture' in wounds infected with spores of anaerobic bacteria. Shortly afterwards, Gye collaborated with E. H. Kettle in an investigation of silicosis and miner's phthisis. He then joined the staff of the National Institute for Medical Research with the intention of participating in the experimental studies of dog distemper which were then being planned. Before this work could proceed, a stock of virus-free dogs had to be bred and Gye, in order to obtain some virus experience, commenced work with the Rous sarcoma.

This work on fowl tumours was continued by Gye, and in 1925 he published a paper on the "Ætiology of Malignant New Growths" which attracted widespread attention. He attributed the specificity of various growths, not to a corresponding multiplicity of viruses but to 'specific factors' derived from the host. This thesis was further elaborated and presented together with many experimental observations on fowl tumours in a book with W. J. Purdy, "The Cause of Cancer", published in 1931.

Gye succeeded Murray as director of the Imperial Cancer Research Fund in 1936. The virus hypothesis continued to be one of his main interests, and the problem of obtaining direct and convincing experimental evidence of a causal virus in transplantable mammalian tumours occupied much of his attention. Because of his own negative results with tumour desiccates over a long period, it is perhaps not surprising that in 1949 he interpreted the successful transmission of such tumours in the Fund's laboratory by means of freeze-dried material as evidence of the existence of such a virus.

A gift of lucid exposition was one of Gye's characteristics. He undoubtedly rendered a great service to oncology by undertaking the study of the fowl tumours described by Rous before the First World War. These had been largely ignored because they could be induced *de novo* by virus obtained from them, and therefore could not be reconciled with other ideas on the genesis of cancer in general. Gye's attempts to extend the hypothesis of virus as a continuing cause to all kinds of cancer were highly ingenious, and it is largely due to him that this alternative to other concepts holds the position it does to-day. He believed fervently in his ideas, and in this controversial subject evoked reactions ranging from great admiration to pungent criticism.

Gye was a man of much personal charm. His post-war years were burdened by an increasing disability due to a heart condition, and on retirement from the directorship of the Imperial Cancer Research Fund in 1949 he went to Perth, Australia. He was elected a Fellow of the Royal Society in 1938 and in 1947 was appointed professor of experimental pathology in the Royal College of Surgeons. Gye was twice married, in 1913 to Miss Elsa Gye, who died in 1943 and by whom he had three sons; and in 1945 to Miss Ida Mann, professor of ophthalmology at Oxford. Miss Mann later retired and assisted Gye in his experimental work in London and in Australia.

J. CRAIGIE

Miss K. C. Boswell

MISS KATHARINE CUMMING BOSWELL, born in October 1889, died on September 19, of heat stroke, at Beni Abbes, deep in the Sahara. During her adult life she had a very close connexion with the (then) University College, Southampton. She was a student before and after the First World War; in 1926 she became a lecturer in the Department of Geography; she resigned her lectureship in 1944, and went as co-principal to the Friends' College, Jamaica, in 1945; she returned in 1949 and resumed close relations with the College and Department at Southampton.

Miss Boswell's main interest was in geomorphology, her studies in which were supported by her thorough learning in geography and by her early studies in geology and biology. Her constant aim was to understand, and to help others to do the same. Her students developed a lasting interest in their work and confidence that they could and should continue such studies long after they had left the University.

From the same desire to understand sprang her long and arduous struggle with the difficult "Morphologische Analyse" of Walther Penck. Controversy raged around his work. She determined that easy access to what he said was necessary. The last weeks, before she went to Algiers for the 19th International Congress of Geology, were spent in reading the proofs of her translation of Penck.

"Land forms under humid and under semi-arid conditions are well known, by personal experience, to the majority of geomorphologists. But I, for one, have never seen the real desert." She tried while visiting South Africa to see Namib but only penetrated the Kalahari. She died in the Sahara, victim of her desire to understand.

Miss Boswell was too modest ever to think that she might have any original contribution to make to geomorphology. Her friends knew otherwise. But understanding was all that K. C. B. asked, and died in pursuit of it.

F. C. Miller

NEWS and VIEWS

Royal Society : Awards of Medals

The following awards of medals have been made by the President and the Council of the Royal Society : *Copley Medal* to Prof. P. A. M. Dirac, for his remarkable contributions to relativistic dynamics of a particle in quantum mechanics ; *Rumford Medal* to Prof. F. Zernike for his outstanding work in the development of phase-contrast microscopy ; *Davy Medal* to Prof. Alexander Robertson for his researches into the chemistry of natural products, particularly the wide range of glycosides, bitter principles and colouring matters containing heterocyclic oxygen atoms ; *Darwin Medal* to Prof. J. B. S. Haldane for his initiation of the modern phase of study of the evolution of living populations ; *Buchanan Medal* to Sir Rickard Christophers, for his outstanding research on malaria and on the *Anopheles* mosquitoes which transmit that disease ; *Sylvester Medal* to Prof. A. S. Besicovitch, for his outstanding work on almost-periodic functions, the theory of measure and integration and many other topics of theory of functions ; *Hughes Medal* to Prof. P. I. Dee, for his distinguished studies on the disintegration of atomic nuclei, particularly those using the Wilson cloud-chamber technique.

Nobel Prize for Chemistry for 1952 : Dr. A. J. P. Martin, F.R.S., and Dr. R. L. M. Synge, F.R.S.

The Nobel Prize for Chemistry for 1952 has been awarded jointly to Dr. Archer John Porter Martin, head of the Physical Chemistry Division of the National Institute for Medical Research, Mill Hill, London, and Dr. Richard Laurence Millington Synge, biochemist at the Rowett Research Institute, Bucksburn, Aberdeenshire. Dr. Martin, after taking Part II of the Natural Sciences Tripos in biochemistry in Cambridge, worked at the Nutrition Laboratory there during 1934–38, mainly on vitamin E and nicotinic acid. Dr. Synge, who had also been trained at the School of Biochemistry, Cambridge, soon became interested, after a short spell in carbohydrate chemistry, in the analysis of proteins. The empirical methods then available for separating the complex mixtures of amino-acids present in protein hydrolysates were unsatisfactory in many respects, and Synge therefore investigated the possibility of separating the N-acetyl derivatives of amino-acids by partition between water and other solvents. In this early work, which was published in 1939, conventional extraction procedures were used. Realizing the relative inefficiency of these methods, Martin and Synge, who had now joined forces, designed and put into operation an all-glass apparatus based on counter-current principles. In 1938, both Martin and Synge accepted appointments at the Wool Industries Research Association laboratory in Leeds, and there ensued a close collaboration in which the respective capacities of these workers complemented one another in an ideal manner. It was realized that bulk extraction procedures were inferior to chromatographic techniques, and Martin and Synge conceived the idea that a combination of the principle of solvent partition and a chromatographic arrangement might be the solution to their problem. They soon found that a system consisting of water-saturated silica as stationary phase and a suitable organic solvent as mobile phase was satisfactory for their purpose. However, the acetylation step was somewhat cumbersome, and attempts were made to separate the amino-acids themselves. It was soon shown that cellulose was suitable as supporting material, and a logical extension of these findings led in 1944 to the development of the now generally familiar paper chromatography. A further and most important extension of these ideas led Martin (now at Mill Hill) to the development of liquid-gas partition chromatography.

Liquid–liquid chromatography, and especially paper chromatography, which were developed originally for the analysis of amino-acids, are now being used in almost every field of organic and inorganic chemistry and biochemistry. The application of these methods especially to the structure and metabolism of natural compounds has made possible advances in our knowledge which would have been considered impossible ten years ago. There has been during the past decade a widespread interest in the general problem of separation of small amounts of closely related substances, in no small measure due to the work of Martin and Synge. The development of synthetic ion-exchange resins, the various modifications of adsorption chromatography and the elaboration of bulk counter-current extraction methods have greatly increased our range of techniques. But the methods evolved by Martin and Synge are probably unique by virtue of simplicity and elegance of conception and execution, and also by the wide scope of their application. This field is still expanding, and it is likely that the invention of liquid–liquid chromatography will be considered by future generations as one of the more important milestones in the development of chemical sciences.

Dr. W. G. Penney, F.R.S.

The recent announcement, recorded in *Nature* of November 1, that Dr. W. G. Penney has been promoted to be knight commander of the Civil Division of the Order of the British Empire will be particularly welcomed by all associated with the Imperial College of Science and Technology. It was to this College of the University of London that Dr. Penney went in 1927, entering as a Royal Scholar. After gaining a first-class honours degree in mathematics he remained at the Imperial College for two more years, devoting his time to research work in mathematical physics. One result of this work was a paper written in collaboration with Dr. R. de L. Kronig which has become well known and is still widely read by students of metal physics. In 1931 he was awarded a Commonwealth Fellowship and continued his research work at the University of Wisconsin. Two years later he returned to Great Britain to study at Cambridge, where he became interested in the theory of molecular structures, a field of research in which he has made notable advances. In 1936 he was appointed reader in mathematics in the Imperial College and served in this capacity until the outbreak of the Second World War. Early in 1940, he undertook part-time research work for the Ministry of Home Security, and since that time has been increasingly concerned with defence research. The very important part which he has played in this field is now well known, and has been recognized, first, by the conferment of the O.B.E. in 1946, and now by the well-deserved honour recently announced.

Economies in the Department of Scientific and Industrial Research

In a written reply in the House of Commons on October 28 to a question from Sir William Wakefield regarding economies in scientific and industrial research (*Hansard*, col. 1735–7; October 28), the Parliamentary Secretary to the Ministry of Works, representing the Lord President of the Council, stated that no major plan or activity of the Department of Scientific and Industrial Research has been eliminated. A reduction of twenty-five posts in its non-industrial staff has brought the Department's establishment to 3,054. Planned recruitment has accordingly been halted, many outstanding vacancies cancelled and the reduced man-power resources re-allocated, reductions in headquarters staff and in the Building Research Establishment providing the further staff essential for the Mechanical Engineering Research and Hydraulics Research Establishments. The original estimates for the Department for 1952–53 have been reduced to £5,390,950 net, an increase of £24,950 over the estimates for the previous year, the total staff being now 4,049 as compared with 4,317 for 1951–52. Non-industrial staff currently authorized for the headquarters was 281 and for building research 420, as compared with 299 and 489, respectively, actually employed on October 1, 1951. In reply to the question whether the proposed cuts had been agreed by the Advisory Council for Scientific and Industrial Research, it was stated that the decision to restrict the available man-power and to reduce the estimates had been communicated to the Advisory Council and that the re-allocations were made with the Council's knowledge.

National Fuel Problems in Great Britain

The debate in the House of Commons on the Ridley report, recently initiated by the Ministry of Fuel and Power, afforded little evidence about a possible Government fuel policy. Reserve was to be expected in the adoption of some of the Ridley Committee's proposals, though the Minister in his rightly cautious remarks about co-ordination gave no suggestion that he has taken the hint given by the Committee and proposes to exercise the powers he already possesses in a way that would make the new body recommended in the report superfluous. Nor is the Minister prepared to recommend the provision of financial incentives to instal improved solid-fuel appliances for domestic heating, either to private consumers or to local authorities, even to the extent of removal of purchase tax. Equally he was unprepared to give industrialists any incentive to instal fuel-saving rather than other capital equipment. While accepting the Committee's view that competition should continue between the fuel and power industries and that, within a proper framework which maintains full freedom of choice for the consumer, the choice could be relied upon to bring about the best use of fuels, he ignored the essential condition laid down—that fuel prices should closely correspond to the relevant costs of supplying the different fuels. Apart from shirking this critical issue of price, neither the Minister nor his Parliamentary Secretary, who replied to the debate, succeeded in making it quite clear what was meant by their acceptance of the recommendation that an independent advisory service on fuel efficiency should be set up, controlled and financed by industry. The Ridley Committee recommended the continuance of the Ministry's own advisory service; but this the Minister proposes to cut down or at least limit to advice on fuel efficiency in government departments. The Parliamentary Secretary's efforts to elucidate this point are likely to have an unsettling effect on the technical advisers at present in the government service rather than to promote economy.

Scientific and Technical Information for Industry

In opening an industrial and commercial information exhibition at the Manchester Central Library on November 3, A. H. S. Hinchcliffe, after referring to his association with Sir John Stopford in forming the Manchester Joint Research Council in 1944, again stressed the importance of securing the effective utilization by British industry of existing knowledge, and the extent to which the Department of Scientific and Industrial Research is concerned with this problem as well as with the acquisition of new knowledge. Mr. C. Nowell, chief librarian of the Manchester Public Libraries, expressed the view that many of the smaller firms in the area are unaware of the existing facilities of the Commercial Library and Information Department, the Technical Library and the Reference Library in Manchester and the services they could render; Sir Raymond Street, in seconding the vote of thanks moved by Mr. Nowell, agreed that the small firm constitutes a major problem in raising the standard of efficiency and productivity in British industry. The exhibition, which has been arranged in association with the Department of Scientific and Industrial Research and the British Cotton Industry Research Association, illustrates not only the services and resources of the Manchester Public Libraries, and more particularly of the Technical Library and the Commercial and Information Department, but also the work of the Department of Scientific and Industrial Research. Although the main emphasis is laid on the work of the Department in disseminating scientific and technical information through its numerous publications and its own information department, some indication is given of the scientific and technical work carried out.

including, for example, a model of the calorimeter building at the Fuel Research Station and photographs illustrating the work of the Shirley Institute. The exhibition is admirably designed to achieve its purpose of demonstrating the value of technical information to industry in general.

Exhibition of Spanish Scientific Books

An exhibition of recent Spanish publications in science, technology and medicine, organized by the Institute of Spain, was opened by Mr. K. B. Potter, president of the Publishers' Association, in the Science Museum Library, on November 6. In welcoming the exhibition Dr. F. Sherwood Taylor, director of the Science Museum, recalled the evidence in Spain of the enormous antiquity of Spanish metallurgy and acclaimed the Spaniard as a great practical chemist and engineer. He looked back to the age of Alfonso the Wise, when Spanish astronomers led the world, to Ramon Lull, who founded a school important in the progress of chemistry, and to the debt owed to Spain for the development of the merino breed of sheep, founders of great flocks in three continents. This exhibition, he added, demonstrated the vigorous life of science in Spain to-day, particularly in the fields of medicine and engineering. His Excellency the Spanish Ambassador, in closing the ceremony, mentioned that the exhibition contains only a sample of the scientific books, particularly original treatises, published in Spain during the past few years—a period in which scientific activity has been intensified with the development of collective efforts in research and teaching as Spain has become increasingly industrialized. He also referred to the wide circulation of both standard textbooks and original works through Spain and Spanish America. In expressing his gratitude to the Science Museum for opening its library to the exhibition, he spoke of the universal interest in science, of the admiration in Spain for the scientific culture of Great Britain and of the world of science which speaks of friendship and a common task. The exhibition will remain open until November 20.

Quantitative Paper Chromatography of Plant Nitrogen

The value of quantitative partition chromatography on paper in the analysis of the alcohol-insoluble nitrogen of plants has been established in recent investigations by J. F. Thompson and F. C. Steward (*J. Exp. Bot.*, 3, No. 8, 170; 1952). The amino-acid composition of egg albumin, zein, edestin and cucumber seed globulin has been determined by a quantitative method which is described, the chromatographic analytical data accounting completely for the amino-acid nitrogen of the protein hydrolysate as determined by the Kjeldahl method. The analyses of the alcohol-soluble and -insoluble fractions of potato tubers of several varieties have now been carried out, attention being directed to differences which have been observed as between both samples and varieties. No correlation has been observed between the relative proportions of free amino-acids in the tubers and in the alcohol-insoluble protein; indeed, certain compounds present in the free state in the tissue do not occur in the protein, while the amides are stated to be considerably in excess of their possible occurrence combined in the protein. Hence the tentative conclusion is reached that the free soluble compounds are not directly combined as such to form proteins.

Petrological Identification of Stone Axes

The third report of the Committee concerned with the petrological identification of stone axes is published in the *Proceedings of the Prehistoric Society* for 1951 (Pt. 2). Polished celts are frequently made from fine-grained igneous rocks, tough materials making carpentry possible. In thin sections these rocks can be identified under a polariscope, and sometimes the material is not one of common occurrence. In such cases the site whence came the rock substance can be located, and indeed a number of such workshop sites are known. This third report continues the investigations and gives much more information on this interesting matter which helps to suggest the lines of ancient trade routes along which were passed the raw materials utilized for the making of ground and polished celts.

Reopening of the Mining Collection at the Science Museum, London

The Mining Collection at the Science Museum, South Kensington, London, S.W.7, will be reopened in much enlarged form by the Right Hon. Geoffrey Lloyd, Minister of Fuel and Power, on November 18. The basic conception in the design of the new Collection, which occupies an area of nine thousand square feet, has been to give the visitor the impression of being underground in the actual workings of a mine; one of the principal exhibits is a full-scale model of a coal face supplied with the latest equipment and machinery. Adjacent to this are various sections illustrating the historical development of the many ancillary services which are essential in mining and which have played such an important part in the safety and social progress of the miner; these sections deal with coal-cutting, metalliferrous mining, breaking ground, mine transport, winding, boring and sinking, mine lighting, mine ventilation, rescue work, hand tools, roof supports and surface mining. The development and building of this Collection has only been made possible by the kindness and generosity of the many manufacturers of mining equipment used in Great Britain, who have provided not only full-sized equipment but also many fine models and finance.

Insignia Award of the City and Guilds of London Institute

The City and Guilds of London Institute has recently established an "Insignia Award" in technology which is designed to be a mark of distinction conferred by the Institute on those who have combined with a sound practical training an adequate knowledge of the fundamental scientific principles of their industry and have shown a capacity for leadership and administration and for applying such wider knowledge to their particular industry. The Award will entitle the holder to use the letters C.G.I.A. after his name. The five main sections at present approved for the Award are the chemical, constructional, electrical, mechanical and textile industries; but these divisions are meant to cover a broad range of particular industries. The preliminary conditions required of a candidate are that he be not less than thirty years of age, have completed the full period of apprenticeship or equivalent training suitable for his industry, have obtained the Full Technological Certificate of the Institute in an appropriate branch of technology, have had at least seven years suitable industrial experience subsequent to his initial apprenticeship (except in very special circumstances, war service cannot be taken into account), and give the names of three referees. The two main tests for the Award are the writing of a thesis and the subsequent interview by a body of experts. As regards the former, the candidate is not expected to present a record of original research, but rather give a critical appreciation of a problem in industry, backed by relevant reading, with practical suggestions for solving the problem and for future developments ; it is suggested that ten to twenty thousand words should be the length of the thesis. The interview, to which much importance will be attached, is designed to gain an appraisal of the candidate's education, training and career, together with any possible points arising from his thesis. All communications regarding the Award should be addressed to the Director, Department of Technology (I.A.), City and Guilds of London Institute, 31 Brechin Place, South Kensington, London, S.W.7.

Mineralogical Society : Officers 1952-53

THE officers of the Mineralogical Society for 1952–53 have been elected as follows : *President*, Dr. J. Phemister ; *Vice-Presidents*, Dr. A. F. Hallimond and S. J. Shand ; *Treasurer*, Prof. J. H. Taylor ; *General Secretary*, Dr. G. F. Claringbull (c/o Geological Society, Burlington House, London, W.1) ; *Foreign Secretary*, Dr. L. J. Spencer ; *Editor of the Journal*, Dr. L. J. Spencer.

University of London : Appointments

THE following appointments have recently been made in the Imperial College of Science and Technology, London : Dr. E. A. R. Braude, to the University readership in organic chemistry ; Mr. M. W. Humphrey Davies, to the University readership in electrical engineering.

Christmas Lectures in London for Juveniles

LECTURES for juvenile audiences in London during the forthcoming Christmas holidays have been arranged as follows. At the Royal Institution (21 Albemarle Street, London, W.1) the 123rd course of lectures will be given on December 27 and 30, 1952, and January 1, 3, 6 and 8, 1953, by Dr. F. Sherwood Taylor, director of the Science Museum, his subject being "How Science has Grown" ; the fee for these lectures is children (10–17 years) £1, adults £2. At the Royal Photographic Society (16 Princes Gate, London, S.W.7) three lectures on "How We see Colour", "How We Measure Light" and "Putting Colour into a Photograph" will be given on January 1, 2 and 5, 1953, respectively ; tickets can be obtained, without charge, from the Secretary of the Society.

Announcements

H.R.H. THE DUKE OF EDINBURGH has been elected president of the Royal Society of Arts. Her Majesty the Queen, who, as Princess Elizabeth has been president since 1947, now becomes patron.

THE Lord President of the Council has appointed Sir Hugh Beaver, managing director of Arthur Guinness, Son and Co., Ltd., to be a member of the Advisory Council for Scientific and Industrial Research. Mr. I. A. R. Stedeford, chairman of Tube Investments, Ltd., has resigned his membership of the Council because of pressure of other duties.

PROF. A. J. KLUYVER, president of the Royal Netherlands Academy, will deliver the Leeuwenhoek Lecture at the Royal Society on November 20 at 4.30 p.m. The subject of the Lecture will be "The Changing Appraisal of the Microbe". Applications for invitations should be sent to the Assistant Secretary, Royal Society, Burlington House, London, W.1.

THE Anglo-Saxon Petroleum Co., Ltd., has informed University College, London, that it intends to give the College £2,700 annually for the provision of scholarships in chemical engineering and of apparatus for the furtherance of the study of chemical engineering in the Ramsay Memorial Laboratory.

THE Humber Laboratory, at Wassand Street, Hull, a new out-station of the Torry Research Station, Aberdeen, will be opened on December 5 by Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, supported by Admiral Sir Robert Burnett, chairman of the White Fish Authority, and Mr. J. Croft Baker, chairman of the British Trawlers' Federation. Dr. C. L. Cutting is in charge of the new Laboratory.

AN appeal has been put forward by Mr. James Paton (*Irish Astro. J.*, **2**, No. 2 ; June 1952) for aurora observers to co-operate in the proposed survey of the frequency of auroræ over the British Isles. The primary purpose of the work is to prepare a map of the area covered by the survey, showing the frequency of aurora nights in each latitude. The success of the scheme requires a large number of observers, and those who are willing to co-operate or who require further information should write to Mr. Paton at the Department of Natural Philosophy, University, Drummond Street, Edinburgh, 8.

THE Institute of Rural Life at Home and Overseas, in co-operation with the Association of Agriculture and the Institute of Education, University of London, is arranging a meeting on "Food Science at Home and Overseas", to be held in two parts, on the mornings of November 22 and 29 respectively, at the Institute of Education, Malet Street, London, W.C.1. The meeting, for which a fee of 1*s*. (including coffee) is charged, is designed primarily for school teachers and students and will consist of four lectures by well-known authorities. Application forms and further information can be obtained from the Secretary, Institute of Rural Life, 84 Eccleston Square, London, S.W.1.

A series of four public lectures has been arranged by the School of Pharmacy, University of London, to commemorate the granting of a Royal Charter to the School. They are : "Organic Chemistry at the Cross-Roads", by Prof. J. W. Cook, regius professor of chemistry in the University of Glasgow (November 18) ; "Adsorption and Reaction in Monolayers and some Biological Implications", by Sir Eric Rideal, professor of physical chemistry, King's College, London (December 2) ; "Genetics and Medicine", by Dr. C. D. Darlington, director of the John Innes Horticultural Institution (December 15) ; "The Future of Pharmacy and Pharmacology", by Sir Henry Dale (February 18). The first two lectures will be delivered at the Westminster Medical School, Horseferry Road, London, S.W.1, and the remaining two at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1 ; the lecture hour is 5.30.

BREWING INDUSTRY RESEARCH FOUNDATION

NUTFIELD, SURREY

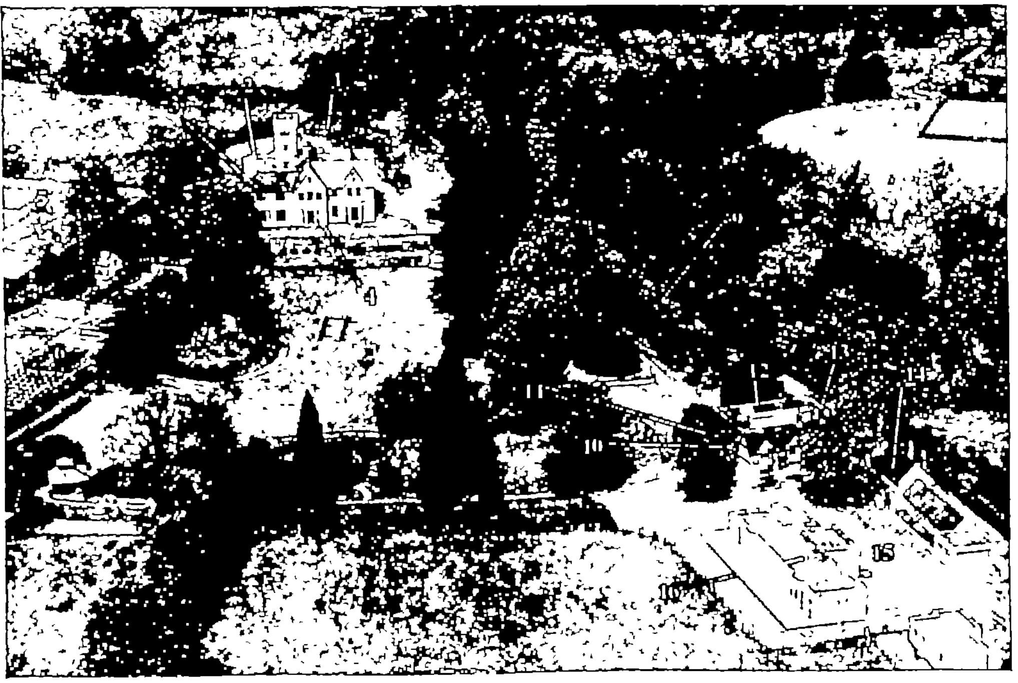
THE new Brewing Industry Research Foundation at Lyttel Hall, Nutfield, Surrey, marks the fulfilment of a scheme developed over many years by the Institute of Brewing and made possible by the generosity of the Brewers' Society. It has been specifically designed for the scientific study of brewing and fermentation generally, with particular emphasis on the fundamental aspects of the many problems involved. Lyttel Hall itself has been skilfully modified and adapted to provide an extensive range of laboratories and other facilities in attractive surroundings. With its staff of scientific specialists and technicians under the direction of Sir Ian Heilbron, the Foundation occupies a unique place among industrial research institutes.

Not unexpectedly, versatile experimental breweries provide a focal point in the Foundation. Of these the larger, of ten gallons capacity and constructed of stainless steel, is complete with air-conditioned fermentation and beer-storage rooms, bottling plant, and pasteurizing equipment.

These breweries form part of an Applied Research Division designed to study, in the light of existing knowledge, the materials and processes of brewing as used to-day, but in greater depth and with greater accuracy than is possible in a commercial production plant. Further, this Division will assist the industry by formulating new or improved methods of analysis and also engage in general technological investigations covering all aspects of brewing.

Another important function of this Division is the much-needed examination of new varieties of barleys and hops for the National Institute of Agricultural Botany, Cambridge, and the hop research stations at Wye College and East Malling, Kent, as a preliminary measure of their brewing value. These tests include brewing trials of the more promising samples, and are of great value to the plant-breeder as they permit comparative tests to be made on small quantities of materials, thus saving valuable time and acreage.

The empiricism which for long characterized the traditional industries—and is, it must be borne in mind, still dominant in brewing—must inevitably be succeeded by scientific knowledge if full economy in the use of raw materials and complete control of operations is to be achieved. With this background, a wide range of studies is in progress in the other two main divisions of the Foundation. Of these, that devoted to microbiology forms a self-contained unit of three laboratories with a complete range of ancillary service rooms in which the most exacting studies of yeast and brewing bacteria can be carried out. The problems here are formidable, and of necessity begin with a survey of the almost unexplored field of British primary yeasts, a survey rendered peculiarly arduous by the difficulty of adequately characterizing and differentiating such yeasts. Similar difficulties complicate the complementary study of 'wild' yeasts—those adventitious



Brewing Industry Research Foundation, Lyttel Hall. 1, Lodge; 2, model brewery; 3, administration offices; 4, main experimental block; 5 and 6, kitchen gardens; 7, swimming pool, 8, ornamental lake; 9, Cooper's Hill Road; 10, electrophoresis laboratory; 11, ultracentrifuge laboratory; 12, light-scattering laboratory; 13, mechanics' workshop; 14, residential cottages; 15, ancillary workshops, 16, canteen

contaminants which often have a deleterious effect on the beer. Again, beers are commonly susceptible to attack by certain types of bacteria, and although our knowledge here is more extensive than with the 'wild' yeasts, there is still need for further systematic study.

In this connexion the preservative action of hop resins assumes outstanding importance. Renewed attention is being given to means of estimating this effect by appropriate microbiological assay, a problem of peculiar difficulty because of the desirability that any test should reflect actual brewing conditions. The microbiological laboratories are also engaged on miscellaneous research such as the systematic examinations of the potential effects of selective herbicides and other agricultural chemicals on the malting quality of barley. Attention is also being directed to genetic studies on yeast, and to the possibilities of yeast hybridization. While many of these topics are of outstanding scientific interest, it must be emphasized that considerable research effort must perforce be devoted to essential but comparatively unspectacular groundwork. The need for this acutely reflects the sparse attention which has hitherto been paid to the scientific study of industrial microbiology, especially in Great Britain. For this reason an institute in which this largely neglected field receives prominence assumes special significance in view of the present meagre university facilities available for such studies.

Finally, mention should be made of the fact that in 1951 the Foundation undertook the important responsibility of maintaining the National Yeast Culture Collection. Some two hundred organisms were originally inherited from the National Collection of Type Cultures, and a further hundred and sixty yeasts of special interest have since been added. Work on the re-authentication of the cultures is already in progress, one-third of the total having been checked. Over the past year, nearly two hundred requests for yeasts have been received both from Britain and from abroad, and it is expected that this figure will increase as more yeasts are added to the Collection and its uses become more widely recognized. It will be appreciated that the National Yeast Culture Collection provides a service which extends far beyond the limits of the brewing industry.

The Chemical Division, which constitutes the third main section, comprises an extensive range of laboratories in which liberal facilities are provided for detailed research in the field of the industry's operations. Much thought has been given to the equipment of these laboratories, in which are installed all the apparatus, instruments and plant necessary to keep abreast of modern advances and techniques throughout the world. For example, the physical-chemical laboratories include the latest type of air-driven ultracentrifuge, electrophoresis apparatus and light-scattering equipment, all indispensable for immediate and long-term research.

The research programme covers the chemistry and biochemistry of the raw materials used in brewing and of the changes which they undergo during the various stages of the brewing process. Of these malt is pre-eminent, providing as it does the substance of beer, while hops supply the flavouring and preservative principles. An important early stage in malting consists of steeping the stored barley in water, an operation which it is now recognized results not merely in the uptake of water, but also in the simultaneous removal of a miscellany of substances. Among the latter are compounds which prevent or retard the normal germination of the grain. The isolation and study of these inhibitors are of considerable importance, for their planned use may conceivably lead to a higher degree of control of malting than has hitherto been possible; this aspect is now being investigated by means of specially designed experimental maltings. The barley grain is primarily a store-house for starches and proteins which are ultimately converted by specific enzymes into simpler compounds, such as dextrins and sugars on one hand and peptides and amino-acids on the other. A considerable effort is being devoted to the detailed study of these materials in barley, malt and wort, as well as to other constituents of the raw materials, notably pectins and tannins. Attention is also being given to the major constituents of hops, more particularly the resins: although the importance of these has been appreciated for years, their full significance has still to be elucidated. This is evident as a result of the application of new techniques to their examination, whereby unsuspected constituents have been revealed.

In addition to these specific studies, many other brewing problems will ultimately only be interpreted as a result of fundamental scientific research. The formation of a 'head' on beer is thought to be associated with the presence of residual proteins; but their identification is still lacking and, moreover, there is complete ignorance of the physics and physical chemistry underlying the phenomenon. Again, the deposition of part of the residual proteins after processing frequently gives rise to the formation of an undesirable haze in the finished beer, and this is being given precise study in the hope ultimately of limiting the incidence of the responsible proteins.

In addition to its laboratory facilities, the Foundation houses the largest specialized brewing library in Great Britain. As part of its functions, it prints and distributes monthly to brewers throughout the country a bulletin of current literature which surveys, without abstracting, all incoming journals, thereby giving the brewing scientist notice of an article within four to six weeks of publication. The library also supplies on request photo-copies of scientific literature, a service which fills a long-felt want and is much appreciated.

This brief survey will serve to demonstrate that the Brewing Industry Research Foundation has not been set up solely to serve the immediate needs of an industry in respect of routine control and *ad hoc* problems, but equally for the prosecution of basic research, without which a full understanding of the vital processes involved can never be attained. The Director, appreciating the breadth of the field which must be covered and the many kinds of scientific experience required for such a task, has wisely taken steps to foster contacts with many university departments and, as occasion demands, to initiate therein extra-mural work.

The visitor to Lyttel Hall is left with a deep impression of an organization which, in its conception and in its whole scientific outlook, is destined not only to contribute substantially to industrial progress, but also, by its own contributions to fundamental knowledge, to take its place as a research centre worthy of the best traditions of Great Britain.

ROYAL SOCIETY OF CANADA

MEETING AT LAVAL UNIVERSITY, QUEBEC

THE Royal Society of Canada held its annual meeting at Laval University, Quebec, during June 2–4. In Section III (Chemical, Mathematical and Physical Sciences) of the Society, the following new Fellows were elected: P. E. Gishler, L. Katz, W. B. Lewis, D. W. R. McKinley, P. Scherk and H. L. Welsh. Dr. G. Herzberg gave his presidential address on "Forbidden Transitions in Diatomic Molecules". This was one of three interesting papers in a symposium on forbidden transitions. The others were "Forbidden Transitions in Atoms", by A. G. Shenstone, and "Forbidden Transitions in Nuclei", by L. G. Elliott.

About a hundred papers were presented before the sub-sections—chemistry, mathematics, astrophysics and spectroscopy, nuclear physics, meteorology and other branches of physics.

Chemistry. The programme of the chemistry sub-section consisted of a series of papers in organic chemistry (P. E. Gagnon *et al.*) and several in physical chemistry. The photolysis of azomethane has been investigated over the temperature-range 25°–190° C. (M. H. Jones and E. W. R. Steacie). Experiments on the photolysis of deuterated methylamines have shown that both the C—H and N—H bonds are ruptured (J. S. Watson and B. deB. Darwent). Various forms of deuterated pentanone-3 have been synthesized (L. C. Leitch and A. T. Morse). The assignments of certain infra-red absorption bands between 1,350 and 1,475 cm.$^{-1}$ to the bending vibrations of the C—H bonds of methyl and methylene groups located at specific positions in the molecule have been confirmed in forms of deuterated pentanone-3 (B. Nolin).

Mathematics. Three papers were presented in algebra and number theory, eight in analysis, and two in geometry. The significance of the work presented and the general interest and enthusiasm made this meeting the most outstanding of any yet held by the mathematics sub-section. It was generally agreed that the upsurge of activity on the part of Canadian mathematicians is due to the stimulus of the biennial seminars of the Canadian Mathematical Congress and especially to the influence of the Summer Research Institute.

Astrophysics and Spectroscopy. The astronomical papers included a discussion of the determination of the masses of eclipsing binaries, the study of interstellar matter, the investigation of the line profiles of *Be*-type stars, and the development of new techniques for the determination of time. The orbital elements of the exceptionally massive eclipsing system, H.D. 228854, have been deduced (J. A. Pearce). These stars are of special class *O* 7 with temperatures of 33,000° K. The orbital inclination is nearly 90°, and the relative orbital velocities are exceptionally large (710 km./sec.). The combined mass is seventy times the sun. A new catalogue of 1,346 variable stars in globular clusters has been prepared (Helen S. Hogg). Investigation of the absorption lines of the eclipsing stars Zeta Aurigæ when light of the hot star traverses the atmosphere of the larger and cooler companion has provided evidence of major prominence activity of irregular character (A. McKellar and R. M. Petrie). The intensities of interstellar sodium and calcium lines for 142 early-type stars have been used to derive a relation between distance and intensity (C. S. Beals).

Relatively high-dispersion spectra of the aurora have been obtained in the region 3300–8900 A. (W. Petrie). The near-ultra-violet emission bands of the N_2^+ molecule support the value 9·75 eV. for the dissociation energy (A. E. Douglas). The rates of change of polarizability with respect to internuclear distance have been found from the ratio of the intensities of Raman and Rayleigh scattering in gases (E. J. Stansbury, H. L. Welsh and M. F. Crawford). Experimental and theoretical results on the splitting of nuclear magnetic resonance absorption lines in single crystals by the interaction of the nuclear electric quadrupole moment with the electric field gradient within the crystal were reported (G. M. Volkoff).

Nuclear Physics. A heavy and varied programme of nuclear physics papers on heavy cosmic primaries in photographic emulsions, photonuclear reactions, neutron physics, radioactive nuclides, and mass spectrometry was presented.

Several papers on neutron physics from the Chalk River Laboratory will be briefly reviewed. Work on the resonant scattering of slow neutrons by samarium, gadolinium, europium, dysprosium and cadmium was reported. The scattering and total cross-sections of cadmium in the resonance region accurately obey the Breit–Wigner one-level formulæ. The total cross-section at resonance is 7,900 barns (B. N. Brockhouse). The neutron capture γ-ray spectra from the even-charge nuclei titanium, chromium, iron, nickel and zinc, and from the odd-charge nuclei scandium manganese, cobalt and copper, were shown and discussed in terms of nuclear shell theory (B. B Kinsey and G. A. Bartholomew). The angular distributions of prompt fission neutrons with respect to the direction of motion of the light and heavy fragments from the thermal neutron fission of uranium-233, -235 and plutonium-239 show that the neutron emission probability is 30 per cent greater for the light fragment (J. S. Fraser and J. C. D. Milton) The neutron capture cross-section for $^{59}\mathrm{Co}(n,\gamma$ $^{60m}\mathrm{Co}$ (10·7 min.) was reported as 19 barns (N. Mos and L. Yaffe). The nuclide radium-227, produced by the $^{226}\mathrm{Ra}(n,\gamma)^{227}\mathrm{Ra}$ reaction with a cross-section o 22 barns, is a β-emitter with a half-life of 41·2 min. a maximum energy of 1·30 MeV., and γ-rays o approximately 291 and 497 keV. (J. P. Butler and J. S. Adam). A curious time behaviour of positon annihilated in liquids and solids was reported. I metals and several other materials, positons ar annihilated with a single mean life-time of abou 2×10^{-10} sec. In other materials (for example, water ice) two distinct life-times were observed—abou 3×10^{-10} sec. and 2×10^{-9} sec. (R. E. Bell and R. L. Graham).

Papers on the radioactive properties of neutron deficient nuclides, cadmium-105 and -104, silver-104 xenon-123, -122 and -121, produced by proton bombardment in the McGill University cyclotron, wer read (J. S. Foster, F. A. Johnson and D. E. Tilley) The X-rays from the 70-MeV. synchrotron at Queen' University have been used to study depth–dos relations in a 'Plexiglas' phantom, the absorption c 17·5-MeV. X-rays in various absorbers with the a of $^{63}\mathrm{Cu}(\gamma,n)^{62}\mathrm{Cu}$ as detector, and the production an cross-sections of photonuclear reactions such as the (γ,n) reactions in carbon-12, copper-63, silver-107 and molybdenum-92 and the reactions $^{12}C(\gamma,3\alpha)$ and $^{16}O(\gamma,4\alpha)$ (J. A. Gray *et al.*). The 25-MeV. betatron at the University of Saskatchewan can be held constant to 5 keV. at a pre-selected energy. Photo-activation curves have been obtained which show a fine-structure that is attributed to absorption by individual levels in the reacting nucleus. The ratios of the cross-sections for the (γ,n) reactions leading to the ground and isomeric states in bromine-80 and molybdenum-91 have been measured and related to the spins of the reacting particles (L. Katz, R. N. H. Haslam *et al.*). Excellent agreement with experimental results on the capture of electrons by protons in hydrogen is obtained if both the ion – nucleus interaction and the electron – ion interaction are included as perturbations in a calculation using the Born approximation (J. D. Jackson and H. Schiff).

Other Branches of Physics. Papers in meteorology included a discussion of the conditions for the production of low-temperature fog (W. L. Godson), a correlation between types of snow crystal and the temperature at the height of formation (L. W. Gold and B. A. Power), and evaluation of fluctuating radar weather echoes (J. S. Marshall and W. Hitschfeld). A method for measuring sub-surface velocities in the Gulf Stream was described (E. E. Watson). A flow-meter, utilizing the cooling of a thermistor element, has been found suitable for measurement of small velocities in liquids (A. D. Misener).

A number of papers were presented on the properties of dielectrics, theory of diffraction, sources of sound, vibration of plates, infra-red detection, and an absolute measurement of the ohm. The failure of the Clausius–Mosotti equation for certain artificial dielectrics was explained in terms of the random distribution and shape of the metallic particles (H. E. J. Neugebauer). Discrepancies between diffraction theories and measurements close to a circular aperture under the influence of a plane acoustic wave have been traced to rapid oscillations in field intensity within the aperture (G. Bekefi). An improved method of calculating the diffraction of electro-magnetic waves by small apertures and scattering by small conducting bodies was reported (A. F. Stevenson). Calculations and observations have been made on the vibration patterns of thick barium titanate disks (R. R. Aggarwal and E. A. G. Shaw). The usefulness of physical theory in solving engineering problems was well demonstrated in a study of chopper-type sources of sound for fog-horns and air-raid sirens (G. J. Thiessen).

Three papers on low-temperature and solid-state physics were read (D. K. C. MacDonald). By suitably modifying a Collins helium liquefier, continuous measurements of electrical resistances of metals over a wide range of temperature have been made. The variation of characteristic temperature has been examined and carefully compared with the corresponding calorimetric data. The problems of anharmonicity in lattice vibrations and of melting are of particular interest, together with the adequacy or otherwise of the Debye model. The anomalous minimum of electrical resistance found at about 10° K. in copper has been systematically investigated with specimens containing controlled small percentages of tin, silver, nickel, lead, bismuth and carbon. Scattering cross-sections can be deduced from the residual resistances. B. W. SARGENT

EMPLOYMENT PROBLEMS OF DISABLED YOUTH IN GLASGOW

INCREASING concern about the employment of the disabled led, in 1944, to the passing of the Disabled Persons (Employment) Act. It was provided in the Act that the Ministry of Labour should establish and maintain a voluntary register of disabled people and that the larger firms should be obliged to employ a quota of workers who were registered in this way. The Act also gave the Ministry power to set up units to train or rehabilitate the disabled.

The practical application of these measures brought many difficulties to light and made it clear that much more detailed information was needed about the medical problems of placing disabled people in employment. In 1948, therefore, the Ministry of Labour asked the Medical Research Council to help. The Council's Occupational Medicine Committee agreed that the first necessity was to collect information about the incidence of disability and the extent to which the various forms of disability interfered with employment, and on its recommendation the Council set up a special Committee on the Resettlement of the Disabled.

A memorandum has now been prepared recording an investigation which was carried out under the ægis of this Committee into the employment experience of two groups of young people in Glasgow; one, a group of registered disabled, the other made up of children who had been to special schools for the physically handicapped*.

In the first group, 683 young persons were registered as disabled and, of these, 104 were not covered by the investigation for various reasons. Of the remaining 579, 146 had infective and parasitic diseases and 164 had diseases of the nervous system. About 18 per cent of the group were found to be unemployed and, of those in work, the majority were employed as semi-skilled manual workers, although quite a number were employed as skilled workers in crafts like boot repairing, cabinet making, market gardening, painting, watch repairing, upholstering, glazing, sheet metal work, baking and bookbinding. Unemployment was noticeably high among the group disabled by diseases of the nervous system; this group included epileptics and congenital paraplegics. The groups disabled by tuberculosis and mental defect showed degrees of unemployment that were substantially above the average. The groups disabled by malformations, poliomyelitis, diseases of the ear and of bones all showed low unemployment-rates. Many of the young people disabled by congenital malformations, accidents, circulatory diseases and poliomyelitis were engaged in non-manual work, while a relatively high proportion of those disabled by poliomyelitis and deafness secured skilled manual work.

The general employment picture was most favourable among those disabled by poliomyelitis and deafness. In the former group this is probably because the disability is not progressive, seldom affects more than one member of the family, and does not often involve the loss of many years schooling. There is a belief that the character of the poliomyelitic patient tends to be robust and free from self-pity. In this survey the way in which they regarded their disability was outstandingly healthy and free from emotion; many drove themselves hard in their efforts to achieve independence.

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* Employment Problems of Disabled Youth in Glasgow. (London H.M.S.O.) 3s.

Another, and in many ways complementary, aspect of the employment problem for disabled youth concerns the number of jobs which a boy has held since registration; thus the high unemployment-rate of the seventy-two who were disabled by conditions affecting the nervous system was accompanied by frequent changes of job. Those disabled by bone diseases also had a high rate of job turnover; but they did not have so much long-continued unemployment.

The most stubborn resettlement problem in the whole survey centred around the seventy-two young people who were disabled by conditions affecting the nervous system. Twenty-six of them were epileptics and forty-two have been paralysed since birth, with disabilities ranging from the involvement of one limb to hemiplegia and diplegia with athetosis. The epileptics showed a fairly uniform picture of unemployment unless medical treatment could control their fits. "Until that happens the epileptic often lives the life of an outcast and is likely to become intensely frustrated and the despair of his family." The only other group approaching the bad employment record of the "nervous system" group was that of the forty-eight mentally handicapped children, of whom forty-three had been educated at special schools for the educationally retarded. The parents of these young people agreed that work of some sort was of great value and that a few weeks of idleness after leaving the discipline of school might be fatal to the future of the youth and render him unemployable.

The most searching criticism of the Disabled Persons (Employment) Act concerned the difficulty, or even the impossibility, of obtaining training courses which were still advertised. The Ministry of Labour and National Service arranged training for twenty-four (4 per cent) of the disabled young people and in ten cases it was given at a Government training centre. In three cases training was given in private or local education authority commercial colleges: two took a general commercial course and one shorthand and typing. The remaining eleven were trained under a scheme of grant by employers approved by the Ministry. At the time of the survey, only 153 youths of the group of 579 were serving an apprenticeship or undergoing a period of training.

The unemployment-rate of these trainees was low and their job stability high, for, at the time of the survey, thirty of the 115 were still holding the same job as they had had when they registered; the great majority of the others had not been employed at the time of registration.

During the survey the young people were asked if they had been given any special advice when they left school regarding suitable employment. The great majority answered "no", though they occasionally recollected that "a teacher had complimented them on their schoolwork and suggested that they should take up art or the like".

Of the social factors affecting the employment of these disabled young people, inadequate housing was found to be of the greatest significance; 113 of the disabled young people included in the survey were existing under conditions that could only be described as appalling. It was also shown that, where there was a high incidence of paternal unemployment, unemployment was prevalent among the children also.

In the second survey, inquiries were made into the employment experience of 408 young people who had previously left schools for physically handicapped children; the findings of the observers were generally similar to those in the first series of the investigations, despite the fact that only 30 per cent in the section group were officially registered as disabled.

The bulletin also contains an account of the work of the Danish Invalidity Court. During the years 1938–44 some 10,000 notifications of "invalidity" were received by the Court, and during the same years 3,167 disabled Danes received "vocational measures" under the auspices of the Court: 1,296 of these had started training before the age of eighteen. From this and other data it would appear that the proportion of disabled young people who receive vocational training is considerably higher in Denmark than in Great Britain.

The general conclusion of the Medical Research Council's Occupational Medicine Committee is that "it is impossible to view with other than apprehension the circumstances disclosed by this study of the welfare of disabled young people. The extent of unemployment and, perhaps more important, the extent of long-term chronic unemployment, and the high proportion of the employed who are engaged in unskilled work which is often grossly unsuitable and likely to lead to physical breakdown or prolonged idleness—these are sinister findings, especially when viewed against the general background of full employment in the past few years. Failure to settle young people of this age group in suitable work must inevitably make a major contribution to the vicious, hard core of unemployment in later years".

Apart from the overriding need to improve basic living conditions, particularly housing, and to harness all the resources of medicine for the prevention of disease, the Committee makes four suggestions which would help to settle disabled young people satisfactorily in employment. It recommends mitigation of the gross educational lack that adds to the difficulties of so many of these young disabled people; adoption of energetic steps to secure satisfactory settlement before the young person begins to drift; the provision of adequate and suitable training courses for disabled young people; and intensive medical and surgical treatment where necessary and the provision of any necessary medical aids or surgical appliances.

ENZYMIC DEGRADATION OF PECTIC ACID AND THE COMPLEX NATURE OF POLYGALACTURONASE

By AUDREY AYRES, J. DINGLE, A. PHIPPS, W. W. REID and G. L. SOLOMONS

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THE pectic enzymes produced by *Aspergillus fœtidus*, Thom and Raper, when the organism is grown on solid bran media [(*S*) type], are different from those produced by growth in submerged culture in liquid media [(*D*) type]. The (*D*) preparations have an optimum *p*H of 5·3 on sodium pectate as substrate, the (*S*) type 4·5. Both types of enzyme reduce the viscosity of pectic acid, until no precipitate is given either with ethanol or calcium ions, and reducing groups are formed simultaneously.

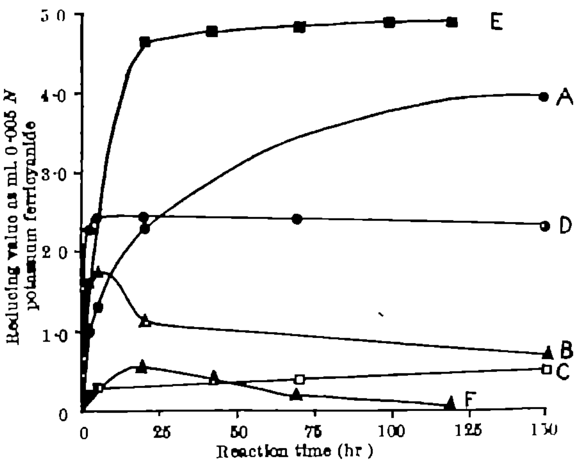
The uronides produced have been separated by paper chromatography using ethyl acetate - acetic acid - water mixtures. Using the original solvent mixtures of Jermyn and Isherwood[1], galacturonic acid and four spots, *A*, *B*, *C* and *D*, were obtained (*R* values for galacturonic acid 1·00, 0·80, 0·58, 0·33 and 0·11 respectively). Each spot reacted as an acid when the dry chromatogram was sprayed with bromophenol blue, and as a reducing substance when treated with *p*-anisidine hydrochloride. By increasing the acetic acid content of the solvent, four other uronides larger than *D* were resolvable. Substances *A* and *B* which occur only in small amounts and have a transitory existence have not yet been identified. Jermyn and Tomkins[2], in a chromatographic study of pectic enzyme action, demonstrated the formation of a series of uronides. An examination of a *Botrytis* bran culture from Dr. Tomkins indicates that *C* and *D* are the same as the 'di-' and 'tri-uronides' of Jermyn and Tomkins.

The calcium salts of uronides *C* and *D* are precipitated by 60 per cent ethanol and can be obtained free from galacturonic acid. The lead salt of *C* is appreciably soluble in water, the lead salt of *D* is insoluble and a separation can thus be achieved. Preliminary studies of the reducing value of *C* and *D* by the alkaline hypoiodite method indicate they are the di- and tri-uronides. A recent paper[1a] shows that a polygalacturonase type enzyme from a yeast produces two compounds with properties similar to *C* and *D*.

The action of (*S*) preparations on pectic acid is characterized by a rapid liberation of reducing groups, with the simultaneous destruction of the colloidal properties of the substrate ; the reaction curve then shows a sharp change to a slower rate. In the initial rapid phase, a mixture of uronides not resolvable upon the chromatogram is produced, and these are then degraded to a mixture in which galacturonic acid and *C* and *D* predominate. In the second, slower, phase of the reaction, *C* and *D* are completely converted to galacturonic acid. With (*D*) preparations, the large uronides first formed are converted to a mixture containing only *C* and *D*, with small amounts of galacturonic acid ; the reaction then ceases, although enzyme active against pectic acid is still present.

For chromatographic analysis, 0·05 ml. aliquots of enzyme substrate mixture were run in duplicate together with duplicate galacturonic acid markers on Whatman No. 1 paper with ethyl acetate - acetic acid - water mixtures for 18 hr. Papers were dried in air, sprayed with bromophenol blue, and appropriate spots dissected, eluted into dilute alkali and estimated by the micro-ferricyanide method. Reducing value of galacturonic acid markers : recovered 95–102 per cent ; reducing value of uronides + galacturonic acid recovered in Exps. 1–3, 95 per cent.

The marked difference between the action of (*D*) and (*S*) preparations may be seen from quantitative chromatograms (see diagram). In Expt. 2, only uronides *C* and *D* and galacturonic acid were detectable in the 20-hr. chromatogram. In Expts. 1 and 2, the amounts of the (*S*) and (*D*) preparations were selected so that their activities on the colloidal properties of pectic acid were the same, that is, their activities were equal both by 'cup-plate'[3] and viscometric[4] methods. Higher concentrations of the (*S*) preparation, Expt. 3, resulted in a more rapid conversion of pectic acid to galacturonic acid. From the action of (*D*) preparations on pectic acid, samples containing only *C* and *D* were obtained in a yield equivalent to 75 per cent of the uronic anhydride content of the original substrate, and the mixture of *C* and *D* was completely converted to galacturonic acid by (*S*) preparations at a *p*H optimum of approximately 3·5.



Chromatographic analysis of the action of (*D*) and (*S*) type preparations on sodium pectate at *p*H 5·3.

Expt. 1 Action of 50 mgm. (*S*) type preparation on 50 ml of 2 per cent sodium pectate. *A*, Galacturonic acid produced, *B*, higher uronides produced

Expt. 2. Action of 800 mgm. (*D*) type preparation on 50 ml of 2 per cent sodium pectate. *C*, Galacturonic acid produced, *D*, higher uronides produced.

Expt. 3 Action of 800 mgm. (*S*) type preparation on 50 ml. of 2 per cent sodium pectate. *E*, Galacturonic acid produced *F*, higher uronides produced

Polygalacturonase[5] has been postulated as an enzyme degrading pectic acid to galacturonic acid, and chromatographic evidence[6] appeared to support this view. From the present findings, it is clear that the degradation of pectic acid to galacturonic acid involves at least two enzymes. One of these (I) degrades pectic acid to uronides *C* and *D*, and another, (II), is necessary to convert these uronides to galacturonic acid. The (*D*) preparations consist of the former enzyme, and (*S*) preparations (and various commercial samples examined) are mixtures of the two. It is not known whether the enzyme (II) attacking the uronides *C* and *D* can also degrade higher uronides, and it is not therefore possible to define assay methods for enzymes (I) and (II). However, by carrying out parallel assays with both pectic acid and a mixture of *C* and *D* as substrates, it can be shown that (*D*) preparations attack pectic acid only, whereas (*S*) preparations attack both substrates ; but the ratio of the two activities varies widely with the preparation.

The (*D*) preparations, when heated at 100° C. in 10 per cent w/v magnesium chloride for 10 min., retain about 30 per cent of their activity, and in their thermostability resemble the pectic 'depolymerase' of tomatoes[6]. A 'depolymerase' isolated from *Neurospora*[7] has similar properties to the (*D*) preparation. Barratt (personal communication) has shown by paper chromatography that a number of uronides accumulate during the action of the *Neurospora* enzyme. A *Neurospora* preparation from Dr. Barratt was compared in these laboratories with a purified

(*D*) preparation. The preparations had equal activities by the 'cup-plate' assay and both rapidly reduced the viscosity of pectic acid; but whereas the action of the (*D*) preparations was practically complete in 4 hr., the *Neurospora* preparation produced in this period a mass of uronides which could not be resolved on the chromatogram; after 18 hr. the reaction products were partially resolvable and small amounts of uronide *D* appeared, but it was eight days before complete conversion to uronides *C* and *D* and galacturonic acid was obtained. These results suggest that the destruction of the colloidal properties of pectic acid and the formation of uronides *C* and *D* are not accomplished by the same enzyme.

A study of the structure of uronides *C* and *D* is in progress, and this, together with the properties of the enzymes, will be reported when completed.

Thanks are due to the directors of H. W. Carter and Co., Ltd., for permission to publish these results, to Dr. Tomkins for a sample of *Botrytis* bran and to Dr. Barratt, who kindly sent us prior to publication the manuscript of a paper on the 'depolymerase' of *Neurospora* and a sample of this enzyme. [May 16.

Note added, October 22. The (*D*) preparations contain two enzymes. The *p*H-activity curves of these preparations on pectic acid show two optima, at *p*H 5·3 and at 3·5. The former peak is due to enzyme (I*a*) which may be inactivated at *p*H 5·0 and 50° C. for 30 min., and attacks pectic acid and pectin (without simultaneous demethylation) with a rapid destruction of the colloidal properties of the substrate and the formation of a "low molecular weight polyuronide"[7]. The peak at *p*H 3·5 is given by enzyme (I*b*), which attacks pectic acid and lower demethylated uronides with a slow destruction of the colloidal properties and a rapid liberation of galacturonic acid and uronides *C* and *D*. Whereas the concentration of enzyme (I*a*) is approximately equal in the (*D*) and *Neurospora* preparations used above, the content of (I*b*) in *Neurospora* is only 5 per cent of that in the (*D*) preparation.

Through the courtesy of Dr. H. J. Phaff we have shown that *C* and *D* are chromatographically identical with his di- and tri-galacturonic acids. (A. P., W. W. R., G. L. S.)

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STREAMING POTENTIAL AND ELECTRO-OSMOSIS

A Model for the Mechanism of Streaming Potential

ALTHOUGH considerable efforts to explain experimental phenomena on the basis of the classical theory of streaming potential have been made, it would appear that the model upon which the theory is based is defective. A more comprehensive theory might possibly be based upon a model described here. In this model it is postulated that: (1) the radial distribution of charge varies smoothly along the capillary during steady-flow conditions; (2) there is no circulation of ions within the fluid.

These postulates are deduced from the following experimental observations. (*a*) A system comprising an arrangement of solid–liquid interfaces at rest is, as a whole, electrically neutral. (*b*) A (thermodynamic) potential generally exists at solid–liquid interfaces and can be detected with a standard electrode. (*c*) Relative movement between solids and liquids is generally accompanied by the setting up of a potential difference along the direction of flow. (*d*) This potential difference tends to a steady value for a given set of flow conditions.

Thus, since a capillary full of liquid receives no charges from outside the system, it follows that any electrical effects during liquid flow must arise from a re-distribution of charges which are present in the stationary state.

In order that any electrical effect may arise, there must be an initial radial distribution of charges in the stationary condition which is disturbed by the onset of liquid flow. This radial distribution can arise in three ways: a transfer of charge from the surface to the liquid; a transfer of charge from the liquid to the surface; an exchange of charges between the liquid and solid. When equilibrium is reached after the separation of charges, the radial distribution of charge within the liquid is determined by a balance of the forces acting on the ions, as a result of the interaction between the ions and the charged wall and the mutual interaction between the ions, the form of the distribution being in accordance with the equations of Poisson and Boltzmann. Axial flow of the liquid within the tube, under the influence of a hydraulic gradient, will tend to strip the diffuse layer at the inlet end of the capillary. The parabolic distribution of flow velocity will cause the rate of removal of charge to vary with the radius, so that a tapering of the diffuse layer will occur along the length of the tube.

Since it is known that the streaming potential reaches a steady value for a given set of flow conditions, it follows that the stripping of the diffuse layer must be counterbalanced by a restoring action. It also follows, from the constancy of the streaming potential, that, for steady conditions, the liquid flowing through the tube must be electrically neutral.

For the present purpose it is postulated that the layer is restored by both the following mechanisms: (1) Under the influence of the axial potential gradient, the ions in the body of the incoming liquid are dependent upon the sign of the charge these carry, either accelerated or decelerated, the unbalanced surplus of one sign so formed being dispersed by radial migration under the influence of the radial potential gradient and inclusion in the diffuse layer. (2) The transfer mechanism at the interface operates to replace the lost charges towards the inlet end of the tube and in the opposite direction towards the outlet end. Thus, over the whole surface of the tube, equal numbers of charges are entering and leaving the wall layer. The present analysis requires the simultaneous operation of both these mechanisms, but does not exclude the possibility of others.

Detailed analysis based on this model shows that

(1) The model leads to an expression dependent on the same variables as the classical equation.

(2) The four common electro-kinetic effects, streaming potential, electro-osmosis, cataphoresis, and sedimentation potential, can be explained.

(3) The special conductivity K_s substituted by Briggs[1] in the classical equation in place of the bulk liquid conductivity is justified.

(4) Possibly (*a*) flocculation and (*b*) dispersion may be explained on this basis.

(5) The observations of Casagrande[2] on the pressure effects arising from electro-osmosis can be explained.

(6) Deviations from Darcy's law observed by various workers can also be explained on this basis.

Acceptance of the model also leads to the conclusion that the term 'zeta potential' has no rigid meaning; and analytical treatment of streaming potential along the lines followed by Elton[3] requires reconsideration.

A full account of the work will be published elsewhere.

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[1] Briggs, D. R., *J. Phys. Chem.*, 32, 641 (1928).

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Mechanism of Electro-osmosis

As indicated above, the Rose and Moss model of ionic distribution for steady streaming potential conditions suggests a similar mechanism for electro-osmotic flow.

The application of an electrical potential gradient along the length of the capillary will disturb the ionic distribution of the diffuse double-layer, at rest, resulting in a thinning down of the layer towards the inlet end of the capillary. The double-layer will be partly restored by ions of the same sign contained in the incoming liquid, and when steady flow conditions are reached, the radial distribution of ions will vary along the length of the tube. The ions of the removed double-layer are discharged at the down-stream electrode while the ions in the incoming water of opposite sign to the diffuse double-layer are discharged at the other electrode, these two ionic streams composing the current concerned in electro-osmosis as distinct from the ordinary galvanic current in the capillary. The ionic force available in the double-layer for overcoming the viscous shear resistance of the double-layer in electro-osmotic flow is proportional to the ionic concentration of the double layer. In the suggested mechanism, the variation of ionic concentration along the length of the capillary means that the ionic tractive force will also vary along the capillary, being a minimum at the inlet end.

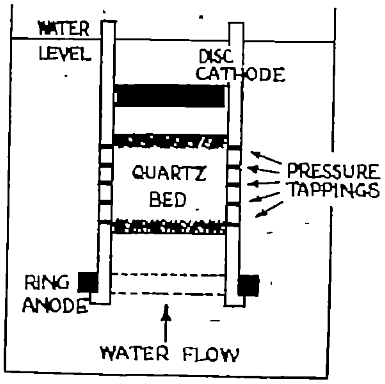

Fig. 1. General layout

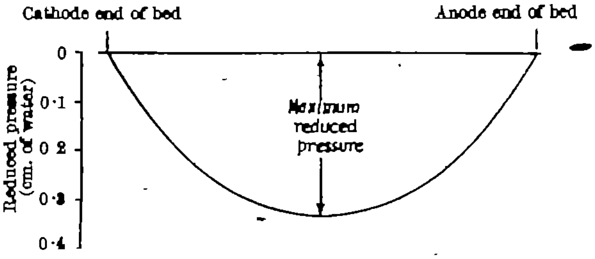

Fig. 2. Distribution of reduced pressures within the bed

From considerations of flow continuity, the rate of liquid flow will be dependent on the mean force available in the capillary. At any point along the tube the tractive force available will differ from the mean ionic tractive force by a certain amount, and a compensating pressure gradient will be induced at that point, the size and direction of which will depend on this difference.

In streaming potential there is no removal of charge from the system, and the solid – liquid system remains electrically neutral, whereas in electro-osmosis it would be expected that the solid – liquid system should contain a deficiency of the ions of the kind forming the double-layer.

Experimental work. Experimental work has been carried out on electro-osmotic flow of distilled water through a bed of quartz powder of size ranging from 50 μ to 140 μ subject to potential gradients of up to 40 volts/cm. Measurements of electro-osmotic discharge of water and of pore-water pressures within the bed were made with no external hydraulic pressure gradient across the bed. The general layout is shown in Fig. 1.

Pressures below that of the free water at either end of the sample were measured in the bed, the distribution of these reduced pressures being of the form shown in Fig. 2, with the greatest pressure reduction occurring near the centre of the length of the bed.

A typical result was that a maximum pressure reduction was obtained near the centre of the bed of 0·33 cm. of water in a quartz bed of 4·67 cm. length under a potential gradient of 21·7 volts/cm., giving a discharge of 1·95 × 10^{-3} c.c. of water per sec. per sq. cm. of bed.

The observed distribution of pressure within the bed agrees with the suggested theory, as the tractive force would be a minimum at the inlet end of the bed (the anode end for a quartz-distilled water system) and therefore less than the mean force governing the rate of flow. A supporting or assisting pressure gradient would consequently be expected towards the inlet end of the bed, reaching a maximum value at that end of the bed, which is indeed observed in the tests. Similarly, the negative or resisting pressure gradient measured towards the outlet end of the bed would be predicted from the theory.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Temperature of the Interior of the Earth

BULLEN[1,2] has derived both the density and the compressibility of the earth as functions of depth, and has found that the bulk modulus k, which is the reciprocal of the compressibility $\varkappa$, is a linear function of the pressure p:

$$k = k_0 + ap. \qquad (1)$$

Ramsey[3] has re-examined this relation from the point of view of the theory of solids, and his conclusions agree with those of Bullen, namely, that the linear relation (1) is valid both in the core and in the mantle below 1,000 km. Ramsey, however, found that the constant k_0 had different values in the core and mantle, although the derivative $dk/dp = a$ was sensibly the same.

In view of equation (1), it seems reasonable to suppose that a similar relationship exists between the volume coefficient of thermal expansion α and pressure p, namely, that the reciprocal of α is a linear function of p:

$$\frac{1}{\alpha} = \frac{1}{\alpha_0} + bp. \qquad (2)$$

In a recent investigation on the thermal properties of the earth (based on the theory of solids), Uffen[4] has obtained values of α within the mantle, and it is found that they are in excellent agreement with hypothesis (2). It is assumed that the relation (2), like the relation (1), is valid both in the core and the mantle. The values of the constants $1/\alpha_0$ and b are found to be:

$$1/\alpha_0 = 2\cdot4 \times 10^4 \,°\text{K.}, b = 6\cdot2 \times 10^{-8} \,°\text{K. cm.}^2/\text{dyne}. \qquad (3)$$

A theoretical investigation for the justification of (2) is in hand.

It is now possible to make an estimate of the adiabatic temperature gradient throughout the earth. The adiabatic gradient may be written

$$\frac{dT}{dp} = \frac{\alpha T}{\rho c_p}, \qquad (4)$$

where ρ is the density and c_p the specific heat at constant pressure. From (2) and (4),

$$\frac{dT}{T} = \frac{dp}{\rho c_p\left(\frac{1}{\alpha_0} + bp\right)}. \qquad (5)$$

Both Uffen[4] and Verhoogen[5] obtained values of the ratio α/c_p in the mantle using seismic data. Uffen found that the values of c_p were approximately constant (in agreement with Bridgman's observations at relatively low pressures), and that the variations in α/c_p were almost entirely due to variations in α. A constant value for c_p is assumed, so that from (5),

$$\ln T = \frac{1}{c_p}\int \frac{dp}{\rho\left(\frac{1}{\alpha_0} + bp\right)} \qquad (6)$$

It is estimated that variations in c_p will not affect the validity of (6) by more than 5 per cent. Since ρ is known as a function of depth (and hence of pressure), equation (6) can be integrated numerically. Hypothesis (2) is assumed to hold at all depths below 1,000 km., although preliminary investigations show that it is not likely to be much in error up to depths of 500 km. Taking T at 1,000 km. to be 3,600° K. (Uffen[4]), values of T can be estimated at all greater depths. It is found that the temperature at the boundary of the core and mantle is 4,350° K. and at the centre of the earth a little greater than 4,800° K. The increase throughout the core is thus only 500°. The results should be of considerable interest to Bullard's[6] theory of the transfer of heat from the core. Further implications of equations (1) and (2) are being investigated, and it is hoped to publish a fuller account elsewhere.

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June 19.

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Effect of Water Vapour on Explosions of Carbon Monoxide

IT is well known that the low-pressure explosion of carbon monoxide – oxygen mixtures is characterized by an upper and a lower pressure limit of explosion at a particular temperature. We find that it is also characterized by an upper and a lower pressure limit for a glow, accompanied by slow oxidation, to occur.

Garner and Gomm[1], Cosslett and Garner[2] and Hadman, Thompson and Hinshelwood[3] found water vapour to have no effect on the lower explosion limit. In accordance with this, we find that water vapour has no effect on the lower glow limit. Hadman *et al.*[3] also concluded that water vapour had no effect on the upper explosion limit. We cannot confirm this conclusion. Water vapour raises both the upper glow limit and the upper explosion limit. As a consequence it reduces the temperature of the tip of the explosion peninsula.

Hadman *et al.*[3] made their statement because, using a dry mixture and a static method, they obtained the following values for the upper explosion limit:

650° C.	67 per cent O_2.	P = 240 mm
680° C.	67 „ „ O_2.	P = c. 360 „

and compared these values with the following, obtained by Kopp, Kowalsky, Sagulin and Semenoff[4], using a wet mixture and a flow system:

650° C.	90 per cent O_2.	P = 260 mm
	33 „ „ O_2.	P = 190 „
680° C.	33 „ „ O_2	P = c. 400 „

The comparison, made in 1932, is scarcely very satisfactory. The agreement is neither extensive nor exact. The comparison ignores any possible difference in results for flow and static systems. Examples are known where ignition temperatures determined in flow systems have been high relative to determinations in static systems. Nevertheless, the statement that water vapour has no effect on the upper explosion limit has been repeated as a fact right through the literature down to the present time (for example, ref. 5, p. 208; ref. 6, p. 70; ref. 7, p. 23; ref. 8, p. 78). It appears that from 1932 to the present study no one set of investigators has carefully determined the upper explosion limit in both wet and dry mixtures and under otherwise similar conditions.

In the literature prior to 1932, there are several observations which should have warned workers against accepting the conclusion of Hadman *et al.* Dixon[9], long ago, found that water vapour has a sensitizing effect on the spark ignition of carbon monoxide – oxygen mixtures at atmospheric pressure. Prettre and Laffitte[10] showed that addition of 5 per cent water vapour lowered the spontaneous ignition temperature at atmospheric pressure by 20°–30° C. Observations by Topley[11] contain a clear statement that the upper pressure limit of explosion depends upon the concentration of water vapour, and an implication that water vapour reduces the temperature of the tip of the explosion peninsula. Topley's work, however, has been completely neglected.

We should also like to mention that we have found the explosion peninsula of carbon monoxide to be expanded by small, and contracted again by large, quantities of methane. A full account of these and other observations relating to the combustion of carbon monoxide will be published elsewhere.

Note added in proof. Since this letter was submitted for publication, we have learnt that Dr. A. S. Gordon (*J. Chem. Phys.*, 20, 340; 1952) has also found water vapour to have a marked effect in raising the upper explosion limit.

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[1] Garner and Gomm, *Trans. Farad Soc*, **24**, 470 (1928).
[2] Cosslett and Garner, *Trans. Farad Soc.*, **26**, 190 (1930).
[3] Hadman, Thompson and Hinshelwood, *Proc. Roy. Soc.*, A, **137**, 87 (1932); **138**, 297 (1932).
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[11] Topley, *Nature*, **125**, 560 (1930)

Poisoning of Oxide Cathode Emission by Oxygen

THE following experiments were carried out in an attempt to determine the mechanism of the reduction of electron emission from oxide cathodes by oxygen.

Metson[1] demonstrated the reversibility of oxygen poisoning, and suggested that a possible recovery mechanism was the outward diffusion of negative oxygen ions after a poisoning attack. An attempt was therefore made to detect directly any change in the emission of oxygen ions after poisoning by using a mass spectrometer with an oxide cathode source.

The emission from mixed barium and strontium oxide cathodes at temperatures in the range 1,000°–1,200° K. was reduced to 10 per cent of its initial value by liberation of oxygen from a heated tungsten wire coated with barium peroxide. After the oxygen flow was cut off, the emission of both electrons and negative oxygen ions was studied. The following points were noted.

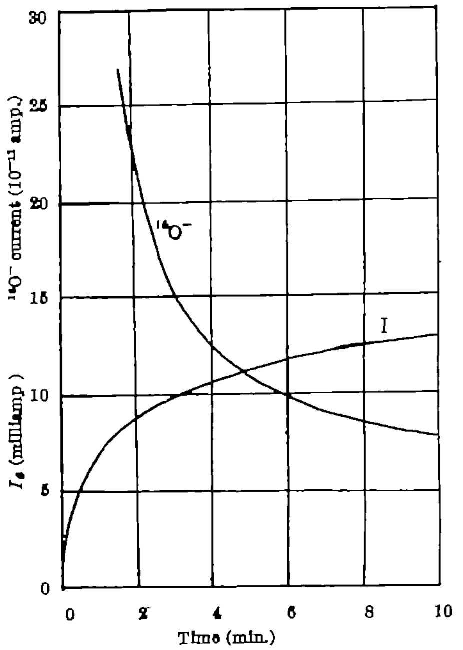

Fig. 1. Typical curves showing variation of oxygen ion current ($^{16}O^-$) and electron emission I with time, during recovery from an oxygen poisoning attack

(1) The poisoning phenomenon was completely reversible, that is, full recovery of electron emission to its initial value occurred, even after several previous attacks.

(2) The emission of ionized oxygen from the cathode increased, often by a factor of 10 or more, immediately recovery commenced, gradually falling off to its original intensity as recovery was completed (see Fig. 1). The predominant oxygen ion was that of mass 16, although traces of the ion oxygen-32 sometimes occurred.

(3) Higher activation-rates existed in the presence of larger potential gradients in the cathode coating.

(4) Poisoning experiments at varying temperatures showed: (*a*) increased sensitivity to poisoning at low temperatures; (*b*) considerably higher rates of oxygen evolution during recovery at higher temperatures.

(5) Energy distribution measurements on the oxygen ions showed that those emitted during normal operation of the cathode were characterized by the possession of energies in excess of the spectrometer accelerating voltage, suggesting formation by bombardment of a surface film of oxygen by high-energy positive ions formed in the electron gun[1,2]. Those emitted after poisoning, however, had their origin in the cathode coating itself. These results may be explained by the assumption that, on poisoning, the oxygen enters the cathode coating, reducing the emission by either (*a*) the formation of surface oxygen films on the emitting oxide crystals, or (*b*) the occupation of vacant oxygen sites (especially near-surface sites) in the oxide crystal lattice.

To determine the relative importance of the two processes under various conditions, further experiments were carried out on the effect of oxygen on electron emission and coating conductivity using

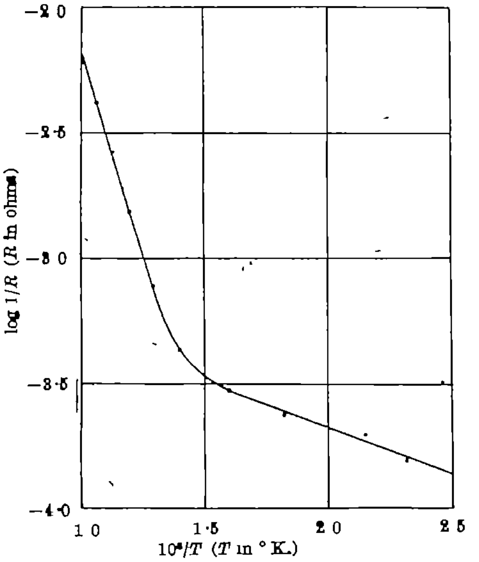

Fig. 2. A plot showing the variation of conductivity of the cathode coating with temperature T. R is the resistance of the coating

low-voltage cylindrical diodes. These valves had mixed barium and strontium oxide cathode coatings of thickness 50–100 microns with a helical nickel probe wire of diameter 0·0125 mm. embedded in the oxide layer. Conductivity measurements were made by applying up to 100 mV. between probe and base metal, in both directions. The experiments showed:

(1) Completely ohmic current-voltage characteristics providing that both cathode base metal and probe wire were efficiently treated in a hydrogen furnace to remove surface oxide films, etc., before assembly.

(2) The variation of coating conductivity with temperature T gave plots of log $1/R$ against $1/T$ consisting of two straight lines, showing the presence of two conduction processes with a transition temperature of about 700° K. in all tubes used (see Fig. 2). The low-temperature activation energy was about 0·1 eV., whereas the high-temperature activation energy was 0·8 eV. This may be explained by the suggestion of Loosjes and Vink[4] that the two processes involved are (*a*) a crystal-to-crystal conduction process, predominating below 700° K., and (*b*) a process of electron emission and absorption across the inter-crystal spaces, predominating above 700° K.

(3) On investigating the effect of oxygen on emission and conductivity, the following facts emerged: (*a*) at temperatures above 700° K., the conductivity of the coating and the electron emission were poisoned by oxygen in the same way; (*b*) at temperatures below 700° K., the conductivity was scarcely affected by the introduction of oxygen into the cathode coating, even though the electron emission was reduced to one tenth of its original value.

It seems probable, in view of the above results, that the main cause of oxygen poisoning is the adsorption of thin films of oxygen on both the outer cathode surface and the interior crystallite surfaces, reducing both emission and conductivity of the coating at high temperatures. At low temperatures, such adsorption will reduce the emission from the outer surface without appreciably affecting the conductivity of the coating, since the main contribution is by direct crystal-to-crystal conduction at temperatures below 700° K.

The experimental work was carried out in the Physical Laboratories of the University of Manchester, and I wish to thank Prof. P. M. S. Blackett and Prof. F. A. Vick for facilities and help.

A complete report on the above work is in course of preparation for publication.

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Coloured 'Perspex' for Darkroom Lights

King and Ventura[1] have recently directed attention to the value of coloured 'Perspex' in the construction of filters for colorimetry, and it may be of interest to describe a similar use to which this material hac been put in this laboratory.

Experimental botanists frequently require ε 'physiological darkroom' in which plants and culture may be grown with minimum disturbance from light. In practice, this amounts to employing weak, phototropically inactive light, which is commonly obtainec by screening the unwanted wave-lengths from ordinary incandescent bulbs. Coloured glass obtainec from glaziers seldom possesses the required transmission, and although special dyed-in-the-mas glasses are obtainable from scientific glass makers they are (in some countries) difficult to obtain, anc relatively expensive in the size required. Red 40 and Amber 300 'Perspex' have been successfull used in place of glass.

Transmissions over the relevant spectral regions determined by a model *DU* Beckman spectrophotometer for sheets ⅛ in. in thickness, are recorded i the accompanying table.

Wave-length (A.)	Transmission (per cent)	
	Red 400	Amber 30
5260		0·02
5360		1·5
5400		6·5
5460		26·3
5500	0·0	41·8
5800	0·0	87·1
5900	4·3	89·0
6000	24·0	89·5
6250	82·4	
6500	90·4	92·0
7000	92·0	92·3

Although there is evidence[2] for some phototropi response of chlorophyll-containing tissues to ligh of wave-lengths greater than 6500 A., wave-length greater than 5500 A. are usually accepted as bein phototropically inactive to etiolated material. Th most careful determination appears to be that c Johnston[3] working with coleoptiles of *Avena sativa* I var. Culberson. He found phototropic sensitivity t be low at 5000 A.; but the threshold was not reache until 5461 A.

Red 400, which produces a light in which visu acuity is moderately satisfactory, should thus be qui safe for such material; but this would not be e pected of Amber 300, which produces a light providin much easier working conditions. However, coleoptil of *Avena sativa* L. var. Victory have shown no phot tropic response to incandescent light screened throug either Red 400 or Amber 300. Coleoptiles of vario ages have been exposed for periods ranging from a few minutes to 18 hr., the intensity of radiation of the red light being of the order of 4 ergs/mm.²/sec., and that of the amber light 7 ergs/mm.²/sec. It may be pointed out that the Schott filter *OG*-2 is recommended for such a purpose[4], and this filter has a transmission of 14 per cent at 5460 A.

The characteristics of Red 400 and Amber 300, taken together, are of further interest in connexion with a technique recently devised by Heath[5] for taking a series of shadowgraphs of *Avena* coleoptiles. Heath employed Kodak *RP15* 'Reflex' paper, and orange or orange-red cellulose acetate filters for producing the exposing light. The same result can be obtained more conveniently with the above 'Perspex' filters and ordinary bromide paper, since the latter is virtually insensitive to light screened through Red 400, which may therefore be used generally in the room for culture, manipulation, etc., and adequate shadowgraphs can be obtained using light screened through Amber 300 without affecting the plants. Exposures for 2 min. at the intensity recorded above are satisfactory.

The findings discussed here apply to plants cultured in red light (wave-length greater than 6000 A.) at intensities of the order of 5–15 ergs/mm.²/sec.

A word of caution should perhaps be added regarding the permanence of such filters. The manufacturers state that, after 12-months exposure outdoors, "very slight fading" occurred[6]. Insufficient experience has been gained under the conditions of an *Avena* test room (25° C. and 90 per cent relative humidity) to assess deterioration. Possibly, any deterioration could be retarded by mounting the 'Perspex' between sheets of plain glass.

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Enzymic Splitting and Synthesis of Glutathione

THE mechanism of the activation of the enzymic splitting of glutathione by glutamine—first considered specific for the amide[1]—may be interpreted as the transfer of the glutamyl moiety from glutathione to glutamine with the formation of the corresponding γ-glutamylglutamine[2,3]. Since it was considered possible that the γ-glutamylglutamine formed from glutathione and glutamine may serve as substrate for glutamotransferase, which can utilize glutamine only[4-9], a detailed study of the activation of the enzymic splitting of glutathione by L-amino-acids and peptides as well as of the effect of γ-glutamyl peptides on the splitting was undertaken. In the experiments to be reported, an extract from sheep kidney, purified by butanol treatment[10] and ammonium sulphate fractionation, served as source of the enzymes. In a similar manner potent enzyme solutions were prepared from brain cortex and liver.

In a representative experiment 6 micromoles of glutathione were incubated with 27 micromoles of the activator to be tested and the enzyme solution (20 μgm. of protein), at *p*H 8·5, in the presence of cyanide, in a total volume of 2 c.c. The liberation of cysteinylglycine was measured by the Sullivan reaction[1]. The initial rates of the splitting of glutathione as activated by various amino-acids and peptides were compared with the activation effected by glutamine, to which a value of 100 was assigned arbitrarily. Glycine, glutamic acid, asparagine, tyrosine, phenylalanine, and glycylglycylglycine activated slightly (0–30), whereas structural analogues of glutamine such as γ-ethylglutamate, methionine, ethionine, and homocysteine proved to be more efficient than glutamine (120–210) (cf. ref. 4). Of equal potency as activators were peptides of glycine in which this amino-acid, as in cysteinylglycine, was substituted in its amino-group (glutaminylglycine, alanylglycine, asparaginylglycine, leucylglycine), whereas dipeptides containing glycine substituted in the carboxyl group were weak activators (glycylglutamine, glycylasparagine, glycylleucine). Glycylglycine as well as glycylalanine—the latter being an exception to the above-described observation—proved to be potent activators of glutathione splitting (220).

When γ-glutamylglycine or γ-glutamylglutamic acid in an amount equal to that of glutamine was added in an experiment in which the amide was used as the activator, much lower colour equivalents in the Sullivan reaction were obtained at the end of the incubation than in control experiments in which no γ-peptide had been added. That we were not dealing with a competitive inhibition of the splitting of glutathione was demonstrated by the observation that the addition of a γ-glutamyl peptide, after incubation of glutathione, glutamine, and enzyme, led to a decrease of the Sullivan reaction of the incubated mixture upon further incubation. The appearance of glutathione, as measured by the glyoxalase test[11], with a simultaneous decrease in the Sullivan reaction, could be demonstrated upon the incubation of cysteinylglycine, γ-glutamylglycine, and enzyme (see table). The discrepancy between the amount of cysteinylglycine disappearing (Sullivan) upon the incubation of the dipeptide with glutamylglycine and the amount of glutathione formed (glyoxalase) is striking. The reasons for this discrepancy may be found partly in the inhibition of the utilization of glutathione in the glyoxalase test by cysteinylglycine, and partly in the conversions which glutathione undergoes under the action of enzymes which deprive it of its ability to activate glyoxalase without concomitant liberation of cysteine or cysteinylglycine. The results, although only of a qualitative nature, show that glutathione may be synthesized from γ-glutamylglycine and cysteinylglycine by an exchange reaction between the two peptides. Cysteinylglycine proves, therefore, to be as effective an acceptor of the γ-glutamyl radical as the other peptides in which the amino-group of glycine is substituted (see above). The synthesis of glutathione by an exchange reaction is of particular interest since the tripeptide can also be synthesized from the component amino-acids with the participation of

ENZYMIC SYNTHESIS (FROM CYSTEINYLGLYCINE AND γ-GLUTAMYLGLYCINE) AND BREAKDOWN OF GLUTATHIONE

	Found after incubation	
	Cysteinylglycine (Sullivan)	Glutathione (glyoxalase)
	(micromoles)	(micromoles)
(1) Glutathione	1·1	0 46
(2) Cysteinylglycine	2·3	0
(3) Cysteinylglycine + γ-glutamylglycine	1 4	0 25

(1) Glutathione 3·3 micromoles, potassium cyanide 40 micromoles, kidney protein 0 4 mgm., $M/15$ phosphate pH 7·4, total volume 2 ml., 30 min. at 37°.

(2) Cysteinylglycine 2·3 micromoles (according to Sullivan reaction), potassium cyanide 40 micromoles, protein 0 2 mgm., $M/15$ phosphate pH 7 4, total volume 2 ml.; 30 min. at 37°

(3) Same as (2) + 33 micromoles γ-glutamylglycine; 30 min. at 37°.

adenosine triphosphate[12], this synthesis consisting in the addition of glycine to γ-glutamylcysteine which is formed first[13]. Whether the synthesis of glutathione by an exchange reaction indicates an alternate pathway or the last step of the synthesis of the tripeptide with the participation of adenosine triphosphate may be decided by study of the respective enzyme preparations.

The experiments show that the transfer of the glutamyl radical is not a property of glutathione alone, but also of other γ-glutamyl peptides (cf. ref. 2*b*). The question arises whether the presence of free γ-glutamyl peptides other than glutathione has escaped discovery because of the lack of an easily detectable functional group or because of their rapid metabolic utilization. It can be visualized that the substitution of an amino-acid in its α-amino-group by a γ-glutamyl radical modifies the properties of the amino-acid in such a way that it may either undergo further synthetic reactions by enzymically catalysed exchange, or is enabled to condense its free α-carboxyl group with the amino-group of another amino-acid with participation of adenosine triphosphate (cf. ref. 14).

This work has been carried out in part under grants from the Rockefeller and the National Vitamin Foundations, and under a contract between the Office of Naval Research and the New York State Psychiatric Institute.

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Essential Role of Thiol Groups in Carboxylase

ESSENTIAL thiol groups of enzymes are usually detected by the inactivation of the enzyme with sulphydryl reagents, such as substances forming mercaptide, or oxidizing or alkylating substances[1]. Yeast carboxylase seems to be affected in a rather uneven and contradictory way by sulphydryl group detectors since 4-aminophenyldichloroarsine[2], *p*-chloromercuribenzoate[3], iodine[3], iodoacetate[3], cupric[3,4], mercuric and silver ions[4], or quinone[5] inhibit the enzyme, while in other experiments, lewisite oxide[6], ethylarsenoxide[7], iodoacetate[4] or ethyl iodoacetate do not modify its activity significantly. It must be pointed out: (*a*) that inhibition by a single thiol reagent does not prove the existence of sulphydryls since even very selective mercurial compounds[9] can inactivate enzymes which by other evidence do not seem to contain essential thiol groups; and (*b*) that the effect of sulphydryl detectors often depends on the purity of the enzyme preparation tested[10], a circumstance neglected in some of the work quoted Therefore, considering the essential part played by thiol groups in most of the enzymes related to pyruvate metabolism[2], it seemed interesting to make a systematic study of the action of several types of thiol reagents on a conveniently purified carboxylase, and for that purpose we have used the preparation described by Green *et al.*[4] (Q_{CO_2} about 12,000).

The activity of carboxylase dissolved in 0·05 *M* phosphate buffer pH 6·0 at 30°, measured manometrically, diminishes by 50 per cent after 15 min incubation with any of the following inhibitors 5·0 m*M* methylarsenoxide; 0·8 m*M* mapharside (3-amino-4-hydroxyphenylarsenoxide hydrochloride) 1·4 μ*M* *p*-chloromercuribenzoate; 1·4 μ*M* mercury (Hg^{++}); 2·5 μ*M* silver (Ag^{+}); 0·44 m*M* copper (Cu^{++}); 2·0 m*M* iodoacetate; 9·7 m*M* ethy iodoacetate; 1·4 m*M* bromobenzylcyanide; greater than 10·6 m*M* chloroacetophenone (highest concentration obtained); 12·5 m*M* alloxane and 1 0 m*M* *o*-iodosobenzoate. Lachrymators, like ethy iodoacetate and chloroacetophenone, affect the activity of carboxylase less than pyruvate oxidative decarboxylation by living cells of *Saccharomyces cerevisiae*[11], and they are the slowest reacting of al the inhibitors tested. The effect of the arsenicals i not reversed by dilution and does not depend on the amount of carboxylase present, while inhibition by heavy metals (and *p*-chloromercuribenzoate) i not reversed by dilution, but depends on the enzyme concentration and may be described as pseudo irreversible, following the definition of Ackerman and Potter[12].

Cysteine, glutathione or 2 : 3-dimercaptopropano (*BAL*) can modify the inhibition of carboxylase by thiol reagents. Thiols protect carboxylase from inactivation by methylarsenoxide and mapharside 2 : 3-dimercaptopropanol being more effective tha cysteine or glutathione against methylarsenoxide; a regards mapharside, however, cysteine is more effective than 2 : 3-dimercaptopropanol. After inhibitio with the arsenicals, carboxylase can be activated wit thiols. 2 : 3-Dimercaptopropanol reduces significantl methylarsenoxide or mapharside inhibition (91·0 an 45·0 per cent, respectively), while an amount o cysteine or glutathione containing an equivalen amount of sulphydryl (As : SH ratio of 1 : 15 mol only diminishes the effect of methylarsenoxid to a smaller degree (40·0 per cent). The toxicity o

Effect of Concentration of Pyruvate on the Inactivation of Carboxylase by Thiol Reagents

0 2 ml. carboxylase solution (45·0 μgm. purified protein) was mixed with the inhibitor in the presence of pyruvate and 0·05 *M* phosphate buffer, *p*H 6 0. Total volume of fluid, 1 0 ml Temp., 30°. Carboxylase activity measured manometrically

1·4 m*M* mapharside		* 3 3 μ*M* *p*-chloromercuribenzoate		10 0 m*M* sodium iodoacetate		1 0 m*M* *o*-iodosobenzoate	
Pyruvate conc (m*M*)	Carboxylase inactivation (%)	Pyruvate conc. (m*M*)	Carboxylase inactivation (%)	Pyruvate conc. (m*M*)	Carboxylase inactivation (%)	Pyruvate conc. (m*M*)	Carboxylase inactivation (%)
None*	57 0	None*	88 0	None*	76·2	None*	47·5
10·0	27·2	—	—	10 0	54·0	19 0	33 0
24 8	21·2	25·0	71·0	25·0	42·1	32·0	19·3
40 0	13 0	51 5	58·7	50 0	39 5	64·0	16·1
103·0	6 6	108·5	33·8	100 0	27 6	160·0	5·7
330·0	0 0	217·0	24·5	200 0	7·2	320 0	5 0

* Carboxylase was mixed with the inhibitor and incubated at 30° for 15 min. before adding 0·1 ml. *M* pyruvate

heavy metals is prevented and almost completely reversed by thiols. 2 : 3-Dimercaptopropanol is more effective than cysteine against cupric or mercuric ions, but their action is similar against *p*-chloromercuribenzoate or silver (Ag^+). Cysteine completely prevents carboxylase inactivation by iodoacetate or ethyl iodoacetate, provides partial protection against chloroacetophenone or bromobenzylcyanide, but does not affect the toxicity of the alkylating agents once they have reacted with the enzyme.

The reversal of the inhibition induced by *p*-chloromercuribenzoate or mercuric ion with cysteine or glutathione enables one to show that both inhibitors, the arsenical compounds *o*-iodosobenzoate and iodoacetate, react with the same group of carboxylase. If the enzyme inhibited by mercuric ions or *p*-chloromercuribenzoate is treated with mapharside, iodoacetate or *o*-iodosobenzoate, it can be activated by adding an amount of cysteine or glutathione unable to reverse the inactivation produced by the same concentration of marpharside, iodoacetate or *o*-iodosobenzoate alone.

The action of arsenicals, *p*-chloromercuribenzoate, mercuric ions, cupric ions, iodoacetate or *o*-iodosobenzoate, is greatly diminished or even nullified when they are added to carboxylase in the presence of pyruvate. The effect of pyruvate is proportional to its concentration, as shown in the accompanying table ; and it cannot be replaced by other electrolytes like sodium acetate or chloride. Pyruvate protection against *p*-chloromercuribenzoate or mercuric ions satisfies the equations of competitive inhibition[13], but only for each concentration of inhibitor. Pyruvate interferes with the combination of carboxylase with the inhibitor but does not dissociate the inactive complex, since once the enzyme has reacted with the inhibitor, the addition of any amount of substrate does not reduce the inhibition. Cocarboxylase and/or magnesium do not affect the action of mapharside, heavy metals or iodoacetate.

From this briefly summarized evidence, it may be concluded that the activity of carboxylase depends on thiol groups closely related to the formation of the carboxylase - pyruvate complex, which are extremely sensitive to heavy metals and their compounds, but less reactive to other thiol detectors like trivalent arsenical compounds, alkylating or oxidizing agents. These thiols do not give the Hefter's nitroprusside test and therefore must be considered sluggish reacting groups. Full experimental details of this work will be given elsewhere.

We are indebted to Boots Pure Drug Co., Ltd. (England), and the British Council ; Parke Davis and Co. (U.S.A.) ; and E. R. Squibb and Sons (Argentine) S.A., for kindly supplying samples of pure 2 : 3-dimercaptopropanol, mapharside and 3-amino-4-hydroxyphenyldichloroarsine, respectively.

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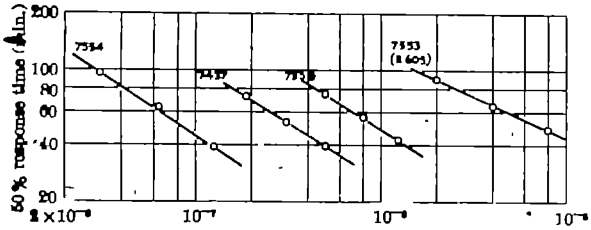
A New Method for the Bioassay of Cholinesterase Inhibitors

Recent studies of the toxicity of anticholinesterase compounds have emphasized the need for a sensitive and reliable method for the biological assessment of their relative activities. We have developed such a bioassay procedure using the freshwater shrimp, *Gammarus pulex* deG.

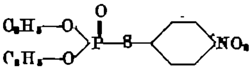
The choice of such an aquatic organism was based on the following considerations : (*a*) the aqueous medium provides a uniform environment and allows of accurate administration of toxic agent ; (*b*) circulation of water through a gill system is likely to facilitate absorption ; (*c*) the presence of a highly organized nervous system is necessary for the development of a well-defined and characteristic response ; (*d*) ready availability, enabling sufficient numbers to be used for statistical significance ; (*e*) robustness and sufficient size to be handled and observed easily.

Investigation of a wide range of candidate organisms led to the selection of *Gammarus pulex* as the most satisfactory. Since an adequate supply of this species is available from local streams, we have not found it necessary to undertake large-scale breeding. Considerable numbers may be kept in shallow trays,



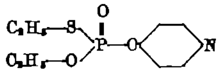
Comparative activity of 'standard Parathion' (E605) with its sulphur isomers and 'toxic batch':

7554.

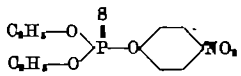


7437, toxic batch

7559.



7553 (E605).



containing not more than one centimetre depth of hard water, for at least a week without deterioration.

A complete test involves the observation of three or more groups of about forty gammarids, each in different dilutions of the toxic agent contained in large Petri dishes and maintained at 21·5° C. For convenience, observations are made at logarithmically separated intervals, and those specimens exhibiting the characteristic response are counted and removed.

The anticholinesterase substances used all produce similar effects, which may be divided into the following phases: (1) an initial phase in which responses appear normal; (2) a phase in which movements, though co-ordinated, are exaggerated; (3) a phase in which the exaggerated movements become inco-ordinated, with characteristic convulsions terminating in dorsal flexure where the concentration of toxic substance is high. This third phase is taken as the response and is followed by: (4) immobility except for the swimmerets and occasional spasmodic leg movements; (5) complete immobility and death.

The 50 per cent reaction-time for each concentration is obtained graphically from a log-normal transformation in which the probit corresponding to the percentage of organisms which have reacted is plotted against the logarithm of the corresponding time interval. This relationship is linear over the significant range between 10 and 90 per cent. When the 50 per cent reaction-time is plotted against concentration on logarithmic co-ordinates, a straight line is obtained, the slope of which is very similar for related compounds (see graph) and which is linear over a very wide range of concentrations.

An interesting application of the method is illustrated in the graph. It was found that certain batches of commercial 'parathion' (consisting mainly of O.O.diethyl O.*p*-nitro phenyl thiophosphate) were several times more toxic to mammals than a standard preparation. Isomerization was suspected, and the two sulphur isomers (O.S.diethyl O.*p*-nitrophenyl phosphate and O.O.diethyl S.*p*-nitrophenyl phosphate) were prepared by the manufacturers and submitted for examination.

The results obtained with the standard 'parathion' (7553), the suspect sample (7437) and the two isomers (7554) and (7559) are shown in the graph. The relative toxicities may be determined from the horizontal separation of the lines, and from these it was possible to confirm that sample (7437), which had a correct 'element' analysis, contained a high proportion of the more toxic isomers.

The systemic insecticide, OMPA (octamethyl pyrophosphoramide), has no action upon *Gammarus*. Dubois *et al.*[2] have shown that it does not inhibit cholinesterase *in vitro*, but is changed to an effective inhibitor by certain plant and animal tissues. Several workers[3] indicate that, in contrast to its sulphur isomers, pure O.O.diethyl O.*p*-nitrophenyl thiophosphate is also a poor inhibitor *in vitro*, but is transformed *in vivo* to an effective inhibitor. This compound, however, is toxic to gammarids.

This bioassay method was first demonstrated at a meeting of the British Pharmacological Society on July 9, 1949. It has been in continuous use for three years and has amply proved its reliability and precision.

Acknowledgment is made to the Chief Scientist, Ministry of Supply, for permission to publish this communication. A fuller account of the work will be published elsewhere.

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Pyrolysis of Dissolved Nitrocellulose

THE course of the thermal breakdown of the nitrocellulose molecule is not well understood. Previous studies of the chemical kinetics of the reaction have been carried out on the solid, and so have been hampered by the need to pyrolyse at low temperatures to reduce self-heating; and it is not certain how far the kinetics of gas evolution are complicated by reactions of the primary products, which probably include nitrogen peroxide. Further, the value of 46·7 kcal./mole recently found for the activation energy of the primary step by Wilfong, Penner and Daniells[1] is difficult to understand in the light of Phillips's demonstration[2] that the typical value for organic nitrates is 36–40 kcal.

A fresh experimental approach to the problem is suggested by Robertson's work on the pyrolysis of solutions of pentaerythritol tetranitrate[3] and cyclotrimethylenetrinitramine[4]. If nitrocellulose also could be studied in dilute solution, the difficulties we have mentioned would be much reduced. We have, in fact, found three solvents for nitrocellulose permitting such a study to be made, which have in sufficient degree the necessary qualities of chemical inertness towards nitrocellulose, low vapour pressure, and low melting point. They are 1-chloro-2 : 4-dinitrobenzene, benzophenone and 1-nitronaphthalene.

A preliminary study of the pyrolysis of nitrocellulose in these solvents between 165° C. and 200° C. has been made by following the evolution of gas, usually from 1 gm. of a 1 per cent solution of the *HX* 30/50 grade of nitrocellulose (11·85 per cent nitrogen). The usual assumption that the reaction is of the first order has proved to be approximately true; but there are certain deviations from the first-order law, as is not surprising in a reactant of this complexity. Thus, during the first one-third of the reaction in 1-chloro-2 : 4-dinitrobenzene, the rate of evolution of gas shows only a slight fall, corresponding to a gradual increase of about 25 per cent in the rate constant; whereas during the last quarter, the rate constant falls to about 60 per cent of its value at the intermediate stage. If one specifies the rate of the reaction, perhaps rather arbitrarily, by the velocity constant prevailing over the middle of its course, one finds that the rates at 175° C. in the three solvents show a spread of only 20 per cent, a sufficiently close agreement to suggest that the solvents are inert towards nitrocellulose.

In 1-chloro-2 : 4-dinitrobenzene, the rates at six temperatures between 165° C. and 200° C. lead to the following equation for the velocity constant :

$$k(\text{sec.}^{-1}) = 10^{18\cdot 6} \exp\,(-43\cdot 0 \times 10^{3}/RT).$$

The average deviation, without regard to sign, between the observed rates and those calculated from this equation is 7 per cent. It is unlikely that this preliminary value of 43·0 kcal. for the activation energy is in error by more than 2 kcal. It is therefore doubtful whether nitrocellulose is behaving as a normal nitrate when judged by Phillips's criterion of the activation energy. The reason for the high value of $10^{18\cdot 6}$ for the B factor is not certain, but even higher values have been recorded before, and Wilfong, Penner and Daniells probably seriously under-estimate the rate of decomposition in this temperature-region when they assume in effect that B has its 'normal' value of 10^{13}.

In 1-chloro-2 : 4-dinitrobenzene and benzophenone solutions, about five molecules of gas come from each sub-molecule of nitrocellulose. This yield of gas seems at first sight small, but it has been observed before[5] that much, perhaps one-half, of the products of pyrolysis of nitrocellulose is involatile. From 1-nitronaphthalene solutions, however, the yield is only 3·5 molecules per sub-molecule. Here the solvent presumably absorbs some of the products, but this need not invalidate the rates measured for its solutions. The reaction products have not been analysed.

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Paper Chromatographic Separation of Barbituric Acids

THE barbituric acid derivatives have a characteristic absorption spectrum in the ultra-violet, and this is the basis of the most reliable methods for their quantitative determination. Small changes of the wave-length at which maximal absorption is found and changes in the absorption curve with varying pH usually are considered to be the means by which the different members of the group can be identified. But these methods have been found troublesome and unreliable. However, as the strength of absorption differs quite appreciably from one member to another, the identification of the derivative is necessary for a quantitative determination.

It seemed theoretically that paper chromatography might be a method for separation and identification, but a difficulty was the lack of any means of detection of the spots. Several colour reactions found in the literature were tried, but were not found reliable. It was clear that a new method had to be worked out, and the following procedure was found to give good results with most derivatives tested.

After development, the dried paper is sprayed with $N/2$ sodium hydroxide, and dried again. It is then brought in firm contact with a fluorescent screen and placed in front of an ultra-violet lamp, the paper facing the light. A low-pressure mercury lamp with a suitable filter letting through a fairly monochromatic light of about 2537 A. and a screen which fluoresces in this light have been used. The acids are seen as dark spots on the fluorescent screen. The method proved to be very sensitive.

As the absorption of the barbiturates is highest at a pH between 9 and 10, the spraying of the paper with an alkaline solution is very important. The resultant alkalinity of the paper is not known, and experiments are in progress to investigate which alkaline solution is to be preferred.

This arrangement of a screen which fluoresces with ultra-violet light seems to be a sensitive method for the detection of all kinds of substances absorbing ultra-violet light, and probably it has wide applications. Permanent records can, of course, be made in the usual way, by taking photographic contact prints of the sprayed and dried paper. It is, however, more convenient to draw pencil marks around the spots on the paper. After copying the drawing, the spots can be extracted if desired. By using this method it was found that the different barbituric acids could be separated by paper chromatography.

We are continuing to investigate this method and a full account will appear in the near future.

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Specificity of Vitamin B_{12} for *Euglena*

IN an earlier publication[1] we reported that vitamin B_{12} could not be replaced for *Euglena gracilis* var. *bacillaris* by vitamin-free casein hydrolysate, carbon-treated peptone, methionine, ascorbic acid, pteroylglutamic acid, a variety of purine and pyrimidine bases or by xanthopterin and a number of related compounds. Hutner *et al.*[2] found thymidine to be ineffective. Vitamin B_{12a} (hydroxocobalamin) was active[1]. We have examined a number of additional compounds for vitamin B_{12} activity on *Euglena*.

Emerson *et al.*[3] reported the vitamin B_{12}-like activity of α- and β-ribazole and some related compounds. Samples of these compounds were obtained through the courtesy of Dr. Karl Folkers and tested on *Euglena* in our liquid medium I [1,4]. At 0·166 mgm. per ml., α- and β-ribazole had an activity on *Euglena* equivalent to 1–3·4 μμgm. of vitamin B_{12} per ml. At 0·00166 mgm. and 0·0000166 mgm. per ml. no effect was observed. For *Euglena*, vitamin B_{12} was from 50,000,000 to 150,000,000 times as active as α- or β-ribazole; for rats, Emerson *et al.* found vitamin B_{12} to be 400 times as active as the ribazoles. At 0·166 mgm. per ml., 1-D-ribityl-5,6-dimethylbenzimidazole and 5,6-dimethylbenzimidazole were inactive on *Euglena* in our experiments. Emerson *et al.* found vitamin B_{12} to have from 8,000 to 20,000 times the activity of the two benzimidazoles on rats. Although the results with *Euglena* agree with those on rats, in that the α- and β-ribazoles were more active than the two benzimidazoles, all the compounds were much less effective than on the rat.

Woolley[5] found that 1,2-dimethyl-4,5-diaminobenzene increased the synthesis of vitamin B_{12} by *Bacillus megatherium*, whereas 1,2-dichloro-4,5-diaminobenzene reduced its synthesis and in sufficient amounts inhibited growth. He suggested that the former compound might be a precursor for vitamin B_{12} and the latter an antagonizer of the precursor. Dr. Woolley generously supplied us with some of each of the above compounds. At 0·5 mgm. per ml. in our liquid medium I, the dichloro compound had little or no effect on the growth of *Euglena* in the presence of 0·00002 μgm. of vitamin B_{12} per ml. Woolley found 0·1 mgm. per ml. under his conditions reduced growth of *Euglena* by 50 per cent. In our experiments the dimethyl compound at 0·1 μgm. per ml. in the absence of vitamin B_{12} had no effect on the growth of *Euglena*. Since *Euglena* responds under our conditions to 1 μμgm. of vitamin B_{12} per ml., the dimethyl compound had less than 1/100,000 the effect of vitamin B_{12}. Woolley reported 1,2-dimethyl-4,5-diaminobenzene to be between 1/500,000 and 1/1,000,000 as effective as vitamin B_{12} for *Euglena gracilis*.

Through the courtesy of Dr. T. H. Jukes, a sample of ammonia cobalichrome was obtained from Dr. V. Petrow (his *AC2*). This compound is vitamin B_{12} with ammonia substituted for cyanide. We were advised that the substance was unstable and could not be heated for long periods in the light. We sterilized a solution of the compound by filtration and pasteurized an aliquot by bringing it to a quick boil. With both methods the substance was added to our liquid medium I after the latter had been sterilized, and the cultures were incubated in the dark at 25° C. Both the filtered and pasteurized samples of the ammonia cobalichrome had about one-half the activity of vitamin B_{12}. According to Cooley *et al.*[6], ammonia cobalichrome has 2·5 times the activity of vitamin B_{12} for *Lactobacillus lactis*, 1·5 times its activity for *Escherichia coli* and equal activity for the chick.

Pfiffner *et al.*[7] reported the isolation of an organism from bovine rumen which under anaerobic conditions produced a mixture of cobalt-containing pigments belonging to the vitamin B_{12} group. Two major constituents were obtained in crystalline form. They had the same order of activity on *L. leichmannii* and *L. lactis* Dorner as vitamin B_{12} but were inactive on chick growth and rat anti-hæmorrhagic kidney tests. Dr. Pfiffner kindly supplied us with samples of crystalline pseudovitamin B_{12}[8], crystalline pseudovitamin B_{12b} and cyano-pigment *C*. Pseudovitamin B_{12} is about as active on *L. leichmannii* and *L. lactis* as vitamin B_{12}; pseudovitamin B_{12} has about half the activity of B_{12} on *L. leichmannii*, *L. acidophilus* and *L. lactis* Dorner, and cyano-pigment *C* has only a trace of activity on *L. leichmannii*[9]. Pseudovitamin B_{12} and pseudovitamin B_{12b} had the same order of activity on *Euglena* as vitamin B_{12}. The activity of cyano-pigment *C* was about half that of vitamin B_{12}.

Dr. C. A. Elvehjem furnished us with a preparation of a substance containing cobalt[10] which was isolated from rat fæces. The material was active on *L. leichmannii* and the chick, but had little or no activity for the rat. In our hands this material had about twice the activity for *E. gracilis* as reported for *L. leichmannii*.

Although vitamin B_{12} has a high degree of specificity for *Euglena gracilis* var. *bacillaris*, our results demonstrate that substances exist in Nature which have vitamin B_{12} activity for *Euglena* and little or none for animals. Assays for vitamin B_{12} made with *Euglena* are not sure indications of the presence of the vitamin.

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Nucleic Acids of Rickettsiæ

Smith and Stoker[1] have noted that the deoxyribonucleic acid of *Q*-fever rickettsiæ (*R. burneti*) grown in embryonated eggs is closely similar in composition to that of chick embryos, the only significant difference being lack of 5-methyl cytosine from the former. To account for this similarity, they mention the possibility that rickettsiæ may incorporate nucleic acid directly from their host. This hypothesis could be tested, they point out, by analysis of the same organism grown in a different host.

We have recently analysed the deoxyribonucleic acid of another rickettsia from the same host. Deoxyribonucleic acid was isolated[2] from epidemic typhus rickettsiæ (*R. prowazeki*) grown in chick yolk-sac endothelium, and the purine and pyrimidine bases estimated[3] after hydrolysis in perchloric acid (70 per cent, 1 hr. at 100° C.). The estimated bases were equivalent to 96 per cent of the deoxyribonucleic acid phosphorus. No methyl cytosine could be detected. The ratios of the bases found (mean of two analyses), along with those reported for *R. burneti*, are as follows:

	Moles per cent			
	Adenine	Thymine	Guanine	Cytosine
R. burneti (ref. 1)	29·5	26·0	22·5	22·0
R. prowazeki	35·7	31·8	17·1	15·4

The deoxyribonucleic acid of *R. prowazeki* clearly differs in composition from those of *R. burneti* and of the host chick embryos. In the *E. coli*-phage system, the deoxyribonucleic acids of host and virus differ markedly[4], and it has been concluded from tracer studies[5] that host nucleic acid is utilized by the parasite only in the form of breakdown products. It is likely that any host nucleic acid used in synthesis of rickettsiæ would also be first extensively degraded.

A common pattern in the composition of deoxyribonucleic acid, first pointed out by Chargaff[6], has apparently wide validity. The molar ratios (adenine) : (thymine), and (guanine) : (cytosine (plus methyl cytosine when present)) have nearly constant values close to unity, whereas the ratio (adenine + thymine) : (guanine + cytosine) is characteristic of the source of the nucleic acid. The rickettsiæ are no exception :

	A/T	G/C	(A + T)/(G + C)
R. burneti	1·13	1·02	1·25
R. prowazeki	1·12	1·11	2·08

If, for as yet obscure reasons, nearly constant ratios of adenine to thymine and guanine to cytosine are the rule in deoxyribonucleic acids, this would greatly increase the probability of two distinct deoxyribonucleic acids having like composition by chance. This may account for the similarity of the *R. burneti* and chick nucleic acids.

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Symbiosis in *Ptilinus pectinicornis* L.

It is well known from the work of Buchner[1], Breitsprecher[2], and others that mycetomes occur at he anterior end of the larval midgut of several species of Anobiid beetles. The mycetocytes are distended with micro-organisms which are of obscure axonomy, but appear yeast-like, and of which the ymbiotic role has been established by Koch's[3] demonstration of their necessary presence in *Sitodrepa anicea*, if the larva is to grow normally. Blewett and Fraenkel[4] have shown that the presence of the ymbionts in *Sitodrepa* larvæ can offset a dietary deficiency of five vitamins of the B group: the ymbionts in *Lasioderma serricorne* can apparently supply six of these vitamins to the larva.

The vitamins could become available to the larva ther by excretion from the organisms, or by digestion of organisms expelled from the mycetocytes into the gut. The former view now gains support om the observation that, in the larva of *Ptilinus ectinicornis*, the mycetomes have migrated forward from the anterior end of the midgut to form a pair of lobed organs dorso-lateral to the front of the gizzard. Connexion with the midgut is retained through a pair of slender ducts, about 16 μ in external diameter, with walls about 4 μ in thickness, passing on either side of the gizzard. These organs are observable both in sections and in dissections. In sections, the mycetocytes can be seen to be packed with minute, round organisms, none of which has been observed in the ducts.

There is therefore strong morphological evidence for concluding that the symbionts in the larva of *P. pectinicornis* secrete a fluid which, by analogy with *Sitodrepa* and *Lasioderma*, should contain vitamins of the B group which the larva requires but is unable to obtain in sufficient quantities from the dead, dry wood in which it normally lives.

When the larva pupates, the mycetomes retain their identity but become a little reduced in size, while the ducts contract and thicken until the mycetomes are drawn back into close contact with the anterior end of the midgut. The mycetomes then look little different from those in the larvæ of several other species of Anobiids in which they appear as short diverticula from the midgut.

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Occurrence of Malonic Acid in Plants

The occurrence of malonic acid has been reported in the leaves of lucerne[1] and in green wheat plants[2]. This acid is well known as a competitive inhibitor of succinic dehydrogenase, and has been used extensively in investigations of the tricarboxylic acid cycle. In consideration of this inhibiting effect of the acid, some further investigations have been made into its presence in plants.

The organic acids present in water extracts of plant tissue have been identified and quantitatively estimated by paper partition chromatography. The acids were extracted from mature leaves by boiling about 6 gm. in water with 1 ml. normal sulphuric acid. The tissue was then ground in a mortar and a clear extract obtained by centrifuging; this was concentrated to 6 ml. before using on the chromatogram. The chromatograms were developed by a method similar to that of Lugg and Overell[3], using as solvent the water-poor phase of *tert.*-amyl alcohol (80 ml.) – chloroform (80 ml.) – water (80 ml.) – formic acid (30 ml.). The acids were detected by spraying with an aqueous solution of bromocresol green. The R_F value of malonic acid (0·59) is identical with that of tricarballylic acid and very close to that of maleic acid (0·60). Malonic acid was distinguished from the others by the use of two different sprays—ammoniacal silver nitrate and ceric ammonium nitrate as suggested by Buch *et al.*[4]. The organic acids separated satisfactorily in the presence of the other substances, for example, amino-acids and sugars in the plant extracts. An acid was only identifiable with this technique when more than 15 μgm. were present on the chromatogram, therefore acids present in a concentration below 0·5 mgm./ml. of extract, that is, 0·5 mgm./gm. fresh weight of tissue, were not identified in this type of extract.

Mature leaves from twenty-seven species of Leguminosæ were examined. Citric and malic acids were present in all of them in concentrations of 1·0–4·0 mgm./gm. fresh weight. Malonic acid was present in concentrations of 0·5–2·0 mgm./gm. fresh weight in eighteen species taken from the genera *Medicago*, *Phaseolus*, *Vicia*, *Ononis*, *Astragalus*, *Trifolium*, *Lupinus*, *Anthyllis*, *Lotus*, *Melilotus*, *Colutea*, *Sophora*, *Thermopsis* and *Trigonella*. Malonic acid could not be identified in nine species taken from the genera *Lathyrus*, *Onobrichis*, *Vicia*, *Cercis*, *Mimosa*, *Piptanthus*, *Hedysarum*, *Cassia* and *Gleditschia*. Other species examined included members of the Umbelliferæ, Rosaceæ, Ranunculaceæ, Chenopodiaceæ and Crassulaceæ. Of these only the Umbelliferæ showed an accumulation of malonic acid comparable to that in the Leguminosæ; for example, the leaves of *Anthriscus* and *Apium* contained more than 1·0 mgm./gm. fresh weight. As well as the accumulation of malonic acid found frequently in these two families, it seems probable that it occurs in smaller concentrations elsewhere. For example, extracts of the leaves of *Helianthus annuus* L., purified and concentrated by the use of ion-exchange resins, were found to contain citric and malic acids (1·0 mgm./gm. fresh weight) and much smaller quantities of malonic, lactic, succinic, aconitic and fumaric acids.

Confirmation of the identification of malonic acid in the leaves of runner bean, *Phaseolus coccineus* L., has been provided by isolation of the pure acid. A water extract of the leaves was purified and concentrated on ion-exchange resins. The acids were separated by paper chromatography, and citric, malic, malonic, lactic, succinic, aconitic and fumaric acids were identified. A chromatogram was run with a complete band of extract along the starting line; after separation the band of paper corresponding to malonic acid (calculated to contain 60 mgm.) was excised and the acid extracted from it with boiling water. On recovery from the water and recrystallization from ethyl acetate, 20 mgm. of crystals were obtained, m.p. 131–133° C. (m.p. malonic acid = 135° C.); there was no depression of the mixed melting point. The *p*-nitrobenzyl ester of the plant acid melted at 83·5–85° C. (m.p. malonic acid ester = 86° C.) and there was no depression of the mixed melting point.

Analysis of the stem tissue of runner bean gave in mgm./gm. fresh weight, citric acid = 0·7, malic acid = 1·1, malonic acid = 2·1 and succinic acid = 0·15. It is therefore necessary in investigations into the reactions of the tricarboxylic acid cycle in such tissues to take into consideration the presence of endogenous malonic acid. For example, the malonic acid forms a solution about 0·03 M in the expressed sap of runner bean stem, and it has been found that a solution as low as 0·02 M malonic acid, adjusted to pH 4·5 with caustic potash, inhibits by 50 per cent the oxygen uptake of disks of this tissue and causes accumulation of succinic acid. Further investigations into the acid metabolism of this tissue are being carried out and full details will be published later.

I wish to thank Prof. T. A. Bennet-Clark for his advice and encouragement during the course of this work and Mr. R. D. Mulley, of the Chemistry Department of King's College, for preparation of the ester of malonic acid.

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Variation in Leaf Form in *Callitriche Intermedia*

Callitriche intermedia shows a well-marked variation in its leaf form, dependent on whether the crown of the plant is submerged or floating at the surface of the water. When the crown is submerged, linear leaves are produced, up to 3 cm. in length and 1 mm. broad. When the crown reaches the surface, ovate leaves are produced, about 1·5 cm. long and 4 mm. broad at the widest point. A reversion to the linear type of leaf is produced if the crown is afterwards submerged.

In considering the mechanism involved in the change in leaf form, it is of interest to refer to the work of McCallum[1] on *Proserpinaca palustris*, where an essentially similar response of leaf form to emergence from the water was studied. McCallum was able to induce the aerial type of leaf by growing the plants in a nutrient solution of a concentration which just failed to plasmolyse the tissues. No compensation for evaporation from the nutrient solutions was made. The suggestion was advanced that the withdrawal of water from the tissues by osmosis created an effect similar to the withdrawal of water by transpiration on exposure to the air. Burns[2], in a criticism of McCallum's work, stated that the aerial type of leaf was produced in the spring and was formed even on submerged shoots at that season. Burns suggested that light was the determining factor in the production of the aerial leaf form.

I have applied a modification of McCallum' methods to *Callitriche intermedia*. Linear-leave shoots were submerged in sea water diluted to 30 pe cent of its original concentration (30 per cent se water just fails to plasmolyse tissues of the linea leaves). In seventeen days (July) small, ovate leave were visible at the crowns. These ovate leaves wer preceded by transitional forms, the intermediat leaves having a more or less ovate proximal part an a linear distal part. The concentration of the dilute sea water was now about 37 per cent. Ovate-leave shoots grown under the same conditions remaine ovate-leaved. Linear-leaved shoots submerged i tap-water remained linear-leaved, while ovate-leave shoots submerged in tap-water produced linear leave

The ovate leaves which are produced by immersio in diluted sea water have the general form of th normal ovate leaves but do not attain a length more than 3 mm. The induced leaves resemb normal ovate leaves in the possession of numero stomates and of isodiametric epidermal cells. Norm linear leaves have few or no stomates, and th epidermal cells are elongated in the direction of th length of the leaf. The induced ovate leaves, howeve have a single vein as in the linear leaf, whereas th normal ovate leaf has three veins. An interestir feature of the shoots bearing induced ovate leaves is the development of axillary buds (with ovate leaves) associated with the absence of elongation of the shoot after immersion in the diluted sea water.

These results are being considered in relation to a general study of heterophylly in *Callitriche intermedia*.

HERBERT JONES

Department of Botany,
University College of Wales,
Aberystwyth. July 22.

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[1] McCallum, W. B., *Bot. Gaz.*, 34, 93 (1902).

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Lowered Liver Vitamin A Reserves in Avian Coccidiosis

DURING the course of a routine series of determinations of vitamin A reserves of poultry in health and disease it became evident that, in the case of fowls affected with coccidiosis, these reserves were almost invariably of a low order.

The range in a series of thirty-nine affected birds submitted for diagnosis from farms in different parts of England was 0–126 I.U. vitamin A/gm., with a mean value of 6·9 I.U./gm.

The birds in question were of varying ages and breeds and were from farms on which widely different systems of husbandry were practised. The infections included both the cæcal type (*Eimeria tenella*) and the intestinal type (*Eimeria necatrix*) of coccidiosis.

Observations were therefore extended to a series of ten Barred Rock and Brown Leghorn × Barred Rock fowls which were suffering from a natural infection of intestinal coccidiosis, and which were from a flock maintained at the Poultry Research Station of the Animal Health Trust, where they had been reared on range in fold units. The ages of the birds varied from 8 to 24 weeks, but in all cases the liver vitamin A reserves were again of low order, the range being 2–38 I.U./gm. with the mean of 20·8 I.U./gm. The food provided was a nutritionally balanced ration and was known to contain 2,100 μgm. carotene = 3,500 I.U. vitamin A/lb. in the form of dried grass meal. The livers of ten unaffected birds from the same flock were examined and found to have normal reserves within the range of 200–420 I.U./gm., with a mean value of 292 I.U./gm.

These findings would appear to be of special interest in view of the fact that the intestine is now recognized as the seat of conversion of carotene to vitamin A, in chicks as well as mammals[1]. It is suggested that invasion of the intestinal wall by the coccidia may have resulted in impaired conversion of carotene to vitamin A. Moreover, it has been shown that the provision of adequate amounts of cod liver oil accelerates recovery from coccidiosis[2], and this may be due to its vitamin A content.

These studies are now being extended to birds artificially infected with *Eimeria necatrix* and receiving vitamin A either as the vitamin A alcohol or as carotene.

I am grateful to Dr. Horton-Smith for his collabration.

ALAN W. DAVIES

Poultry Research Station,
Animal Health Trust,
Houghton, Huntingdon. Oct. 7.

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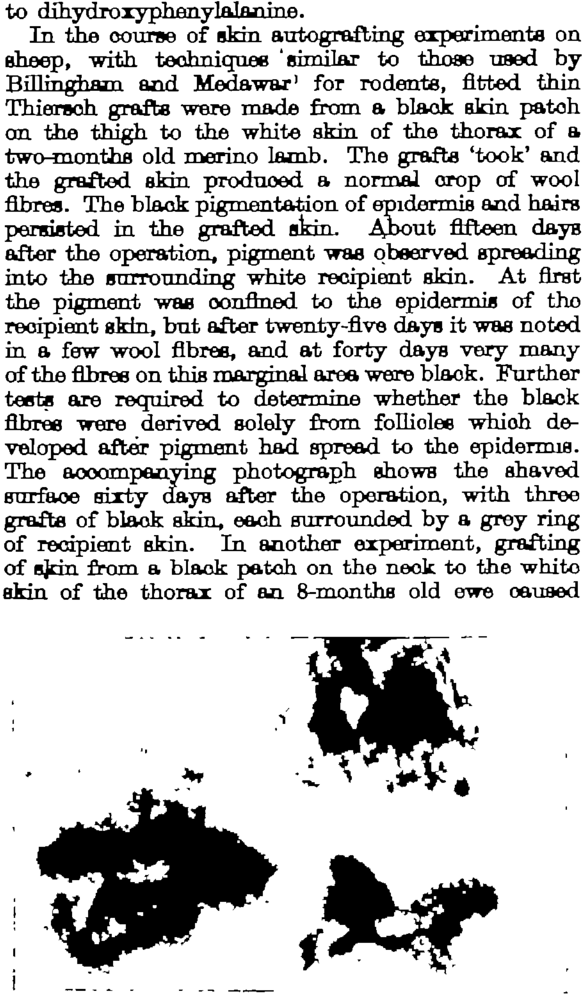
Spread of Pigment in Sheep Skin Autografts

SEVERAL theories have been advanced to explain the spreading of melanin pigmentation in mammalian skin during post-natal life[1]. Billingham and Medawar[2] found support for their theory of 'infective' cellular transformation from skin grafting experiments with guinea pigs. It is well known that if black skin from an adult guinea pig is grafted on to a white area on the same animal, melanin pigment appears in the white skin surrounding the graft, though not in the hairs. A similar phenomenon was recently observed with grafts of cattle skin[3]. The spreading of pigment to surrounding hairs instead of to epidermis has been reported in homografts to new-born mice[4] and in autografts to new-born black hooded rats[1]; but, so far as we are aware, it has not been observed in the healthy skin of more mature mice or rats, nor in any species other than the above.

In the black skin of sheep, pigmented dendritic cells are present in the hair matrix of hair follicles and in varying concentrations in the root sheaths and the basal layer of the epidermis. Boyd[5] showed that dihydroxyphenylalanine-positive but unpigmented dendritic cells were present in the same locations in the white skin of spotted and recessive white breeds. The distribution of dendritic cells was the same in spotted guinea pigs[2], although in the latter the unpigmented dendritic cells were negative to dihydroxyphenylalanine.

In the course of skin autografting experiments on sheep, with techniques similar to those used by Billingham and Medawar[1] for rodents, fitted thin Thiersch grafts were made from a black skin patch on the thigh to the white skin of the thorax of a two-months old merino lamb. The grafts 'took' and the grafted skin produced a normal crop of wool fibres. The black pigmentation of epidermis and hairs persisted in the grafted skin. About fifteen days after the operation, pigment was observed spreading into the surrounding white recipient skin. At first the pigment was confined to the epidermis of the recipient skin, but after twenty-five days it was noted in a few wool fibres, and at forty days very many of the fibres on this marginal area were black. Further tests are required to determine whether the black fibres were derived solely from follicles which developed after pigment had spread to the epidermis. The accompanying photograph shows the shaved surface sixty days after the operation, with three grafts of black skin, each surrounded by a grey ring of recipient skin. In another experiment, grafting of skin from a black patch on the neck to the white skin of the thorax of an 8-months old ewe caused



spread of pigment into the recipient epidermis, but there was little or no pigmentation of recipient hairs.

These observations were confirmed by the histological study of skin samples taken at frequent intervals. In normally black skin, pigmented dendritic cells were found in the basal layer of the epidermis and in the outer root-sheath and hair matrix, and melanin granules were found in some epidermal cells and in the cortex of most hairs. This distribution of pigment persisted in black skin after it was grafted to a white area, and, after twenty to thirty days, pigmented dendritic cells appeared for the first time in the adjacent recipient area, first in the basal layer of the epidermis and later in a few follicles, in the hair matrix or the outer root sheath.

The behaviour of black-on-white skin autografts in the sheep was very similar to that in adult guinea pigs[3] and cattle[4]. In both guinea pigs and sheep, pigmented dendritic cells appeared in the surrounding host epidermis; in both, this might be due to the transformation of the white dendritic cells already present. Pigmentation of follicles and hairs in the host skin occurred to some extent in the sheep but not in the guinea pig or the cow. In all three species the spread of pigment began twenty to thirty days after the grafting operation and the rate was about 1 mm. per week for several weeks.

The sheep thus appears to be a useful subject for the study of the nature of pigment spreading. Further experiments are in progress and will be reported in detail elsewhere.

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Division of Animal Health and Production,
Sydney,
and C.S.I.R.O. Section of Animal Genetics,
University of Sydney. April 2.

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A Lipoprotein Precursor of Sclerotin in the Cockroach Cuticle

RECENT work has shown that quinone tanning of protein structures is indeed of widespread occurrence in the invertebrates, as was suggested by Dennell[1]. The various tanned structures agree in showing a high degree of chemical stability, but the origin of the quinone responsible for tanning has been claimed to differ in different cases[2]. On one hand, in the cockroach ootheca[3] and in the blowfly puparium[4], the quinone has been shown to arise from the enzymatic oxidation of an alcohol-soluble dihydroxyphenol. In certain structures of *Mytilus* and in the egg cases of *Fasciola*[2], on the other hand, it has been suggested that the precursor of the quinone is an alcohol-insoluble amino-acid or protein in which tanning may have evolved through the oxidation of the phenolic hydroxyl groups of tyrosine without removal of the side-chains. A protein, 'prosclerotin', rich in phenolic groups has likewise been described in the cuticle of Myriapods[5], and it has been suggested that this may constitute a similar self-tanning substance.

In the present work, the process of hardening c the cockroach cuticle has been critically followe histochemically and by microchemical analysis, an two conclusions of importance emerge. First, th precursor of sclerotin, the impregnating material c the exocuticle, has been clearly shown to be a lip protein complex similar to that suggested by Wiggle worth[6] as constituting the cuticulin of the epicuticl Secondly, the quinone responsible for the tannin of this precursor is derived from the oxidation of dihydroxyphenol in the presence of a polyphen oxidase at the surface of the cuticle. Hitherto, it h not been unequivocally shown that the hardenin of the exoskeleton of a typical insect takes place i the same manner as in the special cases of the cocl roach ootheca[3] and the blowfly puparium[4].

Sections of the fully hardened cuticle show th tanning involved only the outer zone of the soft pr exuvial endocuticle of the sclerites, whereas the re of the cuticle, as well as the whole of the arthrodi membranes, remains untanned. During preparatic for hardening, a lipoid passes into the presumpti exocuticle, and is shortly followed by a protein ri in phenolic groups which comes to occupy the sam region as the lipoid. The lipoid, shown by th Liebermann–Burchardt test to be a sterol, impar a yellow coloration to the cuticle. The protein sho many of the properties of the 'prosclerotin' of Blowe except that it is restricted to the regions later be tanned, whereas 'prosclerotin' is reported to present throughout the thickness of the sclerite. the two constituents, lipoid and protein, only t latter reduces ammoniacal silver nitrate, and th only to a slight extent. It is likely that the stabili shown by the exocuticle at this stage is due to t presence of the lipoid constituent. Just before t onset of darkening the lipoid loses its colour a ability to stain, possibly as a result of polymerizatic A wave of quinone tanning demonstrable by a pr nounced intensification of the argentaffin reacti then passes from the epicuticle inwards and sto sharply at the inner boundary of the lipoprote complex.

That the inward spread of darkening is truly d to the passage into the cuticle of a dihydroxyphe and its subsequent oxidation to an *o*-quinone, a is not the result of the presence of a self-tanni protein, is indicated by the results of micro-analys which show clearly the presence of dihydroxyphen in the cuticle during the later stages of the proce Further than this, the blood at all stages of hardeni darkens on exposure to air, indicating the presen in it of tyrosine and tyrosinase, and in the later sta there is evidence of the presence of a free phen Finally, the epicuticle of the sclerites, but not of t arthrodial membranes, contains a polyphenol oxid readily demonstrable by the 'Nadi' reagent. Th observations are in fundamental agreement with th of Dennell[4] on *Sarcophaga*.

It appears, then, that the substance tanned i lipoprotein complex, and not the structural prot of the procuticle[4], nor a simple protein passed preparatory to hardening[5]. Experiments on the a ficial tanning of cuticles before the onset of natural process indicate that not only does quinone combine with the lipoprotein complex in natural hardening, but also with the sterol al at an earlier stage. It is suggested that it such a sterol-protein complex, the precursor sclerotin, that has been designated prosclerotin Blower[5].

A lipoprotein complex may be of common occurrence in naturally tanned structures. In both the cockroach ootheca and in the blowfly puparium, I have clearly demonstrated a lipoid to be present throughout the whole thickness of the tanned regions. Furthermore, lipoids have been reported in the exocuticle of Myriapods[7]. It will be of interest to learn whether lipoids are associated with proteins in other tanned structures.

A full account of this and other aspects of the present work will be given elsewhere. My thanks are due to Prof. R. Dennell for his interest and criticism.

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April 28.

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Packed Red-Cell Volume in the Tropics

It was found that when men stayed in air-conditioned rooms at about 30° C. for a few days their packed red-cell volume fell[1,2]. A rise in this value was likewise found in conditions of low environmental temperature[2]. More prolonged exposure to conditions of high environmental temperature caused by change of season was also associated with a fall in the packed red-cell volume[3]. No satisfactory information about the physiological effect on the packed red-cell volume of people living for several months or years in a warm climate could be found in the available literature. The results of an investigation made in Singapore may, therefore, be of interest.

The subjects were healthy, well-nourished men and women of different races (see table) who had lived in the tropics for at least six months, and they were all between twenty and forty years old. Samples of venous blood were collected with minimal stasis, and an ammonium and potassium oxalate mixture used as an anti-coagulant[4]. Estimations of the packed red-cell volume were made by means of Wintrobe haematocrit tubes[5] which were centrifuged for 1 hr. at 3,000 r.p.m.

Packed Red-Cell Volume of Normal Men and Women Living in Singapore

Racial group	No.	Mean (per cent)	S.D.	S.E. of mean
Men				
Chinese	73	47·69	6·518	0·7622
Indians and others	58	47·59	7·266	0·9541
European	121	47·02	5·420	0·4927
All males	252	47·35	4 508	0·2838
Women				
Europeans	57	40·56	6·060	0·8025
Asians	21	41·48	9·824	2·1440
All females	78	40 80	5·429	0·6146

The mean packed red-cell volume of 252 men was 7·35 per cent, and that of 78 women 40·80 per cent. Details are given in the table. The differences between he mean value for each racial group were not tatistically significant by the *t* test[6].

The present findings are slightly higher than those found in temperate climates[7]. The results of this investigation suggest that living in a warm environment for several months or years is not associated with a fall in the packed red-cell volume. The fall in this value found in men during shorter conditions of exposure to heat[1-3] appears to have been a temporary change. Recovery of the packed red-cell volume might provide objective evidence of complete acclimatization.

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May 12.

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Reversal of the Heart-beat in Tunicates

The mechanism controlling the periodic reversal of the heart-beat in tunicates is still in dispute. Internal control has been thought to exist, and to be due either to local nerve centres[1], or to physiologically differentiated areas of cardiac muscle[2], at each end of the heart. Evidence from the action of drugs has been conflicting[3]. Hunter[1] found a ring of cells around each end of the heart which he thought to be nerve cells, and Alexandrowicz[4] described nerve fibres but was uncertain whether ganglion cells exist.

I have found rings of fusiform cells in the heart of *Ciona intestinalis* (L) which seem to correspond to those described by Hunter[1], but they are connective tissue cells and not nerve cells, being the ends of sheets of connective tissue that line the large blood vessels at their cardiac junction. Von Skramlik[2] found evidence for the existence at each end of the heart of a small area of cardiac muscle which initiates the beats; alternating dominance of one area over the other would produce periodic reversal. Lahille[5] believed that certain parts of the peripheral system are unable to accept blood as quickly as the heart supplies it, and that the resulting back-pressure that is built up eventually stops the heart. When the heart starts to beat again, it does so in the opposite direction. Haywood and Moon[6] have revived Lahille's theory and from it have formulated an equation relating the time of beating in one direction with the number of beats. In support of the theory they produced experimental results which satisfied the equation, and also they failed to observe reversal of isolated hearts, a phenomenon recorded by von Skramlik[2].

Periodic reversal of isolated hearts, if it could be shown to occur, would be strong evidence against the back-pressure theory, since no such pressure can be built up in a heart not connected with its closed system of vessels. The heart was therefore removed from a number of specimens of *Ciona* and observed continuously for 6–12 hr. It was found that, in most cases, the newly isolated heart continued to beat in one direction during the first few hours, but eventually reversal started, at first at long intervals but with increasing frequency. The duration, in minutes, of alternate phases in two typical isolated hearts is given, both series being taken about eight hours after isolation. The figures in italic type are for the abvisceral phase, and those in roman type for the advisceral phase.

Specimen 1. *5* 6 *2* 2 *4* 3 *4* 3 *3½* 3 *3* 3½ *1½* 3 *4½* 3½ *3* 3½ *4*
Specimen 2. *1½* 6 *6* 18 *5* 16 *3* 14 *5* 10½ *5* 12 *1½* 14 *12½* 18½ *12* 8 *4½* 10½ *7*

In some of the preparations the wall of the heart was cut open to ensure that the pressures of liquid inside and outside were equal; in others the ends sealed themselves so that a constant pressure was maintained within the heart. In each kind of preparation periodic reversals were made.

The sequence of events during reversal of a weak and slowly beating isolated heart also shows that it is not back-pressure which stops the heart. There is a distinct pause between beats, and very little movement of liquid is produced. Nevertheless, such hearts still reverse, and it can be seen that, immediately before reversal, the hitherto quiescent end starts to beat in opposition to the dominant end, but only takes over control from the latter when, owing to its increasing rate of beat, it initiates a beat before the hitherto dominant end.

I conclude from these experiments that the back-pressure theory is untenable, and that there exists some internal controlling mechanism of the kind described by von Skramlik[2]. Periodic pressure changes may, of course, influence the behaviour of the heart in the intact animal, and may have some effect on the periodicity of reversal; but any such effect is superimposed on the pattern of reversal inherent in the heart.

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Millport.
April 30.

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Level of National Intelligence

THE results of the Scottish Mental Survey[1] presented a paradox which has been difficult to resolve. These results showed a small rise in mean intelligence test score in the eleven-year-old population over a period of fifteen years; but they also established the existence of a negative correlation between intelligence test score and family size—a tendency for intelligent children to be found in small families—which implies the danger of a possible decline in national intelligence, in so far as intelligence is inherited. Though the existence of this negative correlation has now been established, its cause is the subject of considerable controversy, and predictions of the future level of national intelligence depend on how far it can be attributed to a limiting of families by intelligent parents or to the depressive effect of a poor environment on the test scores of children from large families.

The former cause is suggested by the results of previous investigations in which attempts to hold constant such factors as parental occupation or overcrowding in the home have failed to dispel the negative correlation; but such methods are not adequate if the actual size of family is itself an environmental factor—if the lack of adult contact and consequent retardation in verbal development suffered by a child from a large family depress the environmental component of his test score. Such a hypothesis has been shown to be tenable in a survey I have carried out of some 7,600 Aberdeen children; it is consistent with findings in other fields, for example, in the comparison of orphanage children and only children, in studies of bilinguals, deaf children and twins; and model populations can be constructed to show how, on such a hypothesis, the paradox of the Mental Survey results may be resolved, the observed rise being due to improved conditions or to a greater proportion of small families.

While the practice of previous investigators has been to apply one intelligence test to as large a group of children as possible, the method I followed in the Aberdeen survey was to apply several tests with different verbal loadings to the same children. In two groups each of some 2,500 children, aged eleven the partial correlation between size of family and score in a test of English attainment (with intelligence test score held constant) was negative (about − 0·1) and significant in both groups at the 0·05 level. In a random sample of two hundred children aged eleven, the correlation between size of family and score in the non-verbal Matrices Test was − 0·20 while the correlation between size of family and score in a verbal Moray House Test was − 0·30, the difference being significant at the 0·05 level.

These results support the hypothesis that the environment of the large family constitutes a handicap to verbal development, and that this verbal retardation affects general mental development. If this were so, one would expect the negative correlation between intelligence test score and size of family to be more marked at later ages when the cumulative effect o environment begins to show itself; and this prediction was confirmed with tests applied at different ages The correlation between intelligence test score and size of family in an age-group of 1,236 children aged seven was − 0·26; in a similar age-group of 1,27 children aged nine it was − 0·29; and in four such age-groups totalling 5,168 children aged eleven i was − 0·33. The difference between the correlatio at age seven and at age eleven was significant a the 0·01 level, and was not attributable merely t incomplete families. In a group of 178 children wh were tested at ages seven, nine and eleven, confirmatory results were obtained, though the differenc between the correlations in this group was no significant because of the small numbers.

The results suggest that part of (but not all) th negative correlation of size of family and intelligenc test score, such as was found in the Mental Surve among children aged eleven, may be attributed t the environmental influence of the size of family o verbal ability and through it on general ment development. Fuller details of the results and the analysis will be published elsewhere.

JOHN D. NISBET

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May 24.

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[1] "The Trend of Scottish Intelligence" (London, 1949).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, November 17

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria mbankment, London, W.C.2), at 5.30 p.m.—Discussion on "The eld of Application of Metal Rectifiers" (to be opened by Mr. S. A. evens).

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, .C.2), at 6 p.m.—Dr. P. W. Brian: "Microbiology" (Cantor Lec-res). (Further Lectures on November 24 and December 1.)

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, W.7), at 8.15 p.m.—Lord Rennell of Rodd: "Kimberley Division Western Australia".

Tuesday, November 18

UNIVERSITY OF LONDON (in the Anatomy Theatre, University ollege, Gower Street, London, W.C.1), at 1.15 p.m.—Dr. Phyllis M. aberry "Gardening and Social Prestige in New Guinea".*

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the hemistry Lecture Theatre, Royal College of Science, Imperial stitute Road, London, S.W.7), at 2.30 p.m.—Dr. J. J. Lehr (Wagengen): "Sodium as a Plant Food".

EUGENICS SOCIETY (at the Royal Society, Burlington House, iccadilly, London, W.1), at 5.30 p.m.—Dr. Kenneth Hutton: "In-lligence Quotients and Differential Fertility—Some Observations om Winchester College".*

SCHOOL OF PHARMACY, UNIVERSITY OF LONDON (in the Meyerstein ecture Theatre, Westminster Medical School, Horseferry Road, ondon, S.W.1), at 5.30 p.m.—Prof. J. W. Cook, F.R.S.: "Organic hemistry at the Cross-Roads".*

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN OUNTIES SECTION (joint meeting with the POLYTECHNIC CHEMICAL OCIETY, at the Battersea Polytechnic, Battersea, London, S.W.11), 7 p.m.—Dr. H. J. Barber: "The Organic Chemist in Industry".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, ondon, W.1), at 7.30 p.m.—Discussion on "Direction Finding in nimals" (Chairman: Prof. James Gray, F.R.S.; Speakers: Dr. . V. T. Matthews (Birds), Dr. H. W. Lissmann (Fish), Mr. D. Wragge orley (Insects)).

Wednesday, November 19

INSTITUTE OF METALS (at the Royal Institution, 21 Albemarle treet, London, W.1), at 9.45 a.m.—Symposium on "Properties of etallic Surfaces".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, .W.7), at 5 p.m.—Scientific Papers.

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene nd Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—r Ronald Fisher, F.R.S.: "The Expansion of Statistics" (Inaugural ddress of the President).

ROYAL MICROSCOPICAL SOCIETY (at the Cavendish Laboratory, ambridge), at 5.30 p.m.—Dr. V. E. Cosslett: "X-Ray Microscopy".

BRITISH ORNITHOLOGISTS' UNION (in the Lecture Hall, British useum (Natural History), Cromwell Road, London, S.W.7), at p.m.—Annual Scientific Meeting.

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN OUNTIES SECTION (at University College, Gower Street, London, .C.1), at 6.30 p.m.—Annual General Meeting; The President: Theory and Practice".

ROYAL METEOROLOGICAL SOCIETY, MIDLAND CENTRE (at the Birmgham and Midland Institute, Paradise Street, Birmingham), at 15 p.m.—Mr. H. Shaw: "The Recording of Earthquakes".

Thursday, November 20

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), 4.30 p.m.—Special General Meeting to consider the Annual Report Council; Prof. A. J. Kluyver, For.Mem.R.S.: "The Changing ppraisal of the Microbe" (Leeuwenhoek Lecture).

INSTITUTION OF MINING AND METALLURGY (at the Geological ociety, Burlington House, Piccadilly, London, W.1), at 5 p.m.—r. J. B. Dennison and Mr. W. W. Varvill: "Prospecting with the iamond-Drill for Lead–Zinc Ores"; Mr. R. J. M. Dixie and Mr. M. Dover: "The Development of Rotary Blast-Hole Drilling in e Jurassic Rocks of Lincolnshire".

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, ondon, W.1), at 5 p.m.—Miss Katharine Tousey: "Audubon's merica" (colour film); Dr. E. Schelpe: "Vegetation in the Kangra malaya" (colour film).

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical ciety, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Annual neral Meeting; Prof. G. F. S. Temple, F.R.S.: "Theories and pplications of Generalized Functions" (Presidential Address).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Dr. D. H. R. Barton "The Chemistry of the Steroids". urther Lectures on November 27, December 4 and 11.)

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION t Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. Mr. C. A. Cameron-Brown and Mr. P. G. Finn-Kelcey: "Electricity Farm Crop-Drying".

RESEARCH DEFENCE SOCIETY (in the Physiology Lecture Theatre, iversity College, Gower Street, London, W.C.1), at 5.30 p.m.—Howard Florey, F.R.S.: "The Advance of Chemotherapy by imal Experiment" (Twenty-first Stephen Paget Memorial Lecture).

SOCIETY OF CHEMICAL INDUSTRY, ROAD AND BUILDING MATERIALS GROUP (at the Building Centre, Store Street, London, W.C.1), at 6 p.m.—Dr. F. R. Jones "Alkali-Aggregate Interaction in Concrete".

SOCIETY OF CHEMICAL INDUSTRY, MICROBIOLOGY GROUP (joint meeting with the FOOD GROUP, at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.15 p.m.—Discussion on "Technical Problems associated with Microbiological Standards for Foods."

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W.1), at 7 p.m.—Mr. L. H. Leavy and Mr C. J. Saunders: "The Design of a Wind Tunnel Balance".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Mr. H. M. Powell: "The Chemistry of Intermolecular Compounds" (Tilden Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the Liverpool School of Tropical Medicine, Pembroke Place Liverpool), at 7.30 p.m.—Laboratory Meeting.

Friday, November 21

TEXTILE INSTITUTE (at 10 Blackfriars Street, Manchester), at 3 p.m.—Sir Wallace Akers, F.R.S.: "The Chemical Industry and Textiles".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Geophysical Discussion on "The Electrical Conductivity of the Upper Atmosphere". (Chairman: Mr. J. A. Ratcliffe, F.R.S.; Speakers: Prof. S. Chapman, F.R.S., Prof. D. R. Bates, Prof. T. G. Cowling, F.R.S.)

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. W. A. W. Fox and Mr. D. Barnett: "The Vertical Reference in Navigation".

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the APPLIED MECHANICS GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. K. J. B. Wolfe: "Recent Developments in the Machinability of Steel".

ROYAL SOCIETY OF MEDICINE, RADIOLOGICAL SECTION (at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Dr. G. W. Blomfield "Experience with Two Million Volt X-Ray Therapy and a Preliminary Assessment of Clinical Results"; Dr. J. F. Mitchell: "Experience with 30 MeV. Synchrotron as a Radiotherapeutic Instrument".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. C. T. Wilkins: "The Comet".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

JOINT INTELLIGENCE BUREAU OFFICERS, Grade II, Ministry of Defence (with a university degree, preferably a good honours degree, or equivalent academic qualification or corporate membership of a professional body) for research work of university type on matters of defence interest—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 4169/52 (November 20).

EXPERIMENTAL OFFICER, Grade I, IN THE AERONAUTICAL RESEARCH LABORATORY, Fishermen's Bend, Victoria, to assist in the conduct of flight and laboratory tests on aircraft, to analyse the performance of components, and to prepare and calibrate the necessary equipment—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (November 22).

GRADUATE ASSISTANT SCIENCE MISTRESS at Lady Edridge Grammar School, South Norwood—The Chief Education Officer, Education Office, Katharine Street, Croydon, Surrey (November 22).

PHYSICIST TO THE RADIOTHERAPY DEPARTMENT—The Secretary, Romford Group Hospital Management Committee, Oldchurch Hospital, Romford, Essex (November 22).

PHYSIOLOGIST (with a good honours degree in physiology or an equivalent qualification, and research experience preferably involving the perfusion of isolated organs) for research on the bovine udder—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 52/11 (November 22).

RESEARCH STUDENT (university graduate, preferably a physiologist) in the Birmingham and Midland Eye Hospital, Birmingham, for work in connexion with hereditary ocular disease—The Secretary, Dudley Road Hospital, Birmingham 18 (November 22).

SCIENTIST, Grade III (with an honours degree in chemistry, with two or three years experience of precise analytical work, and interested in development of new methods of analysis, and investigational and research work), and a SCIENTIFIC TECHNICAL OFFICER, Grade III (qualified N.C. standard, and interested in electronics, workshop practice and general physics)—The Divisional Establishment Officer, National Coal Board, North-Western Division, 40 Portland Street, Manchester 1 (November 22).

SCIENTISTS (with a first- or second-class honours degree in electrical or mechanical engineering, or in physics, and preferably some research experience) for testing, development and research work in the laboratories and in the field in connexion with the generation, transmission and distribution of electricity—The Director of Establishments, British Electricity Authority, British Electricity House, Winsley Street, London, W.1, quoting AE/299 (November 24).

ASSISTANT LECTURER IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, St. Mary's Hospital Medical School, Paddington, London, W.2 (November 29).

LECTURER IN THE DEPARTMENT OF PHYSICS—The Registrar, University College, Leicester (November 29).

ASSISTANT RESEARCH BIOCHEMIST IN THE SPECIAL UNIT FOR JUVENILE RHEUMATISM, for studies on connective tissue—The Hospital Secretary, Canadian Red Cross Memorial Hospital, Taplow, Maidenhead (November 30).

Scientists, Grade I (chemists, physicists or, preferably, physical chemists, with not less than a second-class honours degree and a good theoretical knowledge and acquaintance with modern laboratory instruments and techniques) to supervise research on a laboratory scale into known and novel methods of separating coal from shale and other unwanted materials (Ref. TT/559); Scientists, Grade II/III, with good honours degree, or equivalent, in chemistry, preference being given to physical chemists (Ref. TT/554); Scientific Technical Officers, Grade II/III (chemists or physicists, preferably of degree or H.N.C. standard), to assist in coal carbonization studies and associated analyses of coals, cokes and gases (Ref. TT/555); at the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (December 1).

Research Assistant (honours graduate in mining or physics) to the Professor of Mining, and a Demonstrator (graduate in physics or mathematics) in the Postgraduate School of Mining—The Registrar, The University, Sheffield (December 6).

Plant Pathologist (with a Ph.D. in plant pathology, considerable research experience in the control of diseases of agricultural crops is preferable)—The Secretary, Tobacco Research Board, P.O. Box 1909, Salisbury, Southern Rhodesia (December 15).

Physicists and Chemists (with good honours degree, or equivalent) at the Central Research Establishment, Stoke Orchard, Cheltenham, for laboratory investigations on the surface characteristics and associated properties of coal and allied materials as applied to briquetting:—Scientist, Grade II, to take charge of the laboratory investigations (Ref. TT/560), a Scientist, Grade III (Ref. TT/561), and Scientific Technical Officers, Grade II (Ref. TT/562)—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (December 29).

Dean of Trinity College (University of Melbourne)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 30).

Biochemist in the Clinical Laboratories of the Oldham Group of Hospitals—The Group Pathologist, Department of Clinical Pathology, Boundary Park General Hospital, Oldham.

Deputy Head of the Department of Aircraft Propulsion—The Registrar, College of Aeronautics, Bletchley, Bucks.

Engineer (Senior Scientific Officer grade) at a Ministry of Supply Experimental Establishment at Christchurch, Hants, dealing with design and development of military bridging and associated equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting B.453/52.

Irrigation Engineer in the Water Development Department, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSD.64/8/02.

Physicist interested in mechanics and engineering, for study and instrumentation of felting machines—The Director British Hat and Allied Feltmakers' Research Association, Stanley House, Manchester Road, Fairfield, Droylsden, Manchester.

Physicists or Electrical Engineers at the Royal Aircraft Establishment, Farnborough (*a*) in charge of small team developing electronic equipment for guided missiles (Ref A.281/52A), (*b*) for design and development in physics and engineering fields of guided weapon control, probably involving association with experimental missile trials and with radar and other electronic techniques (Ref. A.282/52A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

Research Assistant in the Electronics Section—The Research Manager, Motor Industry Research Association, Proving Ground, Lindley, Nuneaton.

Science Graduate (preferably in physics) to undertake abstracting of technical literature, preparation of literature surveys and other technical intelligence work—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

Senior Physicist to work in the Spinning Department, in the first instance on the physics of the generation of tension in the yarn in ring spinning—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20.

Senior Physicist (with good honours degree plus research experience, and an interest in the application of research to practical problems) for investigations mainly on the elastic and viscous properties of rubbers—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Pitt Rivers Museum: University of Oxford. Occasional Papers on Technology, 5: Pictures of Ivory and other Animal Teeth, Bone and Antler; with a Brief Commentary on their Use in Identification. By T. K. Penniman. Pp. 40+20 plates. (Oxford: Pitt Rivers Museum, 1952.) 10s. [307

The Worker's Point of View: a Discussion of 'Reporting Back' based on a Study in a Coalfield. (Nationalized Industry Series 11.) Pp. iv+32. (London: Acton Society Trust, 1952.) 2s. [307

Research and Development in British Industry: a Survey of Expenditure on Industrial Research and Development in the Year 1950–51 made by the F.B.I. Industrial Research Committee. Pp. 19. (London: Federation of British Industries, 1952.) 1s. 3d. [68

Question: a Journal. Edited by H. Westmann. Vol. 4, No. 3: Freedom and Responsibility? By R. H. S. Crossman, the Earl of Verulam, A. H. Cartby and Edwin Barker. (Published for the Present Question Conference, Ltd.). Pp. 217–304. (London: Hammond, Hammond and Co., Ltd., 1952.) 2s. 6d. [13

A Guide to Blakeney Point and Scolt Head Island. Edited by Prof. J. A. Steers. Pp. 56+12 plates. (London: National Trust, 1952.) 3s. 6d. [19

Bulletin of the British Museum (Natural History). Geology, Vol. 1 No. 7: A New *Trochiliscus* (Charophyta) from the Downtonian of Podolia. By W. N. Croft. Pp. 187–220+plates 18–19. (London British Museum (Natural History), 1952.) 10s [19

Department of Scientific and Industrial Research: Food Investigation. Special Report No. 56: The Dehydration of English Fruit By Dr. C. West, Dr. A. C. Hulme, C. R. Furlong and G. H. Crouch Pp. iii+42. (London: H.M. Stationery Office, 1952.) 1s. 6d. net. [19

Register of Research in the Social Sciences in Progress and in Plan No. 9, 1951–1952, with a Directory of Research Institutions. Editor Feodora Stone. Prepared at the National Institute of Economic and Social Research. Pp. 188. (London: Cambridge University Press, 1952.) 15s. [19

General Register Office. The Registrar General's Quarterly Return for England and Wales. No. 413: Births, Deaths and Marriages Infectious Diseases, Weather, Survey of Sickness, Population Estimates; Quarter ended 31st March 1952. Pp. 48. (London: H.M. Stationery Office, 1952.) 2s 6d. net. [19

Council for the Preservation of Rural England. Annual Report 1951–52. Pp. 50+4 plates. (London: Council for the Preservation of Rural England, 1952.) [19

Other Countries

Bulletin of the Museum of Comparative Zoology Vol. 106, No. 10 Foraminiferal Distribution in the Long Island Sound—Buzzards Bay Area. By Frances L. Parker. Pp. 425–474+plate 5. Vol. 106, No. 11 Revisionary Studies of some South American Teiidae. By Rodolfo Ruibal. Pp. 475–530. (Cambridge, Mass.: Harvard College 1952.) [30

Smithsonian Institution. Bureau of American Ethnology. Bulletin 147: Journal of an Expedition to the Mauvaises Terres and the Upper Missouri in 1850. By Thaddeus A. Culbertson. Edited by John Francis McDermott. Pp. viii+164. 75 cents. Bulletin 148 Arapaho Child Life and its Cultural Background. By Sister M. Inez Hilger. Pp. xv+253+40 plates. 75 cents. (Washington, D.C. Government Printing Office, 1952.) [30

Bulletin of the American Museum of Natural History. Vol. 99 Article 3: The Problem of Land Connections across the South Atlantic with Special Reference to the Mesozoic. By Ernst Mayr (Editor) Maurice Ewing, Walter H. Bucher, Kenneth E. Caster, Carl O Dunbar, Marshall Kay, George Gaylord Simpson, Daniel I. Axelrod Theodor Just, Wendell H. Camp, P. J. Darlington, Jr., Alfred E. Emerson Bobb Schaeffer, David H. Dunkle, Edwin H. Colbert and Alfred S Romer. Proceedings of the Symposium on 'The Role of the South Atlantic Basin in Biogeography and Evolution' held at the Fourth Annual Meeting of the Society for the Study of Evolution, New York City, December 28 and 29, 1949. Pp. 79–258+2 plates. (New York American Museum of Natural History, 1952.) 3 dollars. [30

Beach Erosion Board. Corps of Engineers. Technical Memorandum No. 27: Wind Set-up and Waves in Shallow Water. By Thorndike Saville, Jr. Pp. iv+36. (Washington, D.C.: Government Printing Office, 1952.) [30

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien Band 3, No. 1: Recent Lymnaeidae; their Variation, Morphology Taxonomy, Nomenclature and Distribution. By Bengt Hubendick Pp. 223+5 plates. 25 Kr. Fjärde Serien, Band 3, No. 2: Kolchizin induzierte Heteroploidie beim Schwein. Von Gosta Häggqvist und Allan Bane. Pp. 14. 2.25 Kr. (Stockholm: Almquist and Wiksell London: H. K. Lewis and Co., Ltd., 1951.) [31

Commonwealth Observatory, Canberra. Report of the Commonwealth Astronomer for the Year 1950. Pp. 5. Supplement to the Report of the Commonwealth Astronomer for the Year 1950. Pp 11+7 plates. Report of the Commonwealth Astronomer for the Year 1951. Pp. 5. (Canberra: Commonwealth Government Printer 1951–1952.) [31

Commonwealth Observatory, Canberra. Memoir No. 11: Solar Radiation Observations on Mount Stromlo, 1927–1939. By W. B Rimmer and C. W. Allen. Pp. 42. (Canberra: Commonwealth Government Printer, 1950.) [31

Beihefte zum Geologischen Jahrbuch. Heft 3: Monographien der Deutschen Blei-Zink-Erzlagerstätten, Monographie 1, Die Blei-Zink Erzvorkommen des Ruhrgebietes und seiner Umrandung. Von Friedrich Buschendorf, Julius Hesemann, Andreas Pilger und Ma Richter. Lieferung 1. Pp. viii+184+18 plates. (Hannover: Am für Bodenforschung, 1951.) 20 D. marks. [18

Ceylon. Part 4: Education, Science and Art (L). Administration Report of the Acting Director of Fisheries for 1951. By E. R. A De Zylva. Pp. L 30. (Colombo: Government Publications Bureau 1952.) 10 cents. [19

Bulletin of the World Health Organization. Supplement 4: Comparability of Statistics of Causes of Death according to the Fifth and Sixth Revisions of the International List. Pp. 59. (Geneva World Health Organization; London: H.M. Stationery Office, 1952 2s. 9d.; 50 cents; 2 francs. [1

Catalogues

Osram Lamps in the Making. Pp. 24. (London: General Electr Co., Ltd., 1952.)

Michrome Biological Stains and Reagents. Pp. 42. (London Edward Gurr, Ltd., East Sheen, 1952.)

Sunvic Boiling Plates. (Publication BP.10a.) Pp. 4. (London Sunvic Controls, Ltd., 1952.)

'Speedivac' Pumping Units for Pipeline Vacuum Systems. (A.106/ Pp. 4. High Pressure Compressors and Vacuum Pumps. (A.111/ Pp. 2. 'Speedivac' Physics Educational Equipment Models EQ1 an EQ2. (A.116/1.) Pp. 6. Circseal Precision Glass Cone Joints f High Vacuum. (C. 103/1.) Pp. 2. Vacuum Pumping Outfit (E.112/1.) Pp. 6. (London: W. Edwards and Co. (London), Ltd 1952.)

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PRESERVATION OF GEOLOGICAL SITES

BILSTON GLEN

"THE geologist is concerned fundamentally with observation, that is, with the systematic recording of phenomena as they present themselves to him"; so commented Dr. J. E. Richey in his presidential address to Section C (Geology) of the British Association at the recent Belfast meeting (*The Advancement of Science*, 9, No. 34, 122; September 1952). For this reason the geologist must continually be returning for study to the rock exposures that provide him with the material for his 'patterns of evidence'. The importance of preserving, so far as possible, geological sites of outstanding scientific and educational value was recognized by the Council of the eighteenth session of the International Geological Congress, by a unanimous recommendation, endorsed by the General Assembly of the Congress on August 30, 1948, to the governments of all countries represented at the Congress, to take legislative action, if they had not already done so, to safeguard such sites and to secure reasonable access to them[1].

The geological record has often been compared with an obscure and mutilated document, from the surviving remnants of which the geologist must piece together, as best he may, the history of the earth. Here and there natural sections yield exceptionally clear narratives of episodes in that history, and it is such sections that it is especially important to preserve as standards of comparison with more fragmentary records.

Such a standard section has been provided by the Bilston Burn where, about five miles south-south-east of the centre of Edinburgh, but less than a mile from the city boundary, it crosses the upturned strata on the western flank of the Midlothian syncline. Rising east of the Pentland Hills, the Bilston Burn passes under the Edinburgh to Peebles road at Bilston and enters a ravine which, about a mile farther east, attains a depth of about 150 ft. This ravine has come to be called the Bilston Glen; but the old name for it is Dryden, and this is the name by which it was known to Sir Walter Scott, who for a few years lived at Lasswade, in the same parish. Hugh Miller described it thus: "There is not a prettier dell in the south of Scotland than that of Dryden. . . . Dryden is a winding valley overhung by precipitous banks and stately wood, that opens into the wider valley of the Esk, and exposes, in its course, a series of strata singularly interesting to the geologist"; and, again: "I have already referred to the Marine Limestones of Dryden,—one of the best sections of the formation as developed in Scotland which I have anywhere seen"[2].

Dryden, or Bilston Glen, still retains much of its charm, and since Hugh Miller's time it has been frequently resorted to by geologists wishing to study the Scottish development of the Carboniferous rocks, not only from the Edinburgh district but also from all parts of Great Britain and from foreign countries.

Indeed, a geological excursion to the Edinburgh district can scarcely be considered complete without a visit to the Bilston Burn. Its easy accessibility and proximity to Edinburgh have made it especially valuable for demonstration to university students. The range of Carboniferous strata exposed in the glen is unrivalled by any other inland section in Scotland and by few elsewhere in Great Britain. This is due to the prevailing high easterly dip, which averages more than 45°, the Bilston Burn crossing the outcrops nearly at right angles to the strike. Thus, in the stretch of about a mile and a quarter east of the Edinburgh–Peebles road, the strata traversed by the Bilston Burn range from the top of the Calciferous Sandstone Series, through the Lower Limestone, Limestone Coal and Upper Limestone Groups, into the Millstone Grit (Roslin Sandstone), comprising a thickness of nearly 3,400 ft. of beds. Though more spectacular, not even the famous section of the Avon Gorge at Bristol reveals so great a thickness, or a much greater stratigraphical range, of Carboniferous strata.

Exposures in the Bilston Glen are not continuous; but they are sufficiently numerous for a tolerably complete record to have been compiled over the years during which the section has been studied—a record, however, which is even now being amended and added to. Many fossiliferous bands have been located and collected from, and among the most interesting are those in the lower part of the Millstone Grit, the fossils of which closely resemble forms found in the Coal Measures of Nebraska and Illinois, from which circumstance the assemblage has been called the 'Nebraskan Fauna'[3]. The known fossil horizons in the Bilston Glen include nearly all those named bands which serve as index beds in the Scottish Lower Carboniferous sequence; but the presence of some of these bands has only quite recently been established. A natural section such as this, with an active stream and unstable banks, must change somewhat from decade to decade; hence, so long as the glen remains accessible, there will always be the possibility of new discoveries.

The Bilston Glen, then, provides a type section with which to compare the variations of the Lower Carboniferous sequence elsewhere in Scotland. This is not only important from the purely scientific point of view, but is also of great practical value for the mining industry, for the comparison can be made with sections in mine-roads and with the cores of exploratory borings. The utility of such a type section in the training of students who may later apply their stratigraphical knowledge to the solution of mining problems should require no emphasis.

Nevertheless, more than half of this type section is threatened with obliteration. A new colliery, named (perhaps with unconscious irony) "Bilston Glen Colliery", is being sunk on the north side of the Bilston Glen to work the large reserves of coal in the Limestone Coal Group of the district, and it has been planned to dispose of the spoil by filling up the adjacent Glen. Since, in the late summer of 1950, this project became generally known, protests against the spoliation of the Bilston Glen have been registered by scientific bodies, including the Geological Societie of Edinburgh, Glasgow and London and the Britis Association for the Advancement of Science. Mindful no doubt, of the threatened loss of a feature o natural beauty in an area already losing its rura character, the Association for the Preservation o Rural Scotland supported the protest made by th Edinburgh Geological Society. Further, the Natur Conservancy took up the cause of the Bilston Gle in an endeavour to secure its conservation as Nature reserve.

So far, however, these efforts seem to have resulte in no more than a temporary and partial reprieve By a decision of the Minister of State for Scotland made in March of this year, the National Coal Boar has been given permission to use part of the Glen fo the dumping of colliery refuse during the next ten o fifteen years. At the end of this period the possibilit of transferring dumping to another site is to be considered; but, if this is found to be impracticable the Coal Board is to be allowed to use an adjacen part of the Glen, farther down stream, and will b asked to consider whether a third portion, west o that to be used first, could also be filled in with spoil If it is not thought practicable to use another site fo dumping now, it is, perhaps, scarcely likely that i will seem more practicable ten or fifteen years hence when the Coal Board has already been using part o the Bilston Glen for that period. The Minister' decision thus seems virtually to condemn a larg portion of the Glen to destruction. This include what is, perhaps, the most valuable part of th geological section, comprising more than 2,000 ft. o strata and including the whole of the Lower Limestone and Limestone-Coal ("Edge Coal") Groups.

All this part of the Bilston Glen would scarcel accommodate as much as half the total amount o spoil that it is estimated will be produced during th hundred years life of Bilston Glen Colliery. Soone or later, then, some other means of disposing of th refuse must be devised. Is it too much to hope tha even now, more far-sighted counsels may prevail and that the picturesque Dryden, with its class geological section, may be spared for posterity ?

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[1] International Geological Congress. Report of the Eighteenth Sessio Great Britain, 1948; Part 1, General Proceedings, 1950; p. 1

[2] Miller, Hugh, "Edinburgh and its Neighbourhood, Geological a Historical", pp. 71 and 85 (posthumously published, fourth edi Edinburgh, 1870).

[3] Hind, W., "The Lamellibranch and Gastropod Fauna in the M stone Grit of Scotland", *Trans. Roy. Soc. Edin.*, 46, 332 (190

HORSES

Horses

The Story of the Horse Family in the Modern Wor and through Sixty Million Years of History. I George Gaylord Simpson. Pp. xxiv+247+32 plat (New York and London: Oxford University Pre 1951.) 40*s*. net.

SO much of human history has been determined b the existence of domesticated horses that the animals have gained a unique place in folk-lore a in the affections of many men. The horse w apparently domesticated early (probably many tim in the area of distribution of wild horses from Euro to China, and it is probable that selective breedi has long been practised to produce horses fit not only for ordinary life, but also for war. Arabs and Genghis Khan's 'Golden Horde' owed their conquests to well-designed cavalry tactics, and these were dependent on speed and toughness.

Of such specialized breeds the most distinguished is the Arabian. Long inbred in the desert, with pedigrees carefully kept, the Arab horse played its essential part in the development of the Thoroughbred; and the Thoroughbred horse has contributed to light horses all over the world.

G. G. Simpson gives in this book a very condensed but admirable account of the domestic horses, especially of Britain and the United States. He then passes on to consider the colour of horses, especially in American use where there are names—Pinto, Appaloosa and Palomino—which are strange to an Englishman. A Palomino is a horse with a silver mane and tail and a golden body, its body shape being undefined; none the less, Dr. Simpson points out that two independent associations, of the nature of breed societies, exist in the United States. It seems very doubtful if the Palomino colour can exist in a homozygous form; it is normally heterozygous and cannot breed true. Simpson gives a very simple and clear account of the genetics of the condition as determined by W. E. Castle.

From here the book goes on to describe the history of the horse in geological time. The first attempt to do so was in 1872 when T. H. Huxley brought together *Palæotherium*, *Anchitherium*, *Hipparion* and *Equus* as animals which, put in the order of age, formed a graded series in the structure of their teeth and feet; and he suggested that this might be a real example of the evolution of an animal. A year later Kovalevsky, after a much more detailed study, agreed with Huxley and in 1876 carried the matter still further, still using European materials. In fact, none of these animals is in the direct line of the horse; they are aberrant lateral twigs, which nevertheless conform in many characters to true horse ancestors of the same, or often a slightly earlier, stage. Actually, in 1874, O. C. Marsh, of Yale University, claimed to have a series of fossils which lay in the direct line of descent and supplied every important form. In 1876 Marsh demonstrated these materials to Huxley, who immediately accepted his conclusions.

Since then, immense collections of fossil horses and horse ancestors have come from all the continents except Australia, and nearly all vertebrate palæontologists have published something about them. Under the influence of H. F. Osborn, the American Museum of Natural History became the great centre of work on these animals, and for many years W. D. Matthew's little guide to the Museum collection has been the best account of the whole story. This booklet, now out of print, is obsolete, and in the present very readable volume Dr. Simpson gives a most admirable account of the whole history—not of course in detail, for that would mean many thousands of pages of text and of figures, but in outline. He considers not only the actual structural changes, but also the functional effect of these changes in increasing the weight which can be supported by the food which can be ground up by the dentition, and the significance of the structural changes in the feet.

The book is thus authoritative, wide-ranging and easy to read, and it should be read by everyone who is interested in evolution and the mechanism by which it has been brought about.

D. M. S. WATSON

PROGRESS IN NUCLEAR SCIENCE

Annual Review of Nuclear Science

Vol. 1. Pp. x+645. (Stanford, Calif.: Annual Reviews, Inc.; London: H. K. Lewis and Co., Ltd., 1952.) 6 dollars.

ONE index of the increase in the rate of accumulation of scientific information is the post-war efflorescence of reviews and surveys. In physics alone, for example, there have appeared "Progress in Metal Physics", "Progress in Biophysics", "Progress in Cosmic Ray Physics", and so on. Annual Reviews, Inc., of Stanford, California, have for some time published "Annual Reviews of Biochemistry"; now a new series commences, the "Annual Review of Nuclear Science".

The objective of the editors is the preparation of a series of annual review volumes covering the most important developments in the field of nuclear science each year. For the first year (1950), they have certainly cast their net wide. Thus, while about half the book is devoted to physical topics, the other half includes the separation of stable isotopes; metallurgy; actinide elements, and analytical nuclear chemistry; radioisotopes in chemical systems, in biochemical research and in soils research; geochemistry; stable isotopes in biochemical research; and the genetic and biological action of radiation. Of these, some (especially the article on progress in metallurgy) are clear and concise; but in general the articles are too technical to satisfy the average physicist, while probably not detailed enough to satisfy, say, the plant biologist who would otherwise feel that the book is heavily weighted in favour of the other sciences. A better approach might be to restrict individual volumes to individual fields of nuclear science.

The volume, therefore, is presented to that versatile individual, the nuclear scientist, and one might expect the level of the average essay to be that of postgraduate standard. The approach of the various authors, however, varies widely. Thus, on one hand, the article on energy-levels of light nuclei goes to the length of explaining the meaning of the notation $^7\mathrm{Li}(d\alpha)^5\mathrm{He}$; whereas, on the other hand, that on the theory of nuclear structure is addressed to the specialist rather than to the general reader.

Nevertheless, the general impression is that the venture is successful and the effort well worth while. The volume makes an excellent start with an article on meson physics, which is an admirable survey of the subject; supported later by one on the nuclear interaction of cosmic rays. Stable isotopes are discussed in three articles, and high-energy accelerators in five; the essay on the detection of nuclear particles is concise and practical. That on nuclear moments is a little disappointing—one feels that a fascinating field is rather summarily dismissed. In contrast, the article on atomic and molecular spectroscopy is a clear exposition of recent developments in a well-ploughed field. Finally, there is an essay on low-temperature phenomena, which is perhaps an interloper in a volume on nuclear science; but it is so well written, in its sketch of background and review of recent development, that its inclusion is amply justified.

The format is excellent and errors few. No British reader, however, will fail to be interested to learn (p. 178) that a 140-MeV. synchrotron is under construction at "Oxford University, Cambridge, England".

W. D. ALLEN

LAND RECLAMATION

Reclaiming Land for Agriculture

By Moses Griffith, J. F. H. Thomas and R. Line. (Agricultural and Horticultural Series.) Pp. 119+16 plates. (London: Crosby Lockwood and Son, Ltd., 1951.) 12*s*. 6*d*. net.

TO those who can recall the time when meat, cheese and eggs were basic articles in the Englishman's diet, this book will bring hope that their children may live to see those conditions restored. The wastage of our greatest, and potentially inexhaustible, source of wealth—the land—is a national scandal. Mr. Moses Griffith estimates that there are five million acres of hill and moorland alone in Britain "capable of very substantial improvement", and he and Messrs. J. F. H. Thomas and R. Line show that the task of reclamation with modern implements and technique would not be difficult on the hill land, the chalk land and the fen and silt land which they respectively discuss.

Sir George Stapledon, in a comprehensive introduction, points to the very high cost of land reclamation and emphasizes the economic importance of regional planning, and of intensive study of plant and animal ecology, not forgetting human requirements; for unless men and women find social satisfaction on the reclaimed land, it will revert to waste. It is to be hoped that a people which spent nearly £40 million on almost fruitless land reclamation in East Africa will not be deterred by the initial cost from replenishing its larder from its own soil.

It is on the intrinsically infertile, and often inaccessible, hill lands that the economic factor is most intractable. The crawler tractor and other machines have, however, greatly facilitated the task of cultivation, and the aeroplane should equally help to solve the problem of fertilizing these lime- and phosphate-starved soils. Work at Aberystwyth has shown that remarkable improvement can often be effected by ploughing and reseeding with improved herbage, usually after a pioneer crop like rape which is grazed to provide dung and consolidation of the soil by stock. Mr. Griffith leaves the impression that, although many intricate questions remain unanswered, enough success has already been achieved to make very large-scale reclamation of hill land a practical proposition now.

Reclamation of chalk land presents rather easier problems. Much of the land has been highly farmed with sheep in the past and has only recently become partly or completely derelict. Considerable areas were cultivated to exhaustion during the First World War, and these could be restored to productivity fairly easily with adequate fertilizing. Among the major tasks are the clearance and disposal of scrub growth on abandoned land, much of it of high productivity, and the restoration of the rich valley pastures. There is scope for intensification of both arable and livestock farming, and the appropriate land management is better understood than is the case on mountainous hill land.

In the Fen country "the cost of reclamation of the fen is not such an important consideration as the returns per acre that can be expected from this very exceptional soil". Around the Wash there are a hundred square miles of this country awaiting enclosure and development. Good drainage is the key to fenland farming, and much reclaimed land has been allowed to go derelict through neglect of drains. Methods of reclamation and management are well understood, and what are chiefly needed are men, money and machinery. It is to be hoped that the Government will give high priority to this first line of defence—at least as vital to our security as rearmament, for the imperative need to grow our own food will always remain, whatever the international outlook.

G. V. JACKS

THE HORMONES

A Symposium on Steroid Hormones

Edited by Edgar S. Gordon. Pp. xiii+396. (Madison, Wis.: University of Wisconsin Press, 1950.) 6.50 dollars.

Recent Progress in Hormone Research

The Proceedings of the Laurentian Hormone Conference. Vol. 5. Edited by Gregory Pincus. Pp. viii+537. (New York: Academic Press, Inc., 1950.) 8.80 dollars.

The Hormones

Physiology, Chemistry and Applications. Edited by Gregory Pincus and Kenneth V. Thimann. Vol. 2. Pp. ix+782. (New York: Academic Press, Inc., 1950.) 12.50 dollars.

Vergleichende Physiologie

Von Prof. W. von Buddenbrock. Band 4: Hormone. (Lehrbücher und Monographien aus dem Gebiete der exakten Wissenschaften: Reihe der experimentellen Biologie, Band 9.) Pp. 492. (Basel: Verlag Birkhäuser, 1950.) 47.50 Swiss francs.

THE first three of these four volumes were published in the United States in 1950, and to some extent cover the same ground. The fourth is a German work which deals with less-recent endocrinological knowledge.

The "Symposium on Steroid Hormones" is a report of a conference which took place at the University of Wisconsin in 1949, and is concerned with the chemistry, biosynthesis and metabolism of steroid hormones and with their physiological effects. Some of the facts presented at the conference have not previously been published, so that, in addition to a general review, the volume edited by Dr. E. S. Gordon will need to be referred to as a source book of original observations. The ground covered by the contributors to "Recent Progress in Hormone Research", Vol. 5, which is a report of the proceeding of the Laurentian hormone conference for 1949, i much the same as that which was explored at th Wisconsin conference for 1949, and again a larg number of the contributions deal to a considerabl extent with new observations.

Neither of these meetings was concerned to cove the whole field of hormone research. This is th purpose of the two volumes published under the titl of "The Hormones", and edited by Gregory Pincu and Kenneth V. Thimann. Vol. 1 appeared in 194 and dealt with plant hormones; hormones i invertebrates; the internal secretion of the pancreas and various aspects of the steroid hormones, as we as with the chemistry of the anterior pituitary hor mones. Vol. 2 deals with the physiology of ovaria hormones; of androgens; of the adrenal cortex; the thyroid; of the pituitary hormones; as well with the chemical control of nervous activity; an concludes with a section on clinical endocrinolog In their preface, the editors point out that any wor in which separate sections are contributed b different experts runs a risk of being disproportionate in its emphasis. While admitting this danger, they also suggest that the two volumes for which they are responsible nevertheless provide a fairly complete presentation of the subject "at the research level". They can be confident that this is so, and students of endocrinology are greatly in their debt for having undertaken so formidable a task.

Vol. 4 of "Vergleichende Physiologie", by Prof. W. von Buddenbrock, of the University of Mainz, is in an entirely different class. Its purpose is not clearly stated, and it is far less comprehensive in its references to modern literature than any one of the three American volumes referred to above. It is the fourth of a series on comparative physiology, of which the first two were written before the Second World War, and the third was in the press when the War began. The present volume was undertaken at a time when the author did not have access to work that was being carried out either in Great Britain or in the United States, and was brought 'up to date' during only a five-week stay in Switzerland, when Prof. von Buddenbrock had access to the more recent literature. Although published in 1950, the result is that there is an almost negligible record of work published after 1946. The book has a zoological, as opposed to an endocrinological or clinical, orientation, and will be of value to research workers in American and British laboratories who wish to obtain a synopsis of endocrinological research carried out on the Continent of Europe up to the year 1939.

THE PHASE RULE

Principles of Phase Equilibria

By F. E. W. Wetmore and D. J. LeRoy. (International Chemical Series.) Pp. x+200. (London: McGraw-Hill Publishing Co., Ltd., 1951.) 30s.

The Phase Rule and Heterogeneous Equilibrium

By Prof. John E. Ricci. Pp. xi+505. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1951.) 90s. net.

THE introduction of the phase rule into chemistry dates from 1884, when Bakhuis Roozeboom, working in the laboratory of van Bemmelen in Leyden n hydrates of sulphur dioxide, had his attention directed by van der Waals to a rather obscure and brief passage in a paper by Willard Gibbs, published n 1876, which contains the key to the systematic tudy of heterogeneous equilibria. Since then it has proved of inestimable service in many fields. The rst intelligible account of it was given by Roozeoom, and the clear survey by Findlay is still one of he best books for the student. The two books here nder review are intended to help students to undertand and appreciate what is undoubtedly one of the major branches of physical chemistry. Many find the ubject rather unattractive in comparison with other elds of study, since it offers no scope for hypotheses nd does not involve what may be called modern spects of the science, based on new knowledge of tomic and molecular structure. Still, no one can ford to neglect a subject which can and does play n important part in chemical industry, and a good ook on it should always find a welcome.

F. E. W. Wetmore and D. J. LeRoy's book is oncerned mainly with fundamental principles, resented in a form based on experience and making use of thermodynamics. It is intended for students in other subjects, such as arts and engineering, as well as chemical students. The treatment is elementary, and the bright students may find parts of it rather dull, since some points which may be almost obvious are dealt with in some detail. It does, however, reach four component systems, and there is a brief appendix on the thermodynamic basis of the phase rule and on partial molar quantities. The book is sound, but seems to have no obvious superiority over existing ones.

The book by J. E. Ricci, who is an authority in the field, is more ambitious and detailed, and hence, probably, more attractive. It begins with a thorough examination of the basis of the phase rule which all readers will find interesting. It is, however, doubtful if much more has been added to the clarification of the well-known difficulty of the definition of the number of components of a system. This is purely a matter of mathematical book-keeping, and most teachers find that the more this is emphasized and the less concession is made to beginners who feel that they ought to have some 'reasons' given them, the quicker the pace in learning. Another point is the introduction of continuous miscibility at the start, heterogeneous systems with pure phases being brought in as special cases. This is done in some other books, and not all will agree that it is the best way of beginning the subject. It may be the ideal way; but that is a different matter. The book deals with all the important aspects of the subject in a masterly way, and will be regarded as an authoritative monograph. All the important methods of graphical treatment are explained, and I have missed nothing which could be expected to be found in an advanced book. The diagrams are clear and attractive. I think that the subject is best taught in relation to actual systems, and this is done in the book. It makes the subject more real to the student and makes him aware of its value and scope, so that he takes an interest in what might otherwise be rather formal and dull to him. This book is certain to become a standard and should be sure of a warm welcome by those who can afford it.

J. R. PARTINGTON

COLOUR

Colour

In Theory and Practice. Edited by H. D. Murray. A new edition, revised, enlarged and re-written by R. Donaldson, V. J. Francis, P. Holliday, R. G. Horner, N. Laycock, L. C. Thomson, G. T. Winch, and the Editor. Pp. xiii+360+27 plates. (London: Chapman and Hall, Ltd., 1952.) 70s. net.

IT is thirteen years since the first edition of "Colour" appeared (see *Nature*, 144, 227; 1939), and the present book differs very considerably from the original. Mr. H. D. Murray has enlisted seven collaborators instead of his original one. A medical man, for example, has rewritten the chapters concerning the anatomy and physiology of the human eye, and included new material to give a more comprehensive survey. Other specialists have similarly revised and extended the treatment of their own fields.

The consideration of the fundamental physical and chemical aspects of radiation comprises a little less than one-third of the text. Here the authors have devoted some space to atomic physics as a background, and have gone somewhat outside the strict limits of 'colour'. The book has gained rather than lost by this liberal interpretation of the subject, which is also apparent in other places, but some such title as "Visible Radiation" might, therefore, have been more appropriate. In the review in *Nature* of the first edition, it was suggested that the survey of coloured substances could advantageously have been combined with the chapter on the chemistry of colour, but it is now even more completely divorced, as an appendix. Chemical indicators are barely mentioned, despite their great interest.

Human vision, and subjective aspects of light and colour, are accorded an even more expanded treatment. As many workers in other branches of science, and in commerce and industry, never aspire to more precise colorimetric tools than colour charts, further considerations of the limitations and virtues of the popular colour dictionaries would have been welcome.

The third section is highly technical, discussing light sources from sun to candle, from arcs to fluorescent lamps, and the complicated apparatus and methods of modern light and colour measurement. A penultimate chapter concerned with the psychology of colour follows as comparatively light relief.

A very few pages headed "Colour in Nature" are unworthy of the rest of the book; they provide not a single clue to the relevant botanical, and only three references to the zoological, literature. It is a pity that one or more biologists were not included in the team of authors.

The second edition of "Colour" includes most of the original matter, much rearranged, and a good deal of new text, with additional figures. (Although the first edition only claimed three colour plates to the eight of the present book, in fact both have the same number of coloured illustrations, and only two of these have been substituted.) Changes in terminology are to be noted, and the new Appendix 3 is a valuable extract of definitions, for the most part internationally accepted, from the Physical Society's 1948 Report on Colour Terminology. Separate bibliographies for each chapter now replace scattered references in the text—a great improvement. A dual pagination with index references on a chapter rather than book basis seems a needless irritation. The amplified and revised text is, of course, more up to date and satisfactory to the specialist, and more valuable to him as a work of reference; almost inevitably it has also become less easy to read for the non-physicist seeking a comprehensive guide to the whole field of colour.

The first edition was criticized as expensive at 25*s*. After making allowance for the augmented text (but smaller format and more ordinary binding), even by to-day's standards the new edition seems no cheaper.

S. Clay

AGRICULTURAL PHYTOPATHOLOGY

Disease in Plants

An Introduction to Agricultural Phytopathology. By the late Dr. Neil E. Stevens and Prof. Russell B. Stevens. (Manual of the Plant Sciences, Vol. 1.) Pp. xx+219. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson, Sons and Co., Ltd., 1952.) 4.75 dollars.

THIS manual, written by two distinguished American pathologists, father and son, is based on a series of lectures, planned as self-contained chapters, on the general principles of plant pathology. It does not treat of specific diseases and pathogens, but the entire subject-matter forms a comprehensive and valuable introduction to plant pathology designed, as the authors state, for the general reader as well as for the student and professional pathologist.

Stress is laid at the outset on the seriousness of the world food problem to-day, on measures of increased production and of possible preventable losses through disease control. These topics are discussed as part of the whole food situation in relation not only to food crops but also to the healthy production of timber stands and fibre plants as well.

Presumably for the benefit of the general reader, an early chapter (there are twenty in all) is devoted mainly to the anatomical structure and physiology of the healthy green plant, root, stem and leaf, this being followed by descriptions of pathological effects in these organs. The diagrams illustrating the normal anatomy are good and clear, but the same cannot be said of the few photomicrographs showing features of morbid anatomy.

Having already mentioned that bacteria and fungi are the principal instigators of disease, the authors, instead of first giving detailed consideration to these organisms, which are so easily demonstrable in affected tissues, proceed as early as in their third chapter to a consideration of viruses as agents of plant disease. Then follows a comparatively short account of bacteria and fungi, meagrely illustrated, this section closing with a table of classification of phytopathogenic forms. The occurrence, chemical nature, multiplication, mutation, transmission, symptoms, etc., of viruses and their effects are given brief but excellent treatment, this chapter being well illustrated in respect of symptoms of virus diseases. A section is also devoted to parasitic and hemiparasitic seed-bearing plants, and to injurious nematodes and insects. Excellent consideration again is given to nutritional and meteorological factors and to chemical injury in relation to the incidence of disease, with a full citation of relevant literature appended.

It is refreshing to find an entire section being devoted to the significance of such factors as the abundance and uniformity of the host plant when grown in close formation or pure stands, in contrast to growth in mixed culture as conducive to epidemic attacks; growing conditions—temperature, light and nutrition; and disease escape—resistance, tolerance and immunity. In the section on epidemiology which may well have appeared earlier in the manual the qualities, reproduction and dissemination o micro-organisms are treated, brief consideration being given to methods of host-penetration and survival o the pathogen; further discussion of the parasite in respect of variation and physiological specialization is resumed in later sections.

Eight chapters of the manual are devoted to the subject of disease control, embracing such topics a the economy of disease control, chemical treatment seed and soil treatment, crop rotation, sanitation breeding, 'market' pathology (harvest losses, low temperature storage, care in handling) and the incidence of 'new' diseases. This excellent manua apparently the first of a series on plant sciences closes with a plea for greater public support o agricultural research and for the encouragement o intelligent co-operation between grower an pathologist as contributory in no small measure t the success of the world-wide campaign against foo shortage and disease.

S. G. Jones

ELECTRON MICROSCOPY OF SOLID SURFACES

THE normal type of electron microscope allows specimens to be examined by transmission only. The possibility of image formation with electrons scattered from a solid surface was early investigated by Ruska and Müller[1], with normally incident electrons, and by von Borries[2] with grazing incidence. The latter method proved more effective and 'reflexion' micrographs were obtained from a variety of metal surfaces[3]. The development of replica techniques provided a simpler means of investigating topography, applicable in many circumstances, and the reflexion method was temporarily abandoned. However, the widening application of the electron microscope showed the need for a means of continuously observing a surface at high resolution—for example, under chemical treatment or at high temperature. In 1948 an investigation of the possibilities of the reflexion electron microscope was begun in several centres independently: in the U.S.S.R.[4], in the Cavendish Laboratory, Cambridge[5], and in the Engineering Laboratory, Cambridge (by a scanning method). Soon afterwards, the construction of a reflexion instrument was begun at Toulouse, and more recently at least two standard electron microscopes have been adapted to reflexion operation. The progress of most of these projects was reported at a special session of the meeting of the Electron Microscopy Group of the Institute of Physics, held at the H. H. Wills Physics Laboratory, University of Bristol, during September 16–19, which gave a convenient opportunity for assessing the potentialities of the reflexion technique. The parallel development of surface investigation by means of electrons emitted thermionically or photoelectrically was not surveyed, but it is useful to include here a method using ionic bombardment to excite emission.

In the 'reflexion' electron microscope only a small part of the electrons experience reflexion in the true sense, the majority being scattered irregularly from the irradiated surface. If the beam is incident at a grazing angle of a few degrees and the portion 'reflected' at a similar (but not necessarily identical) angle is collected in a system of electron lenses, as in a normal electron microscope, it is found that micrographs of good contrast can be obtained at a useful magnification of several thousand times. M. E. Haine, W. Hirst and A. E. Ennos (Associated Electrical Industries Research Laboratories, Aldermaston) discussed the scattering of electrons of the relevant speed (50–100 kV.) by a solid surface, with particular attention to angular distribution and energy loss. The latter is important, as it introduces a chromatic spread into the reflected beam, which severely restricts the attainable resolution owing to the large aberration of the lenses. From measurements of the unsharpness of the image at high magnification, the loss of energy ΔV was found to extend to about 150 V. With the type of objective lens and angular aperture used in transmission microscopy, the corresponding resolution would be about 400 A., but by using a very small aperture a value less than 50 A. might be attained. Exposure times would then become inconveniently long owing to the relative inefficiency of reflexion and the small aperture. At present, it can be kept to a few seconds by using a normal aperture and the most intense illuminating beam available.

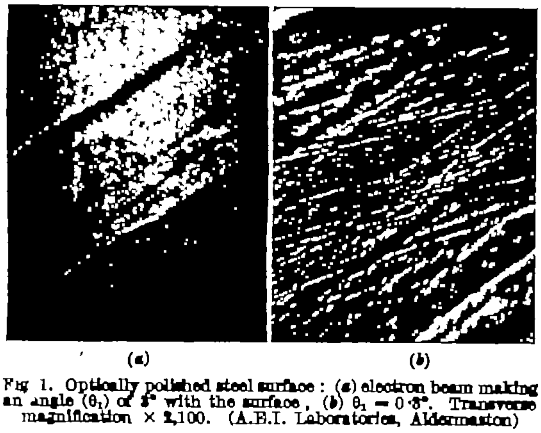

(a) (b)

Fig. 1. Optically polished steel surface: (a) electron beam making an angle (θ_1) of 3° with the surface, (b) $\theta_1 = 0 \cdot 3°$. Transverse magnification × 2,100. (A.E.I. Laboratories, Aldermaston)

The distribution with scattering angle fell less rapidly than expected, falling to about 10 per cent at 10° to the surface. Hence the optical axis of the microscope can be sufficiently inclined to that of the illuminating system to avoid reception of the direct beam without undue loss of brightness in the image. When the surface is optically very smooth, it is found that best results are obtained with a small incident grazing angle ($\theta_1 < 1°$) and a moderate angle of view θ_2 (4°–10°). It is advisable to keep the latter as large as is compatible with exposure requirements, so as to minimize foreshortening of the image. Haine, Hirst and Ennos have investigated an optically polished steel flat, using an adapted Metropolitan-Vickers *EM*3 instrument with an electron gun of continuously variable tilt. Extremely fine detail becomes visible on reducing the grazing angle from 3° to 0·3° (Fig. 1). It is estimated that irregularities in height of the order of 40 A. should be directly detectable by this means. In the opening contribution, entitled "The Evaluation of Surface Topography", Hirst pointed out that surface relief of long period is readily revealed, which would not give adequate contrast by the replica method in transmission even if the field of view were sufficiently large. A crystallographically informative type of diffraction micrograph can be taken by selecting, with an aperture in the back focal plane of the lens, the diffracted beam corresponding to a true Bragg reflexion. A bright-field image of the correctly oriented crystals is then obtained, superimposed on the normal reflexion picture.

Prof. O. Fert (University of Toulouse) described a reflexion microscope in which the inclination of the beam is controlled with magnetic deflecting coils. It is designed to operate up to 250 kV. and has already been used at 100 kV.; an intermediate lens permits electron diffraction operation. The object holder allows every required motion of the specimen, including rotation in azimuth. A resolution approaching 500 A. has been obtained with an aperture of 5×10^{-4} (Fig. 2). He finds that better results are obtained at 100 kV. than at 50 kV., probably owing to the improved value of $\Delta V/V$, since ΔV does not depend on V so long as multiple collisions are not important. Prof. Fert discussed means of restoring

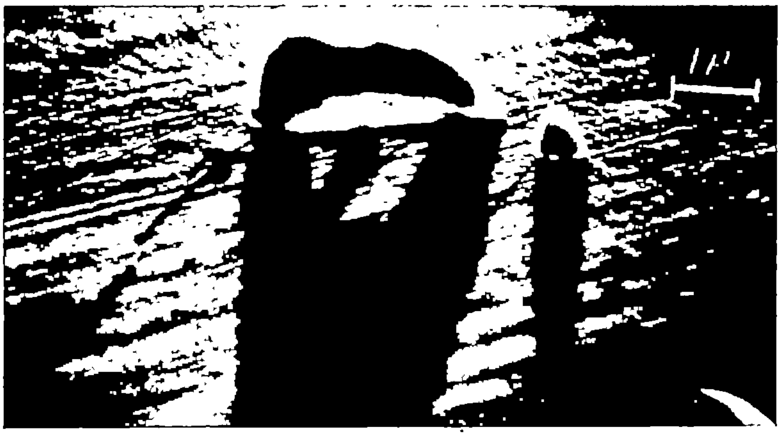


Fig. 2. Surface of polished aluminium, with foreign particles; $\theta_1 = 2°$ and $\theta_2 = 4°$. Transverse magnification × 10,000. (Physics Laboratory, University of Toulouse)

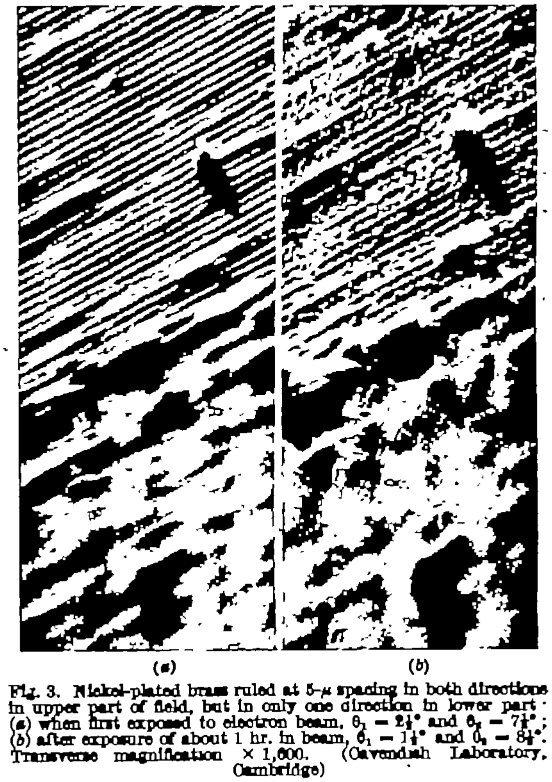
to the image its original aspect, by providing differing magnifications in and across the plane of incidence, with crossed cylindrical lenses, either in the objective itself or in the photographic enlarging system. Alternatively, the recording plate or the printing paper could be inclined to the optic axis in order to compensate the foreshortening.

A similar instrument built at the Cavendish Laboratory, Cambridge, under a project of the British Iron and Steel Research Association, was described by Dr. V. E. Cosslett and D. Jones. It is designed to operate up to 90 kV. with an objective of long working distance ($f = 15$ mm.) so that metallurgical specimens of convenient size can be accommodated. An intermediate diffraction lens is included, and the dimensions of the imaging system are calculated to eliminate distortion and chromatic defects from the diffraction image[5]. The illuminating angle can be mechanically varied from 0° up to 10°, and inclination and translation of the specimen is possible. A large object-chamber is provided so that experiments can be carried out at high temperature or during chemical or mechanical action on the surface of the specimen. Reflexion micrographs of typical metallurgical structures show a resolution of 600–700 A.; an objective of smaller chromatic error is being designed. Comparison with optical photographs assists in interpreting the foreshortened pictures, but it may be preferable to leave them in this state, where the relief is immediately obvious, rather than to correct them to the condition of vertical viewing.

The effect of the electron beam on the specimen must be considered in reflexion as in transmission, though it appears that the danger of artefacts is not here so serious. The temperature rise is not so great, owing to the large thermal capacity and good conductivity of the specimen, but might be serious in non-conductors; the latter can be made sufficiently conducting to avoid charge accumulation by depositing a thin layer of metal on them. But even with metals a slow etching process occurs, either by direct ejection of metal ('electronic sputtering') or by temperature rise sufficient to give thermal etching. Cosslett and Jones showed that the appearance of a ruled grating changed considerably after long exposure (~ 1 hr.) to the electron beam (Fig. 3).

On the other hand, a carbonaceous layer is produced on the irradiated part of the specimen unless the surface temperature is high, but not rapidly enough to obscure detail within the resolving power attainable. Indeed, the 'shadows' thus formed behind projections on the surface have the useful property of allowing ready identification of the irradiated region in subsequent optical examination, as well as estimation of the height of the projections, as pointed out by Dr. J. W. Menter (Physics and Chemistry of Surfaces Laboratory, Cambridge). He described the experience gained with a reflexion head of fixed inclination fitted to an *EM*3 instrument, and also discussed the attainable resolution and the interpretation of reflexion micrographs. A variety of metallic and crystalline surfaces have been examined with an aperture of 3×10^{-3} and a resolution approaching 400 A.[6]. In this way, cleavage steps on mica and growth spirals on silicon carbide have been observed. Slip lines on cadmium show well, if orientated across the line of view, and a cleavage surface of zinc gave particularly striking results (Fig. 4). Very slight inclinations of the surface (~ 4°) across a twin are clearly visible; the black lines across the field of view are cleavage steps. Menter indicated also some possible applications to the study of the surface of biological objects.

A short account of the work in the U.S.S.R. on reflexion microscopy[4] was given in another session of the conference; it follows very closely the developments described here. A rather different system due to Möllenstedt (A.E.G.–Zeiss) was briefly described by Prof. O. Scherzer (Technische Hochschule, Darmstadt). It employs an ion beam, incident

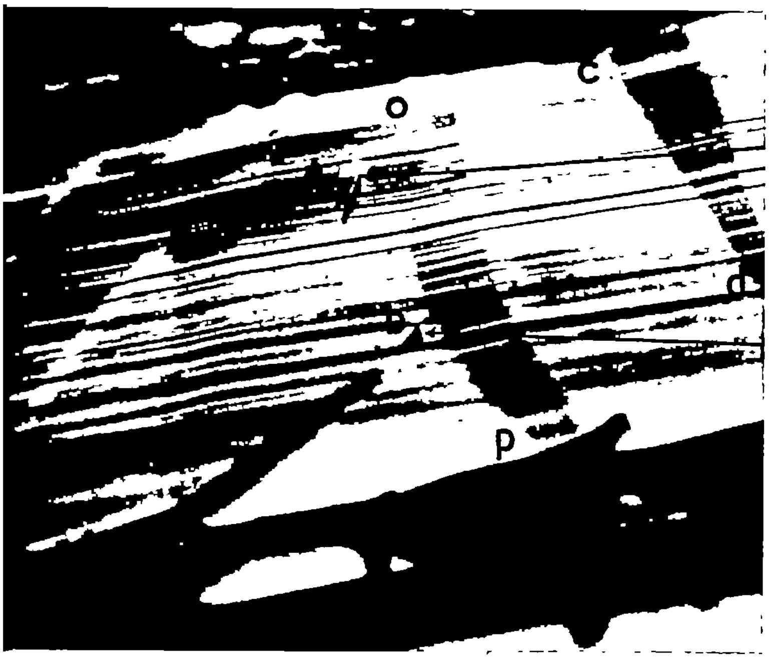


(a) (b)

Fig. 3. Nickel-plated brass ruled at 5-μ spacing in both directions in upper part of field, but in only one direction in lower part: (a) when first exposed to electron beam, $\theta_1 = 2\frac{1}{2}°$ and $\theta_2 = 7\frac{1}{2}°$; (b) after exposure of about 1 hr. in beam, $\theta_1 = 1\frac{1}{2}°$ and $\theta_2 = 8\frac{1}{2}°$. Transverse magnification × 1,600. (Cavendish Laboratory, Cambridge)

at 45° on the specimen surface, to excite emission of electrons, which are then collected by an electrostatic lens at a voltage of 30 kV. Micrographs at a resolution of about 1000 A. have already been obtained. The chief advantages are that the surface is viewed normally so that no distortion occurs, and that the voltage spread of the emitted electrons is only about 3 V., so that chromatic aberration is negligible.

In the usual type of electron microscope a macroscopic area of specimen is illuminated, and the whole of the image is projected at once. D. MacMullan (Engineering Laboratory, Cambridge) described a scanning microscope, in which a fine electron beam is caused to explore the object point by point, the transmitted (or reflected) intensity being collected in an electron multiplier the output of which modulates the intensity of the synchronously deflected spot of a display tube. As there are no lenses beyond the object, the energy loss of the scattered beam leads to no chromatic aberration, and the resolution is limited only by the size of the exploring probe. In principle this can be reduced to the order of Angstrom units by high demagnification of the primary beam, but the intensity becomes impracticably small because of lens aberrations. So far a spot size of some 500 A. has been obtained with a beam current of 5×10^{-12} amp., giving images of this resolution both in transmission and by reflexion. The new instrument is a great advance in both resolution and speed of operation on earlier attempts to use the scanning principle[7]. It promises better ultimate results than the simple reflexion method, both in resolution and in lack of damage to the specimen. As a much greater proportion of the scattered beam is utilized and object points are illuminated successively, not simultaneously, the rate of energy transfer is very low. On the other hand, the reflexion method can be practised by a simple adaptation to an existing microscope, with no extra electrical complications.



4. Cleavage surface of zinc single crystal, showing twins (*cd*, *ef*, *op*) and dust par-les (*a b*); $\theta_1 = 5°$. Transverse magnification × 1,800. (Physics and Chemistry of Surfaces Laboratory, Cambridge)

Both methods open up new prospects of high-resolution microscopy, especially for metallurgy, and the full exploration of their potentialities will be awaited with great interest. V. E. COSSLETT

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CYTOCHEMICAL AND CYTOLOGICAL STUDIES OF DRUG ACTION*

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THE majority of the actions of drugs are exercised at the cellular or lower levels of organization of living matter. As our knowledge of cell physiology is extremely limited, so likewise must our knowledge of drug action be limited. But the present rapid expansion of our knowledge of cellular activities ensures that each year new possibilities become available to the student of drug action. In this article some recent cytological and cytochemical studies of drug action will be briefly discussed.

The mitotic poisons have particularly attracted the attention of cytologists. These substances are of interest from many points of view—in the analysis of nuclear behaviour, for the production of mutant and polyploid strains, for the chemotherapy of tumours, etc. Only in the past few years has it been sufficiently realized that mitosis is not a unitary process, but consists of a considerable number of phenomena which normally, but not necessarily, occur in succession. Among the processes involved or essential for mitosis are duplication of genes and of chromosomes (involving syntheses of specific nucleic acids and proteins), the disappearance and reappearance of nucleoli, spiralization and despiralization of chromosomes, division of the centrosome, breakdown of the nuclear membrane and its reformation, formation and disappearance of the spindle and asters, formation of the equatorial plate of chromosomes and the separation of daughter chromosomes: all this is normally succeeded by cytoplasmic division, which is in itself a separate and complicated group of phenomena. Careful studies by cytologists have shown that substances which interfere with nuclear division may act upon almost all, if not quite all, the individual features of division, with a highly variable degree of specificity. At one extreme, Ostergren[1] and his colleagues have shown that almost any organic substance, if present in a concentration of the order of one-fifth to one-tenth of the level required to exercise a non-specific narcosis, will interfere with mitosis by causing (for example) chromosomes to adhere to one another to an abnormal extent. This is a quite non-specific action. At the other extreme, substances such as colchicine, podophyllotoxin and aminopterin will interfere with some mitotic phenomena at a concentration greatly below the narcotic level[2]. This can be a very specific action, exercised mainly on one or a few of the phases of mitosis. Between these two extremes lie substances which show some degree of specific action. Cytochemical studies so far have indicated only that, when a given cytological abnormality is produced, it has a characteristic cytochemistry, irrespective of the agency which produced the abnormality.

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* Based on a public lecture delivered at University College, London, on February 22.

Many attempts have been made to produce a theory of action of mitotic poisons, for example, that they react with SH groups of proteins, or involve cross-linking of protein or nucleic acid molecules by bifunctional compounds. But no theory has so far been proposed which has commanded any considerable measure of support. It seems improbable that all mitotic poisons work by the same mechanism, and experience in other fields suggests that different groups of mitotic poisons have different initial modes of reaction with cells, and that the resemblances that are seen in the effect of these substances result from a funnelling process. It is common experience in cell physiology to find that if a cell is capable of a given activity, then many unrelated agents will elicit this activity, that is, cells appear to be organized so that a diversity of agents will produce a limited number of responses[3]. In the case of mitotic abnormalities, not only are similar abnormalities produced by X-rays and by many different families of chemical substances, but also by malnutrition and even by simple exposure to hypotonic or hypertonic media. Thus mitotic abnormalities are produced by a wide variety of unrelated agents which produce their end-effects on a complicated sequence of processes.

This phenomenon of the 'funnelling in' of the action of agents to give similar mitotic abnormalities makes it appear probable that we shall only achieve understanding of the mode of action of mitotic poisons by the highly detailed investigation of individual groups of closely related substances. The beginning of such an analysis, on the cytological level, has been made by a number of workers, particularly Ford[4], Revell[5] and Koller[6]. Their work has shown that in the case of the Walker rat tumour and of bean root tips the sensitivity of a cell depends upon its position in the mitotic cycle. Thus the number of chromosome breaks in bean root tips which is produced by a given dosage of X-rays is minimal just after mitosis, reaching a maximum if irradiation occurs shortly before mitosis. But with a nitrogen mustard, and also with a diepoxide, exactly the reverse condition was found: sensitivity was greatest immediately after mitosis, reaching a minimum just before mitosis. This difference is emphasized by the fact that, whereas anoxia and presence of SH compounds affords some degree of protection against the action of X-rays, no such protection occurs against the action of a nitrogen mustard. It thus seems certain that, although X-ray and these two chemical substances produce simila mitotic abnormalities, their modes of action must b quite different. Furthermore, colchicine and amin opterin will produce a maximal effect if applied jus before mitosis: consequently these two substance must produce spindle abnormalities by a proces quite different from that involved in the action of nitrogen mustard[2].

A more intimate knowledge of the mode of actio of some mitotic poisons might be obtained by cytc chemical methods. In principle the site of action o for example, a nitrogen mustard, could be determine either by auto-radiography of a mustard containin a radioisotope, or by the development of a colou reaction for a mustard[7]. So far no results have bee recorded of auto-radiographic studies. But attempt have been made by Bell and Danielli to determin the site of action of an aromatic nitrogen mustar synthesized by Ross. It was found that there was n evidence of specific attack of the mustard on an particular cell site: the action is diffuse. This cor clusion is supported by the results of Ord and Daniel using the technique of nuclear transfer. By thi technique it was shown that an exposure to a nitroge mustard which is just lethal to cytoplasm is also jus lethal to the nucleus. There was no sharp selectivity c the nitrogen mustard for either nucleus or cytoplasm

Although the detailed investigation of the cytc logical and cytochemical effects has not revealed th mode of action of any one mitotic poison, neverthele the work of Koller and others has profoundly ir fluenced our attitude towards these substances a chemotherapeutic agents. For it has been show that, although almost all the compounds which hav a value as chemotherapeutic agents for tumours cau chromosome breaks and mutations, nevertheless it improbable that these beneficial effects are due t chromosome breaks, etc. What then is the significanc of this correlation of therapeutic action with abilit to cause chromosome breakage and mutation Perhaps the answer is to be found in the fact th the tissues which are most sensitive to mitot poisons include tumours, lymphocytes, the bor marrow, the intestinal epithelium; that is, tho systems which are most vigorously engaged in tl synthesis of proteins and nucleic acids. The pr duction of chromosome breaks and mutations ma be viewed as an interference with the synthesis specific proteins and nucleic acids; and so tl correlation between therapeutic effect and ability produce chromosome breaks and mutations m simply indicate that in all cases the agent is actin directly or indirectly, upon the systems synthesizi specific proteins and nucleic acids. If this is so, the will be great difficulty in finding a mitotic pois which is more effective as a therapeutic agent th those which are already known. The reason for tl is that, so long as the agent which is sought is o which is selective in its action upon nucleic acid protein synthesis, the agent must be no mo destructive to tumour cells than to those vit systems of the body which are also normally engag in the rapid synthesis of proteins and nucleic aci To escape from this dilemma a new approach to tl type of drug is essential.

A possibility which appears promising is to desi a drug which, while still a mitotic poison, is depende for its action upon another cell variable, that is, t requirement for whose action is based not one but on two cell variables. The larger the numb of cell variables concerned in determining a drug action, the more selective will that drug be. Two additional variables which will be considered here are (i) enzymic constitution, and (ii) secretory activity.

Greenstein has pointed out that each cellular species, including tumour cells, displays a characteristic spectrum of enzymic activities[8]. There are enormous variations in the concentrations of particular enzymes in particular cell species. If, therefore, we take a mitotic poison, and inactivate it by adding to it another group, we make that substance relatively inert except to those cells which have a high concentration of the enzyme which can remove the inactivating group. In fact, we endow the mitotic poison with the equivalent of a proximity fuse, which is touched off only by a particular enzyme[3]. Instead of having a mitotic poison which is specific only for cells which are rapidly synthesizing nucleic acids and proteins, we should have a poison which should act only on those cells which are rapidly synthesizing proteins and nucleic acids, *and* which also contain a high concentration of a particular enzyme.

Designing a drug to fit into certain cellular secretory patterns also holds some promise. It is known that cells may be extremely selective in the types of molecules which are concentrated within their plasma membranes. But detailed information is much more scanty than is the case for the distribution of enzymes, and consequently the exploitation of this variable is likely to be less rewarding at the present time.

It is perhaps important to point out that these two variables have been exploited in the past—inadvertently. The reason why neoarsphenamine is an effective drug for treatment of certain infections of the central nervous system is that (*a*) as a result of having a particular type of distribution of polar groups, it is caught up by the secretory cells of the blood–brain barrier and transferred from the blood into the brain, and (*b*) once in the brain it is reduced to liberate active arsenoxides from a hitherto inactive compound.

Another stimulating example of the use of cytochemical techniques is the work recently carried out at King's College by P. H. Staple[9] on the use of diphenylhydantoin. This drug is in common use for the treatment of epileptics. It acts as an anticonvulsant, without causing widespread depression of the central nervous system. But in a proportion of patients the drug causes gingival hypertrophy, which interferes with eating and is unsightly. Cytochemical studies of the hypertrophied tissue showed that connective tissue, particularly collagen, was involved. Collagen is known to be influenced by corticosteroids, and the peculiar localization of the hypertrophy and the waywardness of its incidence were suggestive of a 'stress' abnormality involving he adrenals. Consequently the adrenals of mice were examined by cytochemical methods after a period of reatment by the hydantoin. A gross lesion of the adrenals was revealed. On the hypothesis that the drug was acting directly on the adrenals, it was argued that aspirin might antagonize the undesirable side-reactions of the drug. But it was speedily found that administration of aspirin antagonizes the central effects of the drug, and precipitates convulsions.

It thus became necessary to consider the possibility hat both the central and peripheral effects of diphenylhydantoin are mediated through the adrenals, that is, that epilepsy might be caused by either (*a*) excessive secretion of cortisone, or (*b*) abnormal sensitivity of some part of the central nervous system to cortisone. Either possibility might involve a breakdown in glucose supply to part of the brain tissues. In confirmation of this line of thought, evidence has been found that cortisone and adrenocorticotropic hormone may induce epileptic convulsions in a proportion of normal patients, whereas deoxycorticosterone, which in some respects is antagonistic to cortisone, will protect epileptics against convulsions.

It is evident that, with the aid of cytological and cytochemical techniques, entirely new ground can be broken in the study of drug action and in the development of new drugs.

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FIBRES, OLD AND NEW

THE primary needs of man have always been food, shelter and clothing. The first he was promised by the sweat of his brow; the second he found originally in caves and other natural formations until primitive constructive abilities and later engineering skills enabled him to build to his own design; but the third provided him at a very early stage in his development with scope for extraordinary ingenuity, especially in his discovery of the possibilities of fibres. The historical, scientific and economic consequences of this discovery were discussed at Belfast on September 5 by Section B (Chemistry) of the British Association, when Dr. Douglas W. Hill (British Cotton Industry Research Association) introduced the subject, Dr. A. J. Turner (Linen Industry Research Association) discussed "Naturally Occurring Fibres", Dr. A. R. Urquhart (Lansil, Ltd.) "Natural Polymer Fibres" and Dr. Rowland Hill (Imperial Chemical Industries, Ltd.) "Synthetic Polymer Fibres".

The origins of textile manufacture are lost in antiquity. Before history began, men had discovered the secret of twisting fibres together and interlacing the resultant yarns to produce strong and flexible coverings. So valuable did these products prove to be, not only for clothing but increasingly for all kinds of coverings and later for industrial purposes, that the world was combed for raw materials for the textile industry. Animal, vegetable and mineral products, provided they possessed the requisite fibre form, were all pressed into service, and new uses and new manufacturing methods were constantly exploited. The animal world yielded wool, horsehair, mohair and alpaca, the hair of cows, camels and the fur of rabbits, in addition to silk, both cultivated and wild. From the vegetable world came cotton, linen and flax, ramie, jute and coir, hemp, manila, sisal and phormium, and many others as major articles of commerce, as well as locally-used fibres such as those from the pineapple, from which yarns and fabrics of the finest quality have been produced.

Even paper, cut into narrow strips and twisted, has been extensively used. The mineral world yielded asbestos, the only natural fibrous mineral, and also gold, silver, copper, iron and glass, all of which can be converted to fibrous form for use in the spinning and weaving processes. The vast number of industrial commercial natural fibres now in use has been established by a struggle for survival in world markets, but the search for new ones continues vigorously.

The larger proportion of the world's textiles until quite recently was a matter of agriculture. In view of the stress which was rightly laid during the meeting on the importance of research in the production and use of the natural and synthetic polymer fibres, it is perhaps as well to appreciate that, but for research work, there would be only a minute production of the natural fibres. In fact, while it is generally realized that the man-made fibres are a consequence of man's control of physical forces, it should not be overlooked that the present abundance of natural fibres is no less dependent on man's control of biological forces. The original wild, naturally occurring fibres were mostly deficient in the qualities that would make them economically valuable to-day, and they have been improved out of all recognition by selection and breeding. Research continues to-day in greater measure than ever to produce new varieties and strains with improved yield and quality and disease resistance, while extensive agronomic experiments are directed towards improving cultivations.

It might be thought, in the light of the available natural fibres, with all their different chemical and physical characteristics, that the need for and the opportunity of successfully launching man-made counterparts would be negligible. In a world hungry for textiles, however, every possibility of increasing the total supply or widening the range of properties has been avidly seized upon. The suggestion that fibres might be produced artificially is by no means a new one. In 1664 Dr. Robert Hooke put forward the idea that suitable substances could be drawn out to produce fibres, and in 1841 a machine for spinning artificial fibres was actually demonstrated at the British Association's meeting in Manchester. Although this project came to nothing, it is significant in that it was the forerunner of the spinneret afterwards used so effectively in the rayon industry, and that the filaments demonstrated at that meeting were drawn glass, which has become one of the latest additions to the range of commercial textile fibres. The further development of artificial fibres was stimulated not by the textile industry but by the demand for filaments for use in the new electric-light bulbs. Sir Joseph Swan took out a patent in 1883 for fibres drawn from nitrocellulose which was afterwards denitrated, and these were exhibited in 1885 in their first textile form as crocheted nets. The Count de Chardonnet had also patented textile fibres drawn from nitrocellulose in the previous year, but unfortunately he did not denitrate his fibres, and the dangers which he introduced were so great that the use of his products was forbidden.

The rayon industry, as we now understand it, may be said to have started in 1891 with the discovery by Cross and Bevan that cellulose could be dissolved in a mixture of caustic soda and carbon disulphide to produce viscous solutions from which the cellulose could be readily regenerated after drawing out into fibres. From the success of the first regenerated fibre have sprung many others, including cuprammonium rayon, obtained by extruding a solution of cellulose in cuprammonium hydroxide into water; cellulose acetate after the First World War; and in more recent times, 'Ardil' from groundnut protein, alginate fibre from seaweed, 'Vicara' from zein and 'Lanital' from casein. Once again, as in the case of the natural fibres, a great hunt for spinnable materials took place, and every conceivable waste-product was tested for its possibilities for this purpose. Egg-white, feathers, silk waste, soya bean and fish have all been used to provide further weapons in the armoury of the regenerated fibres.

Two facts stand out with peculiar significance in this narrative. The first, and more obvious, is that the advances in fibre production have occurred during the past fifty years. Though the methods of manufacture changed and were continually refined, the same basic materials were used by the milliners in the fashion houses of Paris at the beginning of the twentieth century as had been used thousands of years earlier by the dressmakers in the courts of the Pharaohs.

The second and less obvious fact is that, although the advent of man-made fibres coincides with the development of scientific research, viscose rayon was a discovery of an empirical nature. It could, indeed, scarcely have been anything else, since there was at that time no understanding of the nature of fibre structure. The classical methods of organic chemistry which proved so fruitful in other directions were virtually ineffective when applied to fibres. The properties of fibres to which they owe their value for textile purposes are mechanical ones, such as strength and elasticity, and the chemists of the nineteenth century, though interested in some physical properties of materials, had not regarded mechanical properties as coming within their purview.

At the time when the production of viscose rayon was a fully developed industry, the modern theory of the structure of textile fibres was unborn. Even at the time of the development of acetate rayon, the conception of the cellulose molecule as a very large number of glucose units combined with one another by glucoside-like linkages to form a long thin chain was neither widely known nor generally accepted.

The study of synthetic linear polymers, of which the constitutions were known, provided the key to the problem of fibre structure. It introduced the conception of average molecular weight in place of the previously accepted constant molecular weight together with relationships between viscosity and average chain-length which were independent of chemical transformations.

One well-known phenomenon proved to be a considerable obstacle to the acceptance of the molecular chain theory, for, if cellulose consists only of identica glucose units identically linked, there appears to be no reason for supposing that the conditions which produced rupture of some bonds would not produce rupture of all of them. It was, however, well known that the hydrolytic action of dilute acids on cellulose ceased before complete conversion of the molecule to glucose units. Fortunately the application of X-ray studies to the problem of fibre structure provided a solution. These studies established the presence in the fibre of crystallites interspersed with amorphou regions. In the light of this evidence, the action of dilute acids on cellulose became less a matter of chemical reactivity and more a matter of accessibility, the amorphous, loosely packed, randomly arranged areas being more accessible to the acid than the highly oriented, densely packed crystallites.

The X-ray studies also offered an explanation of the strength of textile fibres and opened up a method of increasing it and of changing the chemical reactivity. According to the modern view the strength of a fibre is determined not by the strength of the glucoside link but by the secondary valencies or hydrogen bonds holding the crystals in a regular pattern; and it breaks, not by rupture of the primary valencies, but by the chains slipping past each other, with a consequent rupture of the hydrogen bonds holding the structure together. The greater the length of the chains, therefore, the longer the overlaps between them and the greater the number of lateral bonds which must be disrupted before breakage occurs. The extent of the crystallinity, it was soon learned, could be increased by mechanical means, particularly stretching, which brought about, as X-ray studies showed, a further orientation of the fibrous molecules.

The climax of the study of fibre structure was reached in the decade following 1928. In that year a long-range fundamental study was initiated in the Du Pont laboratories under the brilliant direction of Dr. W. H. Carothers, which produced in 1931 the announcement of what amounts to a specification for the production of fibres from synthetic polymers. The specification still holds, though it can now be filled in with greater detail. The proof of Carothers's views was provided by the publication in 1938 of the patents covering the production of nylon—polyhexamethylene adipamide—not only the first of the synthetic fibres but also the first fruit of the modern theory of fibre structure.

The pattern of development of both the natural and the regenerated fibres was again followed. A vast search began for synthetic polymers which could be converted to commercially valuable fibres. Nylon, therefore, has been succeeded by others, including 'Perlon', another polyamide, 'Orlon' and 'Acrilan', polyacrylic fibres, 'Vinyon', a co-polymer of vinyl chloride and acrylonitrille, 'Saran', a co-polymer of vinyl and vinylidene chlorides, and 'Terylene', polyethylene-terephthalate.

The discovery of how to use the fibres provided by Nature, by twisting them into yarns and producing from them delicate and serviceable fabrics, must rank as one of the greatest and most lasting achievements of human genius. The unravelling of the inner secrets of their structure is a further chapter in this story, no less enthralling than the earlier episodes, and proving, if proof were needed, that man has sustained his genius through the centuries.

The introduction of synthetic fibres has not meant, so far, that the older fibres have become obsolete. The rayon industry has grown from a production of 2 million lb. a year in 1900 to more than 3,500 million lb. a year in 1950. Synthetic fibres have increased from 2 million lb. a year in 1938 to 150 million lb. a year in 1950. Both are still expanding industries; both offer competition to the natural fibres; yet the use of cotton and wool has also expanded during the century, and even silk, which had a production of 38 million lb. a year in 1900, still reached a production of 36 million lb. a year in 1950, after all the vicissitudes, devastation and trade dislocation consequent upon the Second World War. The present world production of textile fibres is about 22,000 million lb. a year, and during the past decade it has shown an annual increase of about 3 per cent; of this total, the man-made fibres contribute about 15 per cent. The struggle for survival which established the commercially valuable natural fibres will ultimately decide the relative use of the natural, regenerated and synthetic fibres.

It is improbable, however, to say the least, that an ideal fibre suitable for all purposes will ever be discovered. Consider for a moment the many demands which may be made upon fibres. Apart from the fact that they must be available in very large amounts, they may be expected to exhibit strength, elasticity, resistance to abrasion, resistance to shrinkage, to soiling, to fire and to light, moisture absorbency or moisture repellence, warmth, affinity for dyestuffs, chemical reactivity or chemical inertness, and many other properties, some of them all at the same time, and some of them mutually opposing.

Moreover, progressive industrialization demands specialization in fibres as it has already done in metals and other materials. It is true that modern theory has taught us how to modify fibres to meet more exactly the demands made upon them. Rayon, for example, introduced as an apparel fibre, now finds a great outlet in tyre yarns; and nylon, renowned the world over as America's contribution to lustrous hosiery, has gone to war in parachutes, glider tow-ropes and now in bullet-proof vests. Nevertheless, there is a natural limitation to what can be accomplished with any single fibre. It is instead the variety of properties available in different fibres, either alone or in admixture with each other, which makes it possible for designers to fulfil almost any demand that they may be called upon to meet. So varied are these demands that virtually any outstanding property can be turned to advantage, whether it be the buoyancy of kapok, the drape of acetate rayon, the utility of cotton, the warmth of wool, the glamour of silk, the strength of nylon, the fire-resistance of glass or even the solubility of alginate.

On the other hand, the production of the different classes of fibres may well be governed by considerations other than their immediate apparent usefulness. Of the primary needs of man referred to at the beginning of this article, it must be accepted that food is pre-eminent, and an expanding world population, much of which is already below a reasonable subsistence-level, will call for a concerted attack on the problem of food supplies. The natural fibres are all produced in the temperate and warm regions of the world, that is, in just those regions which must be relied upon for any increase in the production of food. Regenerated protein fibres too, though now manufactured from materials unfit for consumption as food, might find that a general food shortage enforced improvements in production methods of their raw materials which would make them suitable foodstuffs for human or animal consumption. The regenerated cellulose and acetate rayons and the synthetic fibres might in such circumstances make a considerable contribution to the food situation. The manufacture of the cellulose and acetate rayons from wood pulp enables a new area to be utilized for fibre production, namely, the Arctic and sub-Arctic forest regions, in which there is no competition with food production. It might be, therefore, that the future will see a reduction in the quantity of natural fibres used, and their replacement by fibres derived from wood pulp.

The future of the synthetic fibres may be limited chiefly perhaps by the availability of raw materials and the vast investment costs of the necessary plant. How great are these costs is not generally appreciated. It is reported that, for the development of nylon, the Du Pont Company spent 45 million dollars on research, 21 million dollars on sales campaigns and 196 million dollars on plant. The new plant of Imperial Chemical Industries, Ltd., for the production of 'Terylene' is estimated to cost £10 million. It is not surprising, therefore, that the birth of a structurally new fibre of merit and distinction is a rare occurrence. The combined efforts of the great many scientific workers who during the past twenty-five years have examined thousands of possible products have led only to five classes of synthetic fibres.

Nevertheless, whatever the future relations may be between the various classes of fibres, textile manufacturers now have at their command a range from which it is possible to create products transcending all past conceptions of textile utility. In the near future, the art or, as it is now fast becoming, the science of textile production may reflect as never before our achievements in the fields of chemistry and physics.

D. W. Hill

ANTIBIOTICS IN ANIMAL NUTRITION

Within the past decade the application of antibiotics has had a profound influence on human and veterinary medicine. Recent developments show that their impact on agriculture may be equally important, and it was apposite that this year at Belfast, Sections I (Physiology) and M (Agriculture) of the British Association should discuss in joint session the place of antibiotics in animal nutrition.

In his opening remarks, Dr. S. K. Kon (National Institute for Research in Dairying) traced the steps that led to the surprising discovery of the growth-promoting effects of these drugs. It has been known for a long time that proteins of animal origin are, on the whole, biologically superior to those derived from plants; in fact, the classic concept of first- and second-class protein was based on this distinction. When later the emphasis shifted from protein as such to its component amino-acids, it became evident that something else apart from a good balance of these was responsible for the special virtue of animal sources of protein. Work with rats and poultry in the United States, especially by Hartman and Cary and Bird and his associates at Beltsville and the Zuckers of Columbia University, showed that these products carry a hitherto unrecognized growth substance which, owing to its association, came to be known as the animal protein factor. It is only fair to recall that some twenty years ago Dr. Katherine Coward, working in England in the laboratories of the Pharmaceutical Society, showed that the purification of casein deprived it of something essential for the proper development of rats on synthetic diets.

With the brilliant isolation in 1948 of the anti-pernicious anæmia factor by Rickes and his associates, of the Merck Laboratories, New York, and by Lester Smith and colleagues, at the Glaxo Laboratories, Ltd., Greenford, and its identification as a vitamin by the former workers, it soon became apparent that vitamin B_{12}, as it was called, accounted for much of the special activity of carriers of the animal protein factor. The value of vitamin B_{12} in enhancing practical rations for pigs and poultry in the United States led to a search for suitable sources, and these were found in the residues from the antibiotics industry, especially from fermentation processes in the preparation of aureomycin and streptomycin. Thus a substance at first believed to ennoble only animal tissues came to be derived mainly from activities of micro-organisms.

The crude product from *Streptomyces aureofaciens* proved better in poultry rations than an equivalent quantity of pure vitamin B_{12}. Shortly after this observation, Stokstad and Jukes, of Lederle Laboratories, announced that the superiority was due to the presence in the residue of traces of aureomycin and that the antibiotic, even by itself, promoted the growth of pigs and poultry. At first sight this unexpected effect seemed scarcely credible, and Dr. Kon confessed his initial disbelief; but confirmatory evidence soon came from numerous laboratories in the United States and from the Shinfield Dairy Institute itself, establishing that animals benefit from the addition to their diet of any one of several antibiotics, especially penicillin, aureomycin, terramycin and streptomycin. Commercial application on a large scale was not slow to follow in the United States, where antibiotics are now included in many practical rations for pigs, chicks and turkeys.

In Great Britain the use of antibiotics is governed by the Penicillin Act, 1947, and their addition to rations is for the time being prohibited. Controlled experiments are now in progress in several centres under the ægis of the Agricultural Research Council, and an official statement of policy will no doubt be made when the tests are completed. This cautious attitude is certainly well founded. To begin with, husbandry and feeds in Britain are so different from those in the United States that British workers cannot call on the wealth of American experience but must work out their own solution. In examining the problem afresh, the possible dangers of placing powerful drugs indiscriminately in the hands of farmers must be carefully considered. Their action on frank disease must be dissociated from that in promoting growth of apparently healthy stock. How the antibiotics act is still a mystery, though all indications are that it is in some way through the gut flora. Long-term effects, with the associated risk of appearance of resistant strains, must thus be faced. Finally, the value of antibiotics for ruminants and for laying birds is, to say the least, doubtful, and care must be taken that they reach only those animals they can help. Antibiotics may well become of major importance in British agriculture, but they should not be introduced without proper safeguards.

Dr. M. E. Coates (National Institute for Research in Dairying) discussed the mode of action of antibiotics. Three hypotheses to account for the growth-stimulating properties of antibiotics, when given by mouth, have been proposed: they may themselves be essential growth factors; they may alter the intestinal micro-organisms to the benefit of the host; or they may suppress some infection in the gut interfering with normal growth.

The first explanation is unlikely, since several antibiotics of different chemical constitution all have a similar growth effect; in addition, this effect is shared, though to a less extent, by sulphonamides, arsonic acids and some detergents and is, therefore, more likely to be brought about through the common antibacterial action of all these compounds.

The remaining two hypotheses were investigated in experiments, which Dr. Coates proceeded to describe. Repetition at Shinfield confirmed the original findings of Stokstad and Jukes that pure aureomycin promotes the growth of chicks, and penicillin and terramycin acted similarly. The antibiotics were effective with normal chicks and with chicks deprived of the animal protein factor. Most of the later work was done with only one antibiotic, penicillin, which was readily available in Great Britain. Assays showed that, given as the procain salt to the extent of 25 mgm./100 gm. diet, it survives in bacteriostatic concentrations as far as the lower intestine, but no consistent bacteriological differences were detected either by direct microscopy or by cultural methods between birds with or without the antibiotic.

Changes in microbial population or in its behaviour are likely to result in changes in vitamin requirements of the host chick, particularly of those vitamins of the B complex that can be synthesized by intestinal micro-organisms. Experiments with diets deficient in any one vitamin indicated that penicillin increases the chick's requirement for nicotinic acid but spares biotin, folic acid and one or more unidentified components of the complex represented in the animal protein factor. Biely, in Vancouver, found that aureomycin spares nicotinic acid, folic acid and riboflavin, but the differences between the two laboratories were probably due to differences in experimental conditions. The salient point was that these vitamin economies alone are insufficient to account for the dramatic growth response to antibiotics, particularly as it was also obtained at Shinfield with baby-chick mashes containing ample vitamins and animal protein. Comparison of these latter findings with those of workers at the Glaxo Laboratories provided a pointer to a different explanation in that chicks at Glaxo given baby-chick mashes did not respond to penicillin. The chick rooms at Shinfield had been in continuous use for poultry for at least ten years, whereas poultry had rarely been housed in the Glaxo Laboratory. In a joint experiment chicks from the same hatch and receiving the same batch of diet were divided between the old Shinfield place, a new room there that had never contained poultry, and the Glaxo Laboratories. Penicillin improved growth only in the old place. The treated chicks grew as well there as those, treated or untreated, in the other two places where penicillin had no effect. The antibiotic was, in fact, preventing a depression, rather than causing an increase in growth. Chicks from the new room showed a similar depression when birds from the old room were placed in the same cages with them. Careful examination of the birds revealed no signs of any recognizable disease, and the evidence suggested that the improved growth with penicillin in the old room resulted from a suppression of an inapparent transmissible 'infectious' condition that prevented the birds from growing optimally. Support for this view came from the work of Reyniers, of Notre Dame University, who, Dr. Coates said, obtained no response to antibiotics in his germ-free chicks.

The characteristics of the infective agent are now being studied at Shinfield by means of 'Perspex' isolation boxes, each housing two cages, in which 'infected' and 'uninfected' chicks are kept side by side. The agent can be transmitted by the whole-gut contents of 'infected' chicks, but not by those of 'uninfected'.

Dr. Coates concluded by saying that in frank disease, and in the inapparent 'infection', the beneficial effect of antibiotics on growth manifested itself both on complete diets containing sources of animal protein and on all-vegetable diets. With 'uninfected' chicks it was obvious only with the latter. Finally, with germ-free chicks, antibiotics should be ineffective whatever the diet.

Dr. W. F. J. Cuthbertson (Glaxo Laboratories, Ltd.) spoke next, on antibiotics and the animal protein factor. After outlining the steps that had led to the recognition of the animal protein factor as a complex of which vitamin B_{12} forms only one of the important constituents, he pointed out that antibiotics behave like animal foods in that they increase the growth of chicks, rats, pigs and turkeys on purely vegetable rations to a greater extent than vitamin B_{12} alone. The joint experiments with the Shinfield workers have shown that, when the growth effect is manifested with good diets containing the animal protein factor, it is due to the presence of a growth-depressant 'infection'. He has found, however, that on all-vegetable rations even 'uninfected' chicks benefited from the addition of antibiotics to their diet; the removal of the 'infection' cannot, therefore, be a complete explanation of the growth-promoting action of these drugs. The vitamin B_{12} requirements of such birds were reduced by the antibiotics. Even when the parent flock was kept on a normal diet and their 'uninfected' chicks received a vegetable ration containing ample amounts of all the known vitamins, including vitamin B_{12}, penicillin still improved growth. This effect could not be explained by a vitamin-sparing action on the known vitamins or by anti-infective activity, but indicates that the antibiotic decreases the chick's need for some unidentified essentials. In fact, the addition of heat-dried liver to the all-vegetable diet improves it only a little; but additional penicillin has a marked effect, whereas the opposite was true with freeze-dried liver, indicating that penicillin has spared a heat-labile unidentified growth essential.

A possible explanation of these findings is that antibiotics control the activities of the gut micro-organisms by encouraging those that synthesize growth factors and removing those that destroy them. Dr. Cuthbertson said that one could further speculate that the growth-depressant 'infection' demonstrated in chicks may act by increasing destruction of growth factors in the gut. Should this prove true, the addition of these factors might increase growth on rations now considered optimal but, in fact, not containing enough of certain components to allow for loss through bacterial activity.

In the discussion Mr. K. L. Robinson (Queen's University, Belfast) said that in his experiments on pigs he had obtained a marked response to antibiotics both with all-vegetable diets and with diets containing fish meal. Food utilization was also increased. Removal of the antibiotics at the mid-fattening stage produced a setback that was cured when the antibiotic was given again. Another speaker, from Dublin, said that in his experience penicillin improved the growth of pigs on diets containing maize, soya-bean meal and fish meal, but that the effect was greater when maize was replaced by wheat offals and oats. With chicks he observed improvement on all diets.

NEWS and VIEWS

Royal Society: Award of Royal Medals

H.M. THE QUEEN has been graciously pleased to approve recommendations made by the Council of the Royal Society for the award of the two Royal Medals for the current year as follows: to Sir Frederic Bartlett, for his creation of an experimental school of psychology which has established under his leadership an outstanding position recognized internationally as without superior; to Prof. C. K. Ingold, for his extensive theoretical and practical studies of the mechanism of, and the factors influencing, organic chemical reactions; and for his analysis of the structure of benzene.

Institution of Civil Engineers: Awards for 1951–52

THE Institution of Civil Engineers has announced the following awards for papers (subjects given in brackets) which were read at meetings of the Engineering Divisions of the Institution during the session 1951–52: *Telford Gold Medal*, Dr. Carlo Semenza (the most recent dams by the Società Adriatica di Elettricità (S.A.D.E.) in the eastern Alps); *Coopers Hill War Memorial Prize*, Dr. E. J. Hamlin (sewerage and sewage disposal in subtropical countries, with special reference to South Africa and Mauritius); *Telford Premiums*, A. A. Fulton (civil engineering aspects of hydro-electric development in Scotland), M. C. White (the design and construction of the new deep-water quays at Leith), R. H. MacDonald (relation between daily rainfall and flow of the River Shin) and J. T. Calvert and P. M. Amoötts jointly (some problems in the disposal of industrial effluents and domestic wastes); *Crampton Prize*, W. Storey Wilson and F. W. Sully jointly (the construction of the caisson forming the foundation to the circulation-water pump-house for the Uskmouth generating station); *Manby Premium*, Dr. B. G. Neal and Dr. P. S. Symonds jointly (the rapid calculation of the plastic collapse load for a framed structure).

Biology at Chelsea Polytechnic, London:

Dr. B. Barnes

DR. B. BARNES will retire from the headship of the Department of Biology at Chelsea Polytechnic at the end of 1952. He was born in 1888 and after service as a schoolmaster and in the First World War he graduated with first-class honours in botany from Birkbeck College, University of London, in 1922. He served for thirteen years as a demonstrator and lecturer at that College, taking his Ph.D. in 1928 and his D.Sc. in 1933. He became head of the Department of Biology at Chelsea Polytechnic in 1934 and has served with distinction in that capacity since that date. He served for a long period on the Council of the Linnean Society and was vice-president during 1937–38, 1942–44 and 1951–52. He also acted as deputy treasurer of the Society during 1942–45 and as botanical secretary during 1944–51. He was president of the British Mycological Society in 1934 and was editor of the *Transactions* of that Society for a long period. He served for thirteen years on the Scientific Committee of the Royal Horticultural Society. He has also played his part as recorder and secretary of Section K (Botany) of the British Association. Dr. Barnes has made many contributions to botanical research and will be particularly remembered for the encouragement which he has given to the large number of research students who have passed through his hands, many of whom have afterwards gained distinction; his sympathy with the part-time student is particularly notable. The Department of which he has been head has grown during his tenure of office; it embraces the subjects of botany, zoology, physiology and chiropody, and no greater tribute can be paid to him than to note that it will in future develop as three separate and fully-fledged departments.

Mr. C. C. Hentschel

MR. C. C. HENTSCHEL has been appointed to succeed Dr. B. Barnes as head of the Department of Biology; the Department will in future deal only with the subjects of botany and zoology. Mr. Hentschel, who was educated at St. Paul's School, St. Bartholomew's Medical College, Birkbeck College and King's College, London, was appointed to the staff of the Polytechnic in 1931, and has been senior lecturer in zoology for many years. He was chairman of the Preliminary Medical Board of Studies of the University of London during 1944–47 and is at present chairman of the Board of Studies in Zoology and the representative of that Board on the Faculty of Science. He is vice-president of the Linnean Society, which office he has held on two previous occasions, and is a fellow of the Zoological Society. As the part author of "Biology for Medical Students", his name is familiar to many students of biology. He has witnessed a remarkable growth in the zoological section of his department since his appointment to the Polytechnic, and in the wider capacity in which he will now act will have opportunities for furthering this development.

Dr. Mary F. Lockett

DR. MARY F. LOCKETT was appointed as from September 1, 1952, to the headship of the Department of Physiology; the Department had formerly been part of the Department of Biology. Dr. Lockett was educated at Cheltenham Ladies College, the Royal Free Hospital Medical School, and Newnham College, Cambridge. She was awarded the degrees of M.B., B.S. in 1935, M.D. in 1936, and Ph.D.(Cantab.) in 1945. After holding resident hospital appointments at several hospitals in London and in Cairo she became Beit Memorial Fellow for Medical Research at Cambridge during 1941–45 and was elected to a research fellowship at Newnham College, which she held during 1945–47, when she unfortunately had to resign owing to the illness of her parents. Dr. Lockett has held posts at University College, London, and the University of Glasgow. She is an active research worker with many publications to her credit, and will have full scope for her great ability in building up her new department at Chelsea Polytechnic.

Research Grants for the Department of Anatomy, Oxford

A GRANT of 12,000 dollars has been made by the Rockefeller Foundation to the University of Oxford for advancing the research in technical methods of microscopy which is being carried out in the Department of Human Anatomy under the direction of Dr. R. Barer. During the past few years, these studies have been concerned with optical methods which are particularly suitable for the investigation of living cells, and the Department is fortunate in possessing (through the generosity of the Nuffield Foundation) the first new Burch reflecting microscope, an instrument which is specially advantageous for ultra-violet and infra-red microspectrography. Other specialized techniques under development include various forms of phase-contrast and interference microscopy, which are now being used for a general programme concerned with the action of physical and chemical agents on living cells. Recently, new methods have been devised for the optical determination of cell mass and the regional concentration of solids within living cells. Some applications of these are likely to prove of considerable value in clinical pathology.

A grant of £1,500 a year for three years has also been made by the National Coal Board for research work to be carried out in the Department of Human Anatomy (under the direction of Dr. J. S. Weiner) in collaboration with the Medical and Rescue Personnel Departments of the Board. For some years the Medical Research Council Climatic and Working Efficiency Unit in the Department has been engaged on fundamental and applied investigations on human adaptation to climate, particularly to hot environments. It is now proposed that this work should be extended to include mining problems concerning the effect of hot and humid atmospheres on health and efficiency. This work was pioneered many years ago by the late Prof. J. S. Haldane and Prof. Neville Moss, and its development in the Department of Human Anatomy at Oxford, at Singapore and (during the Second World War) at the National Hospital, Queen Square, London, has yielded a knowledge of methods and an accumulation of data much of which is particularly applicable to mining problems. The Unit at Oxford has already played a part in the inauguration of similar work in the South African gold mines. The immediate inquiries on behalf of the National Coal Board will be concerned with the performance of rescue personnel at high temperatures and with the effect of age on the ability to withstand high temperatures.

Functions of the Ductless Glands: Fiftieth Anniversary

For the scientific investigator, the most difficult of all feats is to form a new idea in the face of prevailing dogma. At the end of the nineteenth century the body was regarded as a collection of organs co-ordinated and integrated by the nervous system, and the function of individual organs was explained in terms of their nervous connexions. But it was well known that a nerveless pancreas did secrete when acid food entered the intestine. Physiologists, baffled, searched for new nervous paths. Fifty years ago, in 1902, Starling, working in University College, London, suddenly had a new idea that it must be a chemical reflex, and quickly proved this by grinding up the lining of the intestine with some weak acid, injecting it into the blood and obtaining an immediate flow of pancreatic juice. This intestinal substance was called secretin because it caused the pancreas to secrete. The functions of most endocrine glands were known; but it was not until the discovery of secretin that their role in the overall organization of the body was understood. From the example of secretin, Starling and his fellow-worker, Bayliss, postulated that the higher animals possess, in addition to the nervous system, a second co-ordinating and integrating system: substances formed in one organ circulate in the blood and regulate the function of another organ or site. To these they gave the name 'hormone' (to excite), and said that, when this word was used, the attribute of messenger should be understood. This idea of a blood-borne regulation of normal body functions has proved to be one of the most fruitful in physiology, and to-day, with the advent of cortisone and adrenocorticotropic hormone, may be ready to give us a new concept of disease.

Colonial Research and Development

The debate on the Queen's Speech in the House of Commons on November 7 was concerned with Colonial affairs; but attention was focused on the situation in Kenya, and, except in Mr. Bernard Braine's speech, Colonial research received no attention. Mr. Braine, in directing attention to the importance of Colonial development, stressed particularly the urgent need for improved transport and more knowledge about the Colonies and their human and physical resources. In this connexion he referred to some achievements in Colonial research and in particular to the work of the Colonial Products Research Council. Sir Leslie Plummer supported Mr. Braine's remarks on the importance of research, particularly agricultural research. Mr. Braine pleaded for early clarification of the present uncertainty arising from the expiry in March 1956 of the Acts under which the Colonial Development and Welfare Schemes are financed. The Colonial Research Council has already pointed out in its current report that uncertainty is making the planning of long-term research impossible and hindering the recruiting of research workers for the Colonial territories. Nevertheless, no comment on this matter was made when the Under-Secretary of State for Commonwealth Relations replied on the debate.

Laterite and Lateritic Soils

In Technical Communication No. 47 of the Commonwealth Bureau of Soil Science, entitled "Laterite and Lateritic Soils" (pp. 51; from the Bureau, Farnham Royal; 1952; 6*s*.), J. A. Prescott and R. L. Pendleton, the distinguished authors of this publication, quote the early, lucid and authoritative descriptions given by F. Buchanan (1807) and T. J. Newbold (1844). They illustrate the strikingly cellular nature of laterite by photographs of the material when used in building, and present maps showing its wide distribution in India, Australia and Africa. Laterite occurs at shallow depth and at the surface, and the bare slag-like sheets are believed to be the exposed illuvial horizon of an ancient soil. This material has a high content of sesquioxides and is usually associated with resistant minerals and with kaolinite, which may perhaps be formed by silification of gibbsite. In discussing the mobility of sesquioxides, Prescott and Pendleton suggest that high acidity resulting from oxidation of ferrous sulphides may have a bearing on the origin of laterite. Examination of Australian laterite suggests that gallium, molybdenum, lead, vanadium and zinc are concentrated with the iron, and deficiencies of copper, manganese and phosphorus have been noted where present-day soils have developed from broken-down laterite formations; such soils are usually infertile. The red earths and red loams of the tropics are formed from a variety of rocks as well as from broken-down lateritic formations, and it is unfortunate that they have received names such as 'laterite', 'lateritic soil' or 'latosol'. Prescott and Pendleton agree with the United States Soil Survey staff that it would be better to confine the word 'laterite' to such ferruginous materials as harden on exposure and to the relicts of such materials. These relicts can be found in several of the zonal soils, but they can usually be regarded as fossil and as accidental constituents that are not relevant to classification at the categorical level of the 'great soil groups'.

The Linnean Tradition in Sweden

THAT the Linnean tradition of going far afield to collect and bring back plants, thereby extending floristic and taxonomic knowledge, is still very much alive in Sweden to-day is borne out by papers contributed to a recent number of the *Arkiv för Botanik* (1, Pt. 6; 1952). Prof. Von C. Skottsberg, of the Botanical Section of the Naturhistorischen Reichsmuseums, Stockholm, has contributed a further article on the flora of San Ambrosio, off the coast of Chile ("Weitere Beiträge zur Flora der Insel San Ambrosio (Islas Desventuradas, Chile)"), while K. H. Reichinger has written both on "Plantæ novæ syriacæ" and on the flora of Turkey from collections lodged in the Stockholm herbarium.

Trace-metal Dating of Archæological Sites

NEW chemical and physical methods of determining the age of ancient sites are continually being suggested—the fluorine method, carbon-14, and the determination of phosphatic content of the soil are some examples. In a recent number of *Science* (116; July 4, 1952), V. P. Sokoloff and G. F. Carter contribute an article entitled "Time and Trace Metals in Archæological Sites". The metals in question are copper and zinc. These two metals, as well as others, occur in soils in several different forms, both mineral and organic, and they can be determined by analysis. Actually the authors are mainly concerned with the study of various middens outside the suitability and the time-range of the carbon-14 method. It is not suggested that this is a very sensitive form of test, but it could differentiate middens a thousand years old from those of, say, Pleistocene date.

Velocity Distribution of Sporadic Meteors

A PAPER by Mary Almond, J. G. Davies and A. C. B. Lovell (*Mon. Not. Roy. Astro. Soc.*, 111, 585; 1951) gave an account of the application of the radio-echo technique to the study of the velocity distribution of sporadic meteors of magnitudes 4·5–6, and a second paper (*ibid.*, 112, 21; 1952) gives further results attained from the application to fainter sporadic meteors of magnitudes 6–7·5. The apparatus was basically similar to that previously used, but additional sensitivity was acquired by increase in transmitter power and aerial gain. Two series of experiments were carried out: apex experiments during the autumn mornings of 1950; and antapex experiments during the spring evenings of 1951. Details are given of the experiments carried out during November 8–December 14, 1950, between the hours of about 5h. and 7h. in the autumn mornings. On the assumption that the meteors were moving in random directions and at the parabolic velocity limit, J. A. Clegg worked out the velocity distribution to be expected, and it was found that there was no sign of a hyperbolic velocity component. The antapex experiments were carried out between approximately 17h. and 19h. during March 29–May 18, 1951, and the velocities measured. From the velocity distribution the same conclusion is arrived at as before, namely, that there is no sign of any hyperbolic velocity component. A very interesting feature of the curves is that the theoretical curves showing the distribution on the assumption of uniformly distributed parabolic meteors indicate much higher velocities than those derived by experiment. Not only do the results all show the absence of hyperbolic velocities, but they also indicate that a large proportion of sporadic meteors must have relatively short-period orbits. Several other matters are discussed, such as the range of magnitudes and estimates of magnitude from electron densities in the trails, and also by comparison of visual and radio echo-rates. Now that the sporadic meteors can be accepted as members of the solar system, many moving in small orbits, the whole problem of their origin may have to be considered afresh. How did these short-period particles originate, and when were they formed? It seems doubtful whether any theory at present adequately answers these questions.

Conference on Malnutrition in Tropical Africa

A CONFERENCE of nutrition experts opened on November 19, at Fajara in the Gambia, British West Africa, to examine problems of malnutrition in African mothers, infants and young children. This is essentially a conference on kwashiorkor—one of many terms used to describe certain manifestations of malnutrition in young children in tropical and sub-tropical areas, especially in Africa. Kwashiorkor is now regarded as being associated with a deficiency of protein in the diet. The conference is being held under the auspices of the Commission for Technical Co-operation in Africa South of the Sahara. Delegates from the Governments of Belgium, France, Portugal, Southern Rhodesia, the Union of South Africa, the United Kingdom and African territories are to attend. There will also be observers from the Food and Agriculture Organization, the World Health Organization, the U.N. International Children's Emergency Fund and the International Children's Centre. The United Kingdom delegation includes Profs. B. S. Platt and A. A. Moncrieff from London and experts from the West, East and Central African territories.

Survey of Applied Mathematics in the United States

THE United States National Academy of Sciences, under contract by the National Science Foundation, is to make a broad survey of research and training in applied mathematics in the United States. The survey, to be carried out with the co-operation of the Office of Naval Research, the Office of Ordnance Research of the Army, and the Office of Scientific Research of the Air Force, is expected to take one year, and Dr. F. Joachim Weyl, head of the Mathematics Branch, Office of Naval Research, has been loaned to carry out the work with the advice of a committee selected by the Division of Mathematics of the National Research Council. The survey group will seek to determine the nature and extent of research in applied mathematics being carried out by government organizations, universities and industry, and will also report on the training and teaching in the subject, with an indication of the areas which are not receiving adequate support. As part of the study, a conference on training and research needs in applied mathematics will be held during the spring of 1953 to consider the findings of the survey and to examine the future of research and teaching in this field. In general, this survey will be on the lines of that on physiology being carried out by the American Physiological Society, also under contract by the National Science Foundation (see *Nature*, August 16, p. 268).

UNIVERSITIES AND UNIVERSITY COLLEGES IN GREAT BRITAIN

FOR its publication, "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1950–51"*, the University Grants Committee has continued the small format introduced last year. While the record number of students of the previous year was not attained, the decrease was only slight—85,314 instead of 85,421—and the proportion of assisted students also remained high (72·5 per cent compared with 72·8 per cent during 1949–50 and 73·7 per cent during 1948–49); the dependence on Parliamentary grants again increased and now represents 64·9 per cent of the recurrent income, 16·6 per cent coming from fees (compared with 17·7 per cent during 1949–50), 5·5 per cent from endowments and 4·3 per cent from grants from local authorities, as against 5·7 per cent and 4·6 per cent, respectively, during 1949–50. The ratio of staff to students again increased, the full-time teaching staff being now 8,603 compared with 7,930 during 1949–50. Although the number of professors increased by 48 and of readers, assistant professors and independent lecturers by 62, the increase was mainly in the grades of lecturers (360), assistant lecturers and demonstrators (83) or other grades (120). Separate figures are now given for the Colleges and Schools of the University of London for full-time staffs, income and expenditure and libraries.

Of the full-time students, 67,743 were reading for a first degree, 6,244 for a diploma and 11,327, together with 4,158 of the 16,698 part-time students, were engaged in research or other advanced work; 64,180 full-time students were in England, 5,133 in Wales and 16,001 in Scotland, the decrease in Scotland thus offsetting an increase of 776 men and 247 women in England; in Wales there were 216 fewer men but 65 more women. Of the total, 15,098 were at Oxford and Cambridge, 18,412 at London and 30,670 at other English universities and colleges. Only at Bristol and Liverpool were there increases of more than a hundred students. The total for London colleges and schools increased by 913. Elsewhere there were decreases or slight increases. The North Staffordshire University College appears in the returns for the first time. The proportion of full-time students residing in colleges and halls of residence increased to 24·3 per cent, but is still less than in 1938–39 (25·1 per cent), although the number in residence is greater (20,732 compared with 12,555). The proportion of women in residence is still nearly double that of men (38·9 per cent compared with 20 per cent); 39·1 per cent of full-time students were in lodgings and 36·6 per cent at home, compared with 33·2 and 41·7 per cent, respectively, before the War. There was a further slight increase in overseas students compared with 1949–50: 3,657 full-time and 1,628 part-time students came from within the British Commonwealth and 2,902 full-time and 1,290 part-time students from foreign countries. Of the 22,223 students admitted for the first time in 1950–51 (a decrease of 2,108 on 1949–50), 20,292 were reading for a first degree and 1,931 for a diploma, and, of those reading for a first degree, 1,836 were less than eighteen years of age and 11,656 were nineteen or more.

Although the distribution of full-time students did not differ significantly from that during 1949–50, some of the changes in numbers are noteworthy. Arts students represented 43·1 per cent of the total; those in pure science 20·1, in medicine 16·6, in technology 12·4, in dentistry 3·4, in agriculture 3·1, and in veterinary science 1·3 per cent. Of the full-time advanced students, 24·9 per cent were working for a diploma and, of the remainder, 38·8 were in arts, 34·0 in pure science, 11·9 in medicine and dentistry, 11·8 in technology, and 3·3 per cent in agriculture. While the number of full-time students in arts decreased by 455 to 37,243 and those in science increased by 251 to 17,168, there was a decrease of 342 in the students of technology. In spite of the slight increase of 54 in advanced students of technology, there is no evidence in these returns of any response to the call for more university-trained technologists sounded so urgently more than two years ago. Medical students were almost stationary at 14,201, and students in agriculture decreased by 167 to 2,606. An increase of 391 in veterinary science students was due to the incorporation in the University of London of the Royal Veterinary College with 380 students. Of the full-time students, 37,714 out of 49,999 men and 9,627 out of 14,181 women in England were receiving assistance in the way of scholarships, exhibitions or other awards from public or private funds: for Wales, the corresponding figures are 3,314 out of 3,822 men and 1,095 out of 1,311 women; and for Scotland, 8,144 out of 12,010 men and 1,950 out of 3,991 women. The percentage of assisted students in England ranged from 77·9 per cent in the provincial universities, to 65·9 per cent in the University of London; Oxford and Cambridge with 75·7 and 74·3 per cent, respectively, thus came between the two. Of the 65,831 full-time men students, 37·2 per cent were in arts, 21·1 per cent in pure science and 15·8 per cent in technology; for the 19,483 women students, the corresponding figures are 63·0, 17·0, 15·1 and 1 per cent. Medicine and dentistry claimed 44·6 per cent of the part-time advanced students, arts 30·4, technology 9·6 and pure science 8·7 per cent, compared with 45·1, 32·8, 10·8 and 10·8 per cent, respectively, in 1949–50.

The recurrent income of the universities and university colleges of Great Britain increased by £2,258,388 to £24,268,123, of which £15,767,002 was from parliamentary grants, £4,022,459 from fees, £1,329,916 from endowments and £1,040,037 from grants from local authorities. Of the total income from public funds of £16,807,039 and £7,461,084 from other sources, the University of London received £5,075,985 from public and £2,070,651 from other sources; the University of Cambridge similarly received £1,043,657 and £1,080,845; for Oxford the corresponding figures are £945,830 and £729,499; for Manchester, £912,718 and £277,390; for Durham, £720,392 and £315,985; for Birmingham, £724,752 and £271,994; for Bristol, £633,976 and £209,369; for Leeds, £700,876 and £245,261; and for Liverpool, £665,317 and £246,085. No other English university or university college, except Sheffield, with £607,415, had an income exceeding half a million pounds, though three universities in Scotland exceeded this figure: Aberdeen, with £404,450 from public and £134,337 from other sources; Edinburgh, with £738,037 and £345,198; and Glasgow, with £835,650 and £361,388, respectively. The University of Wales, including the Welsh National School of Medicine, received £847,960 from public funds and £327,164 from other sources.

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* University Grants Committee: Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1950–1951. (Cmd. 8638.) Pp. 44. (London: H.M. Stationery Office, 1952.) 2s. net.

Of the total expenditure of £24,269,862, an increase of £2,501,952 on the previous year, administration accounted for 8·7 per cent, departmental maintenance 69·7, maintenance of premises 11·1, and miscellaneous expenditure 9·4 per cent. Capital expenditure met from reserves amounted to £254,274 and allocation to reserves, £236,707; for 1949–50, these figures were £472,327 and £270,993, respectively. Departmental maintenance included salaries of teaching and research staffs and payments for superannuation, the running costs of laboratories, lecture rooms, libraries and museums, and the supply of materials, apparatus, books, specimens, etc. Salaries and superannuation amounted to £11,895,971, an increase of £1,349,625 on the previous year; this represents 49·1 per cent of the total expenditure, compared with 48·4 per cent in 1949–50 and an 8·5 per cent increase in full-time staff.

Library expenditure, excluding general maintenance of library buildings, rates, heat, light, repairs, etc., amounted to £891,385 compared with £788,402 in 1949–50, the percentage of total university expenditure remaining 3·7 per cent. Of this total, £473,087 was for salaries and wages, £197,062 on account of books and £103,305 on periodicals. The University of Oxford spent £32,095 on books, and Cambridge £10,102, while a total of £51,025 (including £7,027 on the Central Library, £5,678 at the London School of Economics and £5,006 at University College) was expended for this purpose in the colleges and schools of the University of London. Nine other universities, Birmingham (£5,102), Bristol (£5,467), Leeds (£6,638), Liverpool (£8,111), Manchester (£9,092), Aberdeen (£6,995), Edinburgh (£9,648), Glasgow (£8,933) and St. Andrews (£5,307), spent £5,000 or more on books, but only London (£30,496), Cambridge (£7,542), Glasgow (£7,263), Manchester (£5,228) and Oxford (£5,175) spent a like sum on periodicals.

While these returns show that university expansion in Britain has now been halted and afford signs, as in the increasing ratio of staff to students and the slight decrease in the proportion of art students, that the universities are already adjusting themselves to current requirements and seeking to maintain or raise standards, they also contain evidence of the vulnerability of such standards to extraneous pressure with the growing dependence of the universities upon State assistance. That in itself supports the contention of the Select Committee on Estimates in a recent report regarding the desirability of giving the fullest possible information to Parliament concerning the expenditure of the grant-in-aid of universities and colleges. A Treasury Memorandum included in the Eleventh Report from the Select Committee on Estimates for the Session 1951–52 (No. 289. London: H.M.S.O. 9*d*. net) accepts the recommendation of the Estimates Committee that a note should be inserted in the estimates reconciling the amount of the quinquennial grant proposed for the academic year with the total figure of recurrent grant shown in the estimates for the financial year, but the Treasury does not consider that the estimates are the most convenient vehicle for giving information to Parliament on changes in recurrent grants. The Treasury proposes to consider the best way of making any specific changes known to Parliament, but rejects the Estimates Committee's further recommendation that the Comptroller and Auditor-General should have the right to inspect the books and accounts of universities in respect of non-recurrent grants for capital development. The Treasury considers that the existing audit of university accounts already ensures that the grant is used for the purpose for which it is intended. The detailed scrutiny of expenditure on the design and equipment of buildings inevitably raises questions of academic policy, and in the Treasury view goes far beyond the broad lines on which control should be exercised if academic freedom is to be unimpaired. The Treasury believes that such scrutiny is best left to the University Grants Committee, and it is satisfied that this Committee, with the help of its own works and buildings sub-committee and of the Ministry of Works, scrutinizes all plans for which aid is sought and requires the universities to accept the lowest tender for their work unless good reason can be shown to the contrary.

The Treasury's attitude on this point is evidence of how firmly entrenched in Great Britain is the desire to safeguard academic freedom; but the universities are now too vulnerable to external conditions for the position to be regarded with complacency. The Treasury memorandum indicates that in accordance with a further recommendation of the Estimates Committee the terms of reference of the University Grants Committee will be revised to remove the obligation to collect, examine and disseminate information on university education abroad. Approval is also expressed of the recommendation regarding continuity in the senior full-time posts of the University Grants Committee.

ELECTRICAL ENGINEERING IN BRITAIN

THE inaugural address of Colonel H. B. Leeson, on taking office as president of the Institution of Electrical Engineers, was delivered on October 9, his subject being "Electricity and Current Affairs". The relationship of the electrical industry to the economic position and prospects of Great Britain was the central theme of the address, which presented not only a detailed picture of the situation of the industry in question, but also set this in perspective in its world background. "For generations," said Colonel Leeson, "cotton and coal have been the staple of our overseas trade; engineering is the staple of the future." In 1951 roughly 39 per cent, or just over £1,000 million, of the value of the exports of all kinds from Britain represented engineering products, and, of this, £189 million came from the electrical industry.

In tracing the growth of the industry during the past fifty years, Colonel Leeson pointed out that the value of the output of the electrical manufacturers, which in 1907 was £14 million, had been estimated for the year 1951 at £700 million and, in that year, nearly six hundred thousand people were employed. Although the electrical industry thus already plays a substantial part in the country's economy, it is destined to play a greater one in the future, and the further expansion of the industry must be considered in relation to the general pattern of the national economy. The drive to balance Britain's overseas account by increased exports requires a very large expansion in the volume of engineering exports. Dealing with the difficulties besetting the achievement of this increase in exports, Colonel Leeson said, "The shortage of coal, our only natural resource, is obviously the major cause of our present instability. Of equal significance is the fall in human effort—in its broadest sense of every form of human endeavour. Typical of the causes of this falling off in human effort are the effects of shorter normal hours of work, the longer time spent in education and training coupled with National Service, and the changing structure of the population. These together have brought about shortages in every direction, such as in food, materials, houses, fuel, power, transport and production generally. All these factors in turn have induced alternating notching up of costs and wages without lasting benefit, unless it be to our foreign competitors; but with lower standards of life for many. The factors are so interlinked in their cumulative effects that it is difficult to know which is cause and which is effect".

There is, of course, a correlation between the activity of the manufacturing industries and the consumption of electricity by the nation, and it is here that the position compares very unfavourably with that of the United States, where the electrical power used per worker is nearly 2½ times that in Britain. The urgent need for the installation of more generating plant is, of course, only too evident in the load shedding which has become customary in recent years. The attainment in Britain of a yearly rate of plant installation of 2,000 MW. is imperative, and a capital investment policy covering this rate of installation is an inescapable economic necessity.

The four basic needs for economic recovery and development in Great Britain are, in Colonel Leeson's opinion, more human effort (that is, more man-hours of work); greater production of the basic commodities such as food, coal, metals, chemicals and other essential materials; more fuel and power for industry and the home; and more capital (that is, greater savings by government, industry and individuals). "We are facing," he said, "a choice and a challenge. Are we, as individuals and a nation, content to accept with complacency the relentless trend of current affairs towards lower standards of living, or alternatively, do we take up the challenge this represents, and by courage and the exertion of more strenuous individual effort on things that really matter, change the trend towards recovery and better times ?"

A considerable part of the address was devoted to reviewing the growth of employment in the electrical industry in its various branches, and Colonel Leeson gave interesting data on the distribution of professional engineers as represented by membership of the Institution of Electrical Engineers in the major subdivisions of the industry. The total number of people employed in the three main branches of the industry, namely, manufacture, electricity supply and electrical contracting, was, in 1951, nearly 846,000. Roughly 70 per cent of this total were employed in manufacture, 22 per cent in supply, and the remaining 8 per cent in contracting. The membership of the Institution of Electrical Engineers, exclusive of students, numbers 31,000, and an analysis of the percentage of this membership by occupation is as follows: manufacture, 29·8; government services, consulting engineers and others, 22·6; electricity supply, 20·6; communications, 10·0; research, education and training, 9·9; and installation and maintenance, 7·1. 18 per cent of the Institution's members are serving overseas.

The education and training of all classes of personnel in the industry are, in these days, matters of exceptional importance. The direct interest of the Institution of Electrical Engineers is by its charter limited to the professional engineer; but the Institution does concern itself with the improvement of facilities for technicians and craftsmen, and it co-operates with the British Electrical and Allied Manufacturers' Association and the Radio Industries Council to that end. Colonel Leeson emphasized the close partnership in which industry, technical colleges and universities are associated in this matter of the education and training of engineers, and he urged the recognition, in relation to professional engineers, of valuable features in industry-based 'sandwich' and part-time courses which are complementary to the full-time courses of universities and technical colleges.

The problem of the needed expansion of higher technological education can, in Colonel Leeson's opinion, best be tackled by the selection, on a regional basis, of a few of the existing major technical colleges for expansion and development. These should enjoy academic freedom under a self-governing representative administration and be free from any direct control by the local education authority. "The first essential to this objective is the setting up of a small body (including a few men of high academic and professional status) under the ægis of the Government with the necessary finance and authority to select and guide the chosen colleges in consultation with professional bodies, learned societies, and industry. It would be the duty of every section of the industry to provide facilities for additional and improved training matched to the higher standard of education—a duty rich in its own economic reward."

PLASTICITY OF MATERIALS

A CONFERENCE on plasticity, arranged by the British Society of Rheology, was held in the University of Southampton during September 25–27.

The diverse nature of the problems encountered in flow technology, problems which still lack a fundamental treatment, was strongly evidenced in the discussions which arose on the papers presented. In spite of their diversity, however, it is remarkable how many of these problems derive from the basic problem of test instrumentation. The momentum of rheological inquiry is still sustained, in the main, by those immediately concerned with the behaviour of real commercial materials, working with instruments designed to give some rapid index from which the relevant property can be deduced. These instruments have been evolved in turn from those developed in more fundamental laboratories where the properties of plastic materials made classical viscometry meaningless. This necessary departure in experimental design was, unfortunately, not accompanied by an equivalent development in theoretical treatment, and the situation has become gradually worse as instruments involving more complex stress-systems have been produced on grounds of general utility. The whole line of inquiry, from that of pure research on simple systems and idealized models to that of the actual behaviour of industrial products under conditions of use, is one which can profit from the experience of those working on other parts of the line. Disagreement still exists, often on quite basic concepts; but the general process of unification, by theory and experiment, continues.

Instrument design, the difficulties of assessing standards, reconciliation of the results of different test methods—such questions as these are of primary concern to the applied rheologist. Dr. J. R. Scott (British Rubber Manufacturers' Research Association) made it plain that no single plastimeter can meet all the requirements of the rubber industry. Either, as in the rotation-type, the shear-rate is limited, and problems of slip at the containing surfaces arise; or else, as in the Williams press-type, while simple repetitive testing can give reproducible results, the system does not appear to be one which can assist the more fundamental approach to the subject. This problem of widening the scope of industrial instruments has been faced by Mr. G. E. Bessey and Mr. K. A. Lammiman (British Whiting Federation Research Council), who described an apparatus, ingeniously adapted to a lathe bed, which can test at constant rates of extension or compression, recording load and extension on a drum. The grip problem in the extension tests is overcome by extending a specially formed closed loop of the material. The machine can also be adapted for rotation tests, recording the stress against the rate of shear, and can handle material of a wide consistency. The results are of striking reproducibility—a rare quality in plastic testing.

Data derived from such instruments are still difficult to relate significantly to other measured quantities. This aspect of interpretation of data was treated by Mr. E. B. Atkinson (*BX*-Plastics, Ltd.), mainly in relation to extrusion and the problem of errors of boundary condition. The simple assumptions of extrusion analysis (those applicable to viscometers using Newtonian liquids at low rates) can all be violated, and these effects, together with the temperature gradients that arise, lead to unusual flow phenomena. The flow curves are difficult to treat theoretically; but a basis for such a treatment—and a general equation—was proposed, and this could be reconciled with an examination of the problem in terms of dynamic similarity. Such treatments are often open to criticism on *a priori* mathematical grounds, but any approach which advances the design of the processing stages will be of positive value to the plastics industries.

Interpretation, then, has its difficulties; and if an applied laboratory device can reproduce the practical conditions to such a degree that similarity can be claimed, then one stage of interpretation is directly bridged, and the problem is reduced to a true model. This, as an aspect again of rheological instrument problems, was exemplified in a paper by Dr. G. G. Meyerhof (Building Research Station, Garston), whose investigations into the behaviour of clay blocks when compressed between plates of various shape are direct analogies of the building problems of structures where the foundations (or footings) form the upper plate, and the surface of the bed below the clay forms the lower. The yield pressure of such blocks increases rapidly with the adhesion of the material to the plates, and also with decreasing block-thickness. The results are in accord with the theoretical estimates of the yield pressure, and with the assumed mechanism of failure. The unusual occurrence of a gas-holder breaking its back enabled a field investigation to be carried out, and, when the formation of the bed below the clay was traced, the results (treated according to the foregoing theory) provided a stress distribution which beautifully accounted for the result of this impressive large-scale experiment. Mr. P. Mason (Building Research Station, Garston) provided further evidence of progress in establishing the behaviour of building materials. A compression test, of a type originally suggested by Roller, was applied to various plaster mixes, and the extraction of one index—namely, the slope of the experimental line (a log–log plot of empirical quantities which approximate to stress and strain)—provided a grading the sequence of which agreed exactly with that which field-workers, on the basis of experience, accorded to the materials.

A more fundamental instrument-technique was described by Dr. W. W. Barkas and Mr. G. N. Christensen (Faculty of Technology, University of Manchester). This has been developed for a study of the behaviour of wood fibre – water assemblies, similar to those used in the manufacture of paper. These assemblies are formed as small cylinders, placed on a sintered-glass plate and connected by wet contact to one arm of a manometer. Changes in the manometer pressure effectively vary the hydrostatic pressure applied to the assembly, and hence stress – strain studies may be made. As the stiffness of the fibres, and the size of the capillaries in such an assembly, effectively control the type of paper produced in the industrial processes, such results have direct applied importance.

Some problems arising in the choice of materials for aircraft purposes were discussed by Dr. E. W. J. Mardles (Royal Aircraft Establishment, Farnborough). Temperature specifications for such materials as greases are severe, a working range being demanded from conditions of high-altitude cold to those of local engine heat. The required properties of lubricants may be masked by effects which are functions of the instrument—surface tension effects, for example, giving rise to an apparent plasticity. The properties of certain gels are also of importance in aircraft research (cellulose acetate, for example), and the time-dependent properties of such materials were surveyed.

The conference opened with two papers concerned with the fundamental interpretation of plastic flow phenomena. Dr. A. J. Kennedy (Royal Institution, London) reviewed the experimental information available on the mechanisms involved in the creep of polycrystalline metals, and, taking such evidence together with that provided by a wide range of non-metallic materials characterized by a strength – weakness structure (long-chain compounds; mixes and aggregates of various kinds), suggested that the phenomenon of transient creep is an outcome of fairly simple statistical considerations, resulting in parabolæ with time powers which fall very closely about that of the Andrade one-third power. The behaviour of a macroscopic mechanical model was reported: this approximates to the kind of curve exhibited by practical materials. Translation into physical terms is difficult, but the physics of a system which would fulfil the requirements was outlined, and this has interesting analogies with the question of the representation of voters in a two-party electoral system.

Mr. A. Graham (National Gas Turbine Establishment) approached the representation of creep data from the same general point of view, namely, that the striking fact emerging from plasticity results is that different materials behave so similarly. Using observations on a heat-resistant alloy at high temperatures, attempts were made to find an equation capable of general application. By a process of trial and error, an equation was developed from those of Nutting and Boltzmann which can be shown to be a special case of the fractional differential equation of Scott-Blair. This equation is capable of successfully embodying the four variables—strain, stress, time and temperature—and is able to fit the various types of creep curve encountered. It is true that several constants may be involved in the more complex cases, but this is defended on the grounds that mechanisms must certainly be multiple and complex, and particularly so in the case of metals.

A. J. KENNEDY

BRITISH ELECTRONIC INSTRUMENTS IN RESEARCH AND INDUSTRY

DURING the period September 2–5 the Scientific Instrument Manufacturers' Association of Great Britain held, in London, an exhibition of electronic instruments, and associated with this was a symposium of papers describing the application of such instruments in research and in industry. This was the fourth such gathering in a series which began in 1948, the previous exhibition being in 1950, and it is now proposed to hold future symposia and exhibitions biennially.

The papers read at the symposium covered a wide field of instrumentation. At the first session a description was given of electronic control systems for large astronomical telescopes. After a discussion of the factors leading to the requirement of very accurate control of 'rate' in drives for such telescopes, there followed a review of techniques used up to the present time for achieving this purpose, culminating in the present-day forms of electronic control. A modern requirement is the ability to introduce small variations of rate, and to this end use has been made of very stable resistance-capacity tuned oscillators, either as the actual source of a reference frequency or as the means of introducing some frequency variation of a crystal-controlled source. Reference was also made to a 'photographic zenith tube', shortly to be installed in Great Britain, which will provide a new standard of absolute time determination.

An account was given at the next session of the development of resistive elements and wave-guide attenuators from a semi-conducting ceramic. In contrast to the majority of semi-conductors, pure zinc oxide has a temperature coefficient of resistivity which can be controlled between high positive and negative values; the addition of titanium dioxide makes it possible to achieve this control with commercially available materials, and to control the value of the resistivity. Small resistors, up to ten thousand ohms, and having tolerances and stability similar to grade-*B* carbon-composition resistors, have been made, and these may be used with surface temperatures up to 200° C. The material has proved to be very satisfactory for the manufacture of dummy loads to fit in metal wave-guides, as it is unaffected by rapid changes of temperature; these loads absorb microwave energy strongly and also provide a good impedance match in the wave-guide.

Research and development based on precise methods of measurement are responsible in a large degree for the progress upon which the electrical industry depends. Among other topics discussed at later sessions of the symposium were electronics in strain measurement, and electronic measurement and control for industry. In the field of strain measurement, such features as multi-channel strain-display equipment, high-speed self-balancing strain bridges, load cells, load indicators and torque meters were dealt with.

The use of ultrasonic vibrations in many diverse applications has been made possible by the development of electronic methods for the generation of such vibrations, and the final paper of the symposium was concerned with this subject. The applications for industrial purposes cover processes of emulsification and the production of finely divided suspensions; in these processes the action required is that of the dispersion of one material in another. The same principle is involved in the action of cleaning, and the use of ultrasonic techniques has been proposed both for scouring textiles and for the removal of foreign matter from solid bodies. All these effects depend upon the phenomenon of cavitation, which also makes possible the tinning of aluminium by a method involving the use of vibrations of ultrasonic frequency. Other metallurgical applications include the degassing of melts and grain refinement. Most chemical effects occur at relatively slow reaction-rates, but ultrasonic depolymerization has been widely studied: in the biological field micro-organisms have been destroyed, and claims of striking therapeutic results have been made. It appears, however, that there still remains some doubt about the practical usefulness of some of these applications, particularly in cases where high intensities of ultrasonic energy are necessary.

Many different kinds of instruments were to be seen in the exhibition which accompanied the symposium. There were examples of improved design in instruments of various types shown on earlier occasions: instruments for the accurate measurement of power, voltage, current and resistance, and also several items of equipment—signal generators, valve testers, impedance bridges, *Q*-meters—which are now the indispensable tools of the radio engineer. In addition, examples were shown of relatively new developments.

The use of direct-writing instruments for recording variable electrical quantities has until recently been confined to cases in which the rate of change was comparatively small, and direct recording was not possible when frequency components exceeding a few cycles per second occurred, the only recourse then being to photographic recording with Duddell or cathode-ray oscillographs. A new recorder has now been developed which has a moving-coil element so efficient that it may be driven by a simple valve amplifier, but which yet has sufficient restoring torque to deflect a stylus across the paper record in as little as 2·5 msec. It is thus now possible to obtain records of high-speed phenomena directly in a dry and permanent form. The suspension of the recorder is of a stiffness which makes the instrument robust enough for use in aircraft or vehicles.

With the increasing demands for maximum efficiency in temperature measurement, cold-(thermo) junction temperature control has become a factor of major importance. A new, mains-operated thermostat has been designed which overcomes the difficulties and problems of such control encountered in the past. The thermostat will stabilize the temperature of the cold junction to an extent that variations will not exceed 0·1 deg. C. There are therefore no temperature changes to note, nor is ice or liquid required. The instrument is arranged normally to be set to a temperature in the range 42°–48° C., and takes about forty-five minutes to reach stable conditions after switching on.

The needs of the chemist have not been neglected: instruments are now available which will give a continuous indication of the pH of any given liquid under examination, so that rapidly changing conditions may be followed without difficulty. These meters are automatic in operation and can be used in conjunction with a recorder to provide permanent records. Also for the chemist is the conductivity controller: electrolytic conductance measurements afford a convenient and sensitive method for determining a number of factors of basic importance in industrial processes, and the usefulness of such measurements is greatly increased when they are applied to the automatic control of the process being monitored. The instrument shown consisted of a modified Wheatstone bridge network operated at a frequency of 2·9 kc./s., and incorporated an amplifier and relay circuit which enable electrical process control to be effected.

Examples of various miniature circuit units were to be seen at the exhibition. Silver conductors are screen-printed and fired, and resistors are formed with a series of baked-on graphite dispersions. The range of resistivities is from 10 ohms to 1 megohm per square, and one type of dispersion will withstand a temperature of 200° C. for one hour with no more than 1 per cent change in resistance. The resistor noise is of the same low order as that of grade-1 resistors (cracked hydrocarbon type). Ceramic capacitor tablets covering the range 1–10,000 $\mu\mu$F. per unit are available.

The exhibition showed that British instrument makers are keeping abreast of the times, and, in all fields of instrumentation where electronics can play a useful part, it is evident that the user may continue to expect to have new tools placed at his disposal.

J. A. SAXTON

MEDICAL RESEARCH COUNCIL

REPORT FOR THE YEAR 1950–51

THE report of the Medical Research Council for the Year 1950–51* follows the policy of the Council, initiated in the preceding report, of giving, not a complete picture of all that the Council is doing, but a selective account of its activities which discusses the most important work in progress, together with discussions of particular trends of the Council's activities. The report also contains a single classified list of papers published by the Council's individual research workers, an outline of the Council's research programme and the research programmes of each of its many Departments, and lists of the personnel of each of these Departments. An appendix to the report for this year gives in full the text of the memorandum on the future organization of medical research, submitted to Parliament in 1918 by the late Viscount Addison, a memorandum which placed the Medical Research Council under the authority, not of the Ministry of Health, but of a Committee of the Privy Council. Anyone who wishes to understand Viscount Addison's reasons for this wise move will find them here explained. Another section of the report pays tribute to the considerable labours of Viscount Addison on behalf of British medicine.

The particular trend of the Council's work that is discussed in the report is "The Training of Research Workers". The discussion of this important subject recognizes that the main responsibility for training these workers rests on the universities, with which the Council has always been closely associated. Agreeing with the late Sir Charles Sherrington that the best way to get scientific fruit is to cultivate the tree, the Council has from the first given grants to support research assistants in university and other departments and has helped to provide opportunities for the training of junior workers in the research of their own establishments. Recently the Council has increased facilities for research workers. It believes that by far the best training for them is actual investigation under the guidance of an expert, and a flexible scheme for the assistance of the training in research has been devised. This scheme is intended to meet individual needs, and there are three main aspects of it: research scholarships (formerly called studentships), clinical fellowships and travelling fellowships.

Postgraduate scholarships are intended for those who have graduated recently in medicine or science, although they include also arrangements for more senior workers, and supplement opportunities provided by the universities. They are available for workers training in any branch of medical science and are awarded for one year, being renewable for a maximum of three years. This scheme began in 1944, and 221 scholarships have so far been awarded. More than half of them have been for subjects allied to chemistry, and a quarter have gone to workers interested in the preclinical subjects.

The clinical fellowships are intended for more senior workers and were created because postgraduate studentships (scholarships) attracted few medical graduates to careers in clinical research. The stipend is that of a registrar in the National Health Service, and they carry continuation of the superannuation provided by departments of health. Provision is also made for any non-clinical work that may be necessary. Any academic or hospital department sponsoring an applicant is required to undertake to give the applicant an opportunity to return to that department if he desires to do so.

The Council has five groups of travelling fellowships at its disposal: Rockefeller fellowships in medicine, Eli Lilly research fellowships in medicine, Dorothy Temple Cross fellowships in tuberculosis, Alexander Pigott Wernher Memorial Trust fellowships in ophthalmology and otology, and French exchange scholarships in medical science. The first two groups are available to workers in clinical and non-clinical subjects, the third and fourth in the special subjects stated, and the fifth in non-clinical subjects only. All are normally tenable for one year. The report describes these fellowships and gives a table that summarizes the careers of those who have held them in the past.

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* Committee of Privy Council for Medical Research. Report of the Medical Research Council for the Year 1950–51. (Cmd. 8584.) Pp. iv+214. (London: H.M.S.O., 1952.) 6s. net.

The selective account of the Council's work entitled "Some Aspects of Medical Research" is, like the similar section in the preceding report, a valuable discussion of modern knowledge of the following subjects: research on proteins, the preservation of spermatozoa and other cells at low temperatures, statistics in medical research, whooping cough, tuberculosis, antibiotics, diseases of the eye and skin, the experimental study of human skilled performance, climatological medicine, cortisone and adrenocorticotropic hormone, malaria, and insecticides. It is impossible, in the space available in this article, to do more than indicate in this way the scope of this interesting section. It does not cover, and it is not intended to cover, the full extent of the Council's activities and interests, the breadth of which is realized only by a study of the research programmes of the Council's numerous departments.

The reports of the Medical Research Council, and also those of kindred organizations, reveal the noble uses to which scientific work is actually being put. Not only is science daily saving the lives and mitigating the suffering of human beings and animals; it is also extending the span of life, fitting it to the demands of modern civilization and preparing for later generations a better and a healthier world. There is much in the history and literature of the world to remind one of man's desire to help his fellows and other living things; but readers of the reports of the Medical Research Council may well ask themselves where else, outside unpretentious documents such as these, a man may find a comparable record of human labour entirely devoted to the welfare of mankind. G. Lapage

PHOTOGRAPHY IN RESEARCH AT THE UNIVERSITY

On October 4 nearly two hundred people gathered at the Zoology School, Cambridge, to hear a series of short papers on the applications of photography to research in the university. This very successful all-day symposium was organized by the Scientific and Technical Group of the Royal Photographic Society and made possible largely through the enthusiastic co-operation of a number of Cambridge workers, including Prof. J. Gray, Dr. R. H. J. Brown, Mr. A. M. P. Brookes, Mr. Fairfax-Fozzard and Dr. J. S. Courtney-Pratt.

Mr. V. Gallafent opened the symposium by outlining the aims and objects of the Scientific and Technical Group in the advancement of photography. The Second World War, and its after-effects, have prevented the Group from acting on its agreed policy of fostering subsections in the provincial centres. The present meeting at Cambridge marked the first real step towards the realization of this policy; and it was clear that it was a popular one.

A résumé of photographic reciprocity failure by Dr. W. F. Berg led to an interesting discussion on the merits of latensification by a long, low-intensity exposure after the short camera exposure. Mr. G. S. Moore urged, from the floor, that full development in a low-contrast metol developer would give as much speed as could be achieved by latensification, but possibly the latter process gives finer grain at a given γ (which defines contrast in the image).

In a very clear paper, Mr. A. M. P. Brookes presented what might best be called a system of approach to any problem in high-speed photography as applied to engineering. It is usual to decide the exposure-time first. Still and ciné techniques differ inasmuch as the shutter-speed for a photograph destined to be examined as a still needs to be shorter than that for a ciné frame, where slight blurring helps to produce a jerk-free movement on projection. Mr. Brookes showed a graph from which the exposure-time could be read off against subject-speed after allowing for scaling-down in the camera. The graph was based on a 0·1-mm. movement of image on the emulsion. For illumination of the subject, counting the light output from a photoflood as 1, a studio light would be 10, a high-intensity mercury arc 50, a flashbulb 1,000, and a discharge tube 10,000.

Dr. R. H. J. Brown, of the Department of Zoology, Cambridge, was principally interested in the study of animal movements—the flexure of a pigeon's wings, fish swimming, etc. He dealt, in his paper, mainly with the problems of illumination. For micro-cinematography the BTH type *FA5* lamp having a source 4·5 mm. in length is very good. It can be run continuously at 125 W. or flashed at a rate equivalent to 3½ kW.

Mr. H. S. L. Harris described experimental difficulties in connexion with the bringing into operation of a mercury-vapour flash-tube for the photoelastic study of the stressing of gear teeth while running under load.

In the afternoon session Mr. R. G. Horner read a short paper on the limitations of colour photography in the recording of colour. Colour photography is sold to the public in order to give pleasing pictures, and it was never intended as a simple short-cut to colorimetry. When used for recording colours, it is necessary to apply all the standard photometric techniques used in photographic photometry.

A particularly interesting paper was presented by Prof. J. S. Mitchell (professor of radiotherapeutics in the University of Cambridge) dealing with ultra-violet and fluorescence photography, particularly that of cancerous tumours. Work is in progress on the relation between the disturbance of cellular nucleic acid metabolism (as revealed by ultra-violet absorption) and the production of structural changes in chromosomes by the therapeutic doses of irradiation.

Animal experiments have confirmed the increased fluorescence to ultra-violet light of the actively growing parts of the tumour and some other tissues following the injection of tracers. Prof. Mitchell appealed for guidance in colour-photographing the yellow fluorescence of the dissected tissues so as to yield quantitative results. A similar appeal was made by Dr. K. W. Rizk, who is engaged in recording the flow patterns that occur when water containing a blue indicator (such as litmus) is injected into a tank containing a colourless solution that turns the indicator red. Dr. Rizk was disappointed to find that the boundary between the blue central cone of the jet and the red mantle varied according to the camera exposure. No help was forthcoming from the meeting for Prof. Mitchell or Dr. Rizk beyond a re-emphasis of the limitations of commercial colour-processes.

In the section on radiation microscopy, Dr. V. E. Cosslett (Cavendish Laboratory) considered the suitability of photographic materials for electron and X-ray work. For ordinary work the available materials are satisfactory, but for some purposes it would be advantageous to have specially improved materials. Dr. Cosslett appealed for more work to be carried out on the relationship between electron voltage and the characteristics of the photographic materials exposed to them. Very puzzling is the marked difference in response of photographic emulsions to electrons and X-rays.

Dr. J. W. Menter (Physics and Chemistry of Surfaces Laboratory, Cambridge) showed some very fine electron-reflexion micrographs of solid surfaces. These were obtained using a Metrovick *E.M.*3 electron microscope that had been adapted for reflexion work.

Mr. W. D. Kemp dealt with the application of television to the recording of motion-picture films. There is no space here to follow the detailed technical argument, but it was summed up well in the short film that was projected. The quality was far above anything seen on the broadcast television screen. Questioned as to whether the lines had been eliminated by spot-wobble, Mr. Kemp replied that they had been visible on the negative but were lost in the printing stage.

In the last paper of the symposium Mr. J. G. Yates described the experimental difficulties attending the slow-speed recording of low-frequency 'noises' such as the spontaneous variations in carbon resistors that occur under load.

FULMER RESEARCH INSTITUTE

OPEN DAY

AN open day was held at the Fulmer Research Institute on September 30 to mark the completion of the first five years of work at the Institute; it was also the occasion for unveiling a memorial plaque to the founder, the late Colonel W. C. Devereux. After welcoming the guests, Mr. Percy Horsfall, chairman of the group of companies forming Almin, Ltd., explained that the Institute has been provided with the necessary capital by his organization, but that the Institute facilities are available to all without any preference to the Almin group. In the absence of Lord Hives, who had gone abroad, the unveiling ceremony was performed by Sir Archibald Rowlands, permanent secretary of the Ministry of Supply, who was a close personal friend of Colonel Devereux. In a memorable and moving speech Sir Archibald described Colonel Devereux as a happy man with great abilities, enormous drive and a warm heart, who had provided in the Fulmer Research Institute something for Great Britain similar to the well-known Battelle and Mellon Institutes of the United States.

After luncheon Lord Waverley (better known to many as Sir John Anderson) spoke on the successful efforts that have been made in Great Britain since the First World War to make good the deficiencies in the national scientific equipment, particularly in the application of science to industry. He recalled that some seven years ago at a conference of the Federation of British Industries on the application of science to industry, he had expressed regret at the absence in Britain of any institution comparable with the Battelle and Mellon Institutes. Despite the amazing increase in scientific effort through the larger industrial units, the universities and the research associations, and other establishments under the ægis of the Department of Scientific and Industrial Research, Lord Waverley still thought there is scope for further effort and expressed the hope that the work of the Fulmer Research Institute would be multiplied many times in other fields.

After paying a personal tribute to Colonel Devereux, Mr. E. A. G. Liddiard, director of research in the Institute, outlined the progress made by the Institute over the first five years, during which the income, now approximately £78,000 a year, has more than trebled and the staff more than doubled. All the income came directly from research contracts, and the Institute received no other income in the form of endowments or government grants. About half the total income was derived from government contracts, and there was a substantial proportion of direct dollar-earning sponsorship from the United States and Canada. There was, however, a steady increase in the volume of work for British industry and he looked for further growth in the future. He considered that the problem most appropriate to a sponsored research institute is one in which research results need considerable expenditure in subsequent development work, and it is essential that those incurring these costs should be assured of a return for their expenditure and for the risk taken by having some form of monopoly in these new developments—preferably in the form of patents covering the original research results. The connexions established in the United States and Canada would, he said, help in the full exploitation of research results obtained for British sponsors.

Sir Frederick Handley Page, on behalf of the guests, thanked the hosts and stressed the opportunities available in the Institute for British industry, particularly for small firms which cannot afford the equipment or staff necessary for the solution of a particular problem.

The laboratories of the Institute were open for inspection and contained exhibits of various items of work completed and in progress. In the Physical Chemistry Section the work of Dr. P. Gross and his colleagues on the refining of metals by reactions involving metal halide vapours was illustrated. This included the determination of heats of formation of metallic halides and the equilibrium and kinetics of various reactions, particularly the reaction $2Al + AlCl_3 \rightleftharpoons 3AlCl$, which forms the basis of the so-called 'catalytic' distillation of aluminium. A small pilot-plant operating this refining process was an important feature. Samples of titanium metal produced in the laboratory by different reactions, details of which were not available, were on show together with samples of titanium trifluoride and of beryllium produced by indirect distillation.

In the Physics, Metallurgy and Engineering Sections, under Dr. A. H. Sully, alloy research included an investigation into the mechanism of age-hardening and work on aluminium–bronze and aluminium–tin bearing metals. The aluminium–copper–cadmium alloys developed by the Institute were claimed to have properties similar to the duralumin-type alloys but to be free from any tendency to age at room temperature and to have exceptionally good hot-working properties. Work on high-temperature materials included an investigation into the ductile-brittle transition of chromium and of metal-ceramic aggregates, and a good deal of interest was shown in the development of low-emissivity protective ceramic coatings for combustion chambers of gas-turbine engines. The Physics Section employs Guinier-type single and double monochromators for studying structural changes in age-hardening alloys; and in the Engineering Section high-temperature fatigue and creep testing in both tension and compression was in progress, and the use of strain gauges for evaluation of residual stresses and for recording movements in large structures was illustrated. In the Corrosion Section work was in progress on vapour-phase impregnation of iron and steel with silicon, hydrogen embrittlement of steel, and electrodeposition of manganese. Attention was directed to the marked influence of directionality in light-alloy extrusions on resistance to corrosion and stress corrosion.

A large proportion of the equipment and apparatus on view had been constructed in the laboratory workshops, including the pilot plant for aluminium distillation, the vacuum induction and arc-melting furnaces, gas X-ray sets, compression creep machines, furnaces and temperature controllers.

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

THE annual report of the Indian Association for the Cultivation of Science for 1951–52* records the completion of the transfer to the Association's new buildings at Jadarpur and the removal of the Department of Organic Chemistry in June 1951, but research work was considerably curtailed by the removal. Research schemes for the X-ray study of coal and for the construction of osmometers for high-polymer research, sanctioned by the Council of Scientific and Industrial Research, were continued, and a new scheme was sanctioned for the construction of a light-scattering apparatus for measuring the molecular weight, size and shape of high polymers.

In the Department of X-rays and Magnetism a systematic investigation has been undertaken into the structures of phenanthrene derivatives, particularly hormones, and N. N. Gupta has been able to show that the nature of the low-angle scattering of X-rays does not depend upon the internal structure of the crystal but only on the size and shape of the particle. R. K. Sen has perfected the method of determining the elastic constants of a crystal by the X-ray diffraction method, and the limitations of the Jahn–Jeller effect have been investigated. Measurement of the conductivity of single crystals of graphite from 80° to 500° K. has been completed, as well as the major equipment for the liquid hydrogen plant.

In the Department of Optics, studies on *p*-dichlorobenzene have shown that crystals cooled once below 0° C. give a different Raman spectrum from crystals not treated thus. New lines in the low-frequency region have been observed in the Raman spectra of *p*-xylene and benzyl bromide, and the ultra-violet absorption spectra of acetophenone, methyl benzoate ethylbenzene and *iso*propylbenzene have been studied in the liquid and solid states, as well as those of the cresols, *o*- and *p*-xylene, benzyl alcohol and benzyl chloride. In the Department of Theoretical Physics, besides work on the meson fields and nuclear scattering, good progress has been made in improving the Born approximation by taking higher terms of a onsistent expansion in powers of the constant denoting the strength of the coupling between the field and the particle.

In the Department of Physical Chemistry detailed study has been undertaken of chain transfer in uncatalysed polymerization of styrene methyl methacrylate and methyl acrylate in solvents, and investigations have also been made of the polymerization of methyl methacrylate with hydrogen peroxide in non-aqueous solvents, triphenylmethylcellulose and the solubilization of mixed detergents. In the Department of Inorganic Chemistry, which formally started in July 1951, preliminary investigations were made on co-ordination complexes and ion-exchange methods in inorganic chemistry. Lists of papers published during the year are included, with lists of books and periodicals added to the Library.

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* Indian Association for the Cultivation of Science. Annual Report for 1951–52. Pp. ii+40. (From the Association, Calcutta 32; 1952.)

THE CHAYEN PROCESS FOR EXTRACTION OF OILS AND FATS

THE normal process for the extraction of oils and fats from naturally occurring cellular material involves the use of a hot solvent. This process requires steam heating for many hours, resulting in the formation of some undesirable degraded products.

British Glues and Chemicals, Ltd., gave a demonstration of a new process devised by Mr. I. H. Chayen and his associates at their Stratford factory in London on October 28, when they were able to show an entirely new technique. In this process, crushed bones are passed, together with a stream of water, into a modified disintegrator where complete fat rendering is achieved in about one second while the material is in the mill. In this disintegrator, the normal blades had been replaced by beaters arranged to give a clearance of about 4 in. from the mill-casing. With a blade tip-speed of about 12,000 ft. per min., the high-speed impulses given to the water break open the cell-walls of the tissue and enable an easy extraction to follow.

The fat and degreased bone leaving the mill are separated by gravity from the water stream, the fat being skimmed off and purified and the bones passed on for drying, when they are ready for glue making or for incorporation in bone meal.

The importance of this technique lies not only in the fact that it has provided a much improved process for one industry, but also that it has provided a new chemical engineering tool and principle, namely, the use of high-speed impulses to break down mechanical barriers, in this case the cell-walls. The application of high-speed vibrations in the chemical process industries is as yet a largely unexplored field, but this application is already showing a great reward. The degreased bone is ready for glue making in 8 min. and the fats are of much finer quality, since the process is carried out in the cold. The continuous process offers many advantages compared with the old batch one in the form of simplified plant layout and operation, as well as very considerable saving in fuel.

This is an interesting example of a machine produced for one purpose being applied with but small alteration to provide a new mechanism in another industry. British Glues, Ltd., are to be congratulated not only on their discovery of a new principle, but also on the quick way in which they have passed from the pilot plant to the commercial plant, for they now have this process in use in four factories, including one in Canada. They were able to show on a pilot plant the same technique for handling herrings, and the next development may well be in the valuable fish-liver industry.

J. M. Coulson

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Extractability of the Lotmar–Picken Material from Dried Muscle

Bear and Cannan have reported[1] new experiments with muscle exhibiting the so-called Lotmar–Picken[2] X-ray pattern. We, too, recently found a muscle (in our case a *Mytilus* adductor) which gave the pattern, and we have repeated their observation that after extraction with water it gave only the normal α-pattern characteristic of myosin. In addition, our specimen gave a number of new reflexions in the form of almost continuous circles, distinguished from the Lotmar–Picken reflexions in showing scarcely any orientation and in having a more grainy texture; these reflexions, too, disappeared on extraction with water. We attribute them to a new substance which we provisionally call '*X*'. An analysis of the diffraction pattern on these lines is given in the first three columns of the accompanying table.

Whole muscle			Extract
Lotmar–Picken material		Substance '*X*' (continuous circles)	
Equator	First layer line		
0·075 m			
		0·080 m	0·076 m (*X*)
0·086 vw			
	0·105 vw		
0·107 m			0·106 m (LP)
		0·118 s	0·118 m (*X*)
	0·127 m		0·127 m (LP)
0·128 vw			
0·135 w			0·133 w (LP)
	0·140 w		0·139 w (LP)
0·145 m			0·144 w (LP)
		0·161 mw	0·160 m (*X*)
		0·170 mw	0·167 m (*X*)
0·176 w			0·172 w (LP)
	0·178 w		0·178 vs (NaCl)
		0·186 w	0·186 w (*X*)
		0·193 vw	0·189 w (*X*)
		0·221 m	0·219 w (*X*)
		0·229 w	0·226 w (*X*)
			0·251 s (NaCl)

Figures are sin θ/λ values. Letters indicate intensities as follows: vs = very strong; s = strong; m = moderate; mw = moderately weak; w = weak; vw = very weak. In col. 4, lines attributed to the Lotmar–Picken material are marked 'LP', those attributed to substance '*X*' are marked '*X*', and those attributed to sodium chloride are marked 'NaCl'.

We have obtained some new information by evaporating to dryness the water used to perform the extraction. The residue was seen under the microscope to contain: (*a*) single highly birefringent crystals, and (*b*) soft hygroscopic dendritic deposits which had the appearance of being crystalline but were not detectably birefringent. After thorough drying, the residue gave an X-ray powder pattern which can be analysed into three components: (*a*) strong lines with spacings characteristic of sodium chloride, (*b*) a set of lines the spacings of which are identical with the stronger lines of the Lotmar–Picken pattern, and (*c*) a set of lines corresponding to the continuous circles in the pattern of the original muscle, and presumably due to substance '*X*' (see column 4 of table). This analysis is confirmed by the fact that components (*a*) and (*c*) have a more pronounced graininess than (*b*), and by the observation that on exposure of the specimen to damp air part of the pattern disappears, namely, the lines due to the Lotmar–Picken material, which is presumably deliquescent. We provisionally identify the hygroscopic dendritic deposits with the Lotmar–Picken material and the birefringent crystals with substance '*X*'.

We made two other observations of interest: (*a*) after heating the dried extract to 100° C. for 1½ hr., its X-ray pattern (including the Lotmar–Picken component) was unchanged; and (*b*) a dried water-extract of a 'normal' muscle (exhibiting neither the Lotmar–Picken pattern nor that due to substance '*X*') gave a powder pattern made up of the lines of sodium chloride and the lines characteristic of substance '*X*'; no Lotmar–Picken lines were present.

These observations appear to establish the fact that the Lotmar–Picken material is a soluble, crystalline substance which can be extracted from the muscle by water; and thus, since actomyosin and myosin are most unlikely to be extracted under these conditions, they render it very improbable that the Lotmar–Picken pattern is merely a manifestation of an unusually perfect orientation of myosin. The results argue almost equally strongly against the material being a protein of any sort; the powder pattern of the extract contains no lines with spacings greater than 6·6 A., and the smallest spacings in it which are attributed to the Lotmar–Picken material are of 2·9 A. The powder patterns of all dry protein crystals hitherto examined have included lines of much greater spacing than the former, and have generally faded out before reaching the latter, value. Thus we agree with the view expressed by Bear and Cannan that the Lotmar–Picken substance is probably not a protein, and consider that our results lend additional support to it. The close agreement between one cell dimension of the Lotmar–Picken substance and the axial repeat of myosin would therefore appear to have no significance, except perhaps in the sense that it may encourage the substance to crystallize in the muscle in preferred orientation.

In order to exclude absolutely the possibility that the Lotmar–Picken substance is a protein, we attempted (*a*) to recrystallize the material from a solution which had been heated to 100° C., (*b*) to pass a solution of it through a fine-pored dialysis membrane and then to recrystallize it. These experiments were unsuccessful; but the amount of material available was insufficient to repeat them, and we do not regard the negative results as significant—crystallization of the substance is always a matter of chance, for we found that it did not take place on every occasion when we dried the initial water extract from the muscle. For the same reason we do not consider that our failure to obtain a Lotmar–Picken pattern from the dried extract of a 'normal' muscle proves that the substance is absent from such muscles.

H. E. Huxley
J. C. Kendrew

Medical Research Council Unit for Research on the
Molecular Structure of Biological Systems,
Cavendish Laboratory, Cambridge. Sept. 30.

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[1] Bear, R. S., and Cannan, C. M. M., *Nature*, 168, 684 (1951).

[2] Lotmar, W., and Picken, L. E. R., *Helv. Chim. Acta*, **25**, 538 (1942)

Is α-Keratin a Coiled Coil ?

All recent work[1–4] has confirmed that the structure of the synthetic polypeptide poly-γ-methyl-L-glutamate is based on the α-helix of Pauling and Corey[7]. This structure gives a strong 1·5-A. reflexion on the meridian, and both MacArthur[8] and Perutz[1] have shown that this reflexion also occurs in α-keratin. This suggests forcibly that the α-helix forms an important part of α-keratin.

There are certain difficulties in this idea. One of the main features of α-keratin is the strong reflexion at 5·15 A. on, or very close to, the meridian. The normal α-helix gives strong reflexions on the 5·4-A. layer line, but displaced from the meridian. The difference in spacing is not an insuperable objection, since the α-helix might be more tightly coiled; but it is difficult to see how one could obtain such a narrow meridional arc as is observed for α-keratin, even allowing for our ignorance of the details of the side-chain arrangement.

One way to bring the reflexion nearer to the meridian would be to tilt the α-helix. Since the α-keratin pattern is of wide occurrence, one would expect the tilt to be a constant feature of the structure. The most likely general solution is that the α-helix is bent into a super-helix, or coiled-coil. If the α-helix is twisted into a super-helix with a pitch angle of about 18°, its projection on to the axis would have a periodic variation in density at intervals of $5{\cdot}4 \cos 18° \simeq 5{\cdot}1$ A., and so might explain the observed meridional reflexion which corresponds to this spacing. A pitch angle of 18° could be obtained, for example, from a super-helix of radius 10½ A. (the probable distance between helices) and axial spacing 198 A. (the repeat of African porcupine quill)[8,9].

It is possible to make a rough estimate of the energy required to deform the α-helix by this amount by assuming that (1) the forces preventing small rotations about single bonds are small; (2) the hydrogen bond can be fairly easily deformed by small amounts in direction; (3) the main restoring force comes from the resistance of the hydrogen bonds to deformation in length.

Assuming a force constant for a hydrogen bond of, say, 3×10^4 dynes/cm. (see, for example, Davies[10]), the average energy per residue to deform the α-helix by the amount described above is about one-tenth of a kilo-calorie per residue, which is small. This energy increases roughly as the fourth power of the pitch angle, so that the α-helix can easily be bent through small angles, but resists large deformations.

So far, no reason has been given why the α-helix should be deformed. It seems probable that this is due to the difficulty of fitting together the side-chains of two adjacent α-helices.

I should like to suggest that there may be a general plan underlying the detailed packing of all the various side-chains found in proteins. If the side-chains of the α-helix are thought of schematically as knobs on the surface of a cylinder, then it is found that the pattern on this surface consists of knobs alternating with 'holes', that is, spaces into which the knobs from a neighbouring α-helix could fit. The position of these holes is roughly independent of the exact nature of the surrounding side-chains.

In poly-γ-methyl-L-glutamate, the side-chains are long and flexible and they can reach out towards the nearest hole without deforming the α-helix. In proteins, on the other hand, the side-chains are, on the average, smaller and less flexible, and neighbouring helices are nearer together (10½ A. compared with 12 A. for poly-γ-methyl-L-glutamate). It is therefore not unreasonable to simplify the undoubtedly complicated packing of side-chains into a set of standard rigid knobs fitting into standard holes.

It is impossible to pack such models of the α-helix closely side by side, since a good fit in one place produces a bad fit somewhere else, due to the non-integral nature of the helix. However, it can be shown that by deforming the helices into coiled-coils the knobs can be made to interlock systematically. The energy for deforming the helices could come from the closer fitting together of the side-chains.

The objects of this communication are to stress that the α-helix can be deformed an appreciable amount if the deformation is systematic, to suggest that there may be a general plan underlying the packing together of side-chains, and to show that these two ideas lead to a coiled-coil which may explain some of the data[11] better than a straight α-helix.

F. H. C. Crick

Medical Research Council Unit for Research on the
Molecular Structure of Biological Systems,
Cavendish Laboratory,
Cambridge. Oct. 22.

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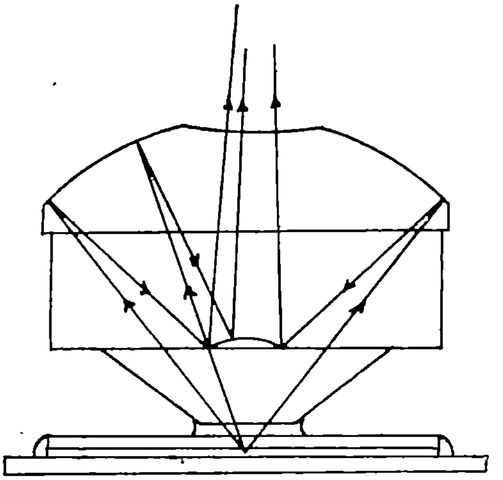
An Easily Used Ultra-Violet Microscope Objective

The ultra-violet microscope is a useful cytochemical tool because it enables one to locate and measure the amounts of absorbing substances in cells (see, for example, Caspersson[1]). It is a considerable advantage if the microscope objective is achromatic throughout the visible and ultra-violet regions of the spectrum; focusing of the microscope in visible light is then simplified, and many wave-lengths may be used simultaneously in order to obtain an absorption curve. Reflecting microscopes are completely achromatic, and hence have been much favoured for cytochemical use (cf. refs. 2 and 3, for example). After several years of use of reflecting objectives, we find they have three main disadvantages: (*a*) the numerical aperture at present possible, ≃ 0·65, is rather low for many purposes; (*b*) the ultra-violet reflectivity of front-surface mirrors sometimes deteriorates rapidly; (*c*) very exact positioning of the mirrors relative to each other is necessary. If the mirrors are preset during manufacture, dislocation may take place in use, thus necessitating return to the maker; if, however, the objective is adjustable, some users may have trouble in making the adjustments. In this communication we describe a simple objective which has been designed to overcome all these disadvantages.

The numerical aperture of a reflecting objective may be increased by a factor μ when a normal-incidence immersion lens of refractive index μ is placed over the object (cf. ref. 4, for example). The lens and two mirrors of the objective must all be adjusted relative to each other, and, as this is much more difficult than adjusting a simple reflecting objective, such compound objectives are not likely to come into general use. If the normal-incidence immersion lens is enlarged so that it fills the space between the mirrors, the objective is transformed into a solid type[5] (see diagram). The difficulty of finding a suitable means of manufacturing such an objective for ultra-violet use has now been overcome. Solid objectives composed of three pieces of glass cemented together with canada balsam have been made[6] for use with visible light. For use with ultra-violet, our objective is made of fused quartz, and, because no really satisfactory ultra-violet transmitting lens cement is known, the parts are optically contacted. Before being permanently contacted, the mirrors are centred by sliding one component of the objective over the other, while viewing a pin-hole test-object.



The mirror-pair consists of two spherical surfaces which would give 0·60 numerical aperture in air. In the solid objective, the refractive index is that of fused quartz and therefore the numerical aperture is $\simeq$ 0·90. The central obstruction of numerical aperture is 35 per cent and the focal length is 1·7 mm.

The objective is made to screw on to any ordinary microscope and to be parfocal with normal objectives. To obtain exact achromatism, it is necessary to use an immersion liquid having the same dispersion as fused quartz. Water almost fulfils this requirement, and the small residual chromatic aberration is compensated by slight refraction at the quartz–air interface where the light leaves the objective. Spherical aberration, due to refraction in the water layer between coverslip and objective, is compensated by suitable separation of the two mirrors. The residual spherical aberration is approximately λ/8 for 2500 A. The only aberration which limits field-size is coma, and this reaches the Rayleigh limit[7] at a field diameter of $\simeq$ 50 microns for 5400 A. The objective may be designed for use with any thickness of coverslip up to several millimetres, and hence is very suitable for looking through thick windows on pressure-vessels, etc. Coverslips of 0·5 mm. and thicker have the advantage of not cracking when roughly treated.

Objectives of this type have proved very satisfactory during test. There are no adjustments to make, and the objective is no more difficult to use than any normal refracting immersion objective. Achromatism is exact and, when focused for visible light, the objective is also in focus for ultra-violet. Thus really easy ultra-violet microscopy is made possible for any biologist. The mirror surfaces are in contact with the quartz and protected from deterioration due to the atmosphere.

We would like to thank Prof. J. T. Randall for much encouragement during this work.

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Magnetostrictive Effect and the Δ-*E* Effect in Nickel

In connexion with the communication in *Nature* of December 1, 1951, p. 963, on sound propagation in ferromagnetic materials, the following experiments may be of interest.

Several authors have remarked upon the change of Young's modulus by the Δ-*E* effect in ferromagnetic materials. Giebe and Blechsmidt[1], for example, excited nickel rods in their resonant modes by their magnetostrictive effect, and detected maxima of vibrations by the same principle. They observed alterations of resonance frequencies when the rods were placed in a magnetic field, and ascribed them to changes in the elasticity due to the Δ-*E* effect. They, and others, do not seem to have noticed that the magnetostrictive effect may modify the changes in resonant frequencies caused by the Δ-*E* effect.

Due to the magnetostrictive effect, there is an interchange of vibrational mechanical energy and magnetic energy, and it can be shown that the ratio between these two forms of energy in a longitudinally vibrating magnetostrictive rod in a magnetic field is expressed by :

$$\frac{W_{\mathrm{m\cdot g.}}}{W_{\mathrm{m.ch.}}} = k^2 = \frac{8\,\mu\varkappa\lambda}{\pi^2(2n+1)^2 E},$$

where μ is permeability of material, λ is magnetostrictive constant, ϰ is inverse magnetostrictive constant, E is Young's modulus, $(2n + 1)$ is number of vibrational mode, n being an integer, while k is usually called the coupling constant. For even modes, the coupling constant is zero, and it is consequently impossible to excite a rod by the magnetostrictive effect in these modes. If the rod is surrounded by a coil, the frequencies of the modes where the coupling factor has a finite value will, however, depend on the impedance between the terminals of the coil in addition to the elasticity and density of the material.

If the coil is short-circuited, no induction can be set up by the inverse magnetostrictive effect, and consequently no magnetostrictive force is developed. The resonance frequencies of the rod will in this case depend on the density and the elasticity only,

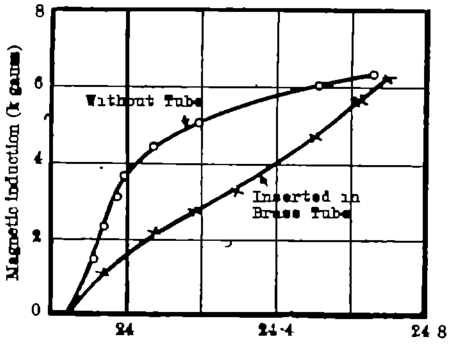

Fig. 1. Deviations of fundamental frequency in nickel rod, with and without surrounding brass tube

the latter modified by the Δ-*E* effect. If, on the other hand, the rod is vibrating in an odd mode, and the surrounding coil is on open circuit, the magnetostrictive force developed will modify the vibrational behaviour of the rod. This last change in resonant frequencies is due to the magnetostrictive effect only, and it is thus possible to separate the two effects. The following measurements show the magnitudes involved.

A laminated nickel rod, 10 cm. long with a cross-section of 1 cm.^{2}, is longitudinally excited at one end, and the vibrations are detected at the other. In order not to have any reaction from the mechanical generator and detector impedances, a thin wire, approximately 1 cm. long, is soldered on to the nickel rod at either end, and the excitation and detection by two Rochelle salt transducers take place through these wires. Thus no electro-mechanical effect in the rod itself is used for excitation or detection. Permanent magnets are used to produce a polarizing field of varying magnitude in the rod. The rod is then excited in its fundamental mode, in which the coupling according to the formula should be a maximum (10–20 per cent in practical cases). First, the rod is vibrating freely, and the change of resonance frequency versus magnetic field is plotted. Next, the rod is inserted in a short-circuited coil in the form of a brass tube. The change in frequency is again plotted against magnetic field. The results of these two measurements are shown in Fig. 1.

As will be seen, the change of resonant frequency caused by the Δ-*E* effect is counteracted by the magnetostrictive effect and in a certain range of magnetic field is of the same order. If the rod is excited in its first harmonic frequency, no coupling occurs, and no difference is measured when the rod is inserted in the brass tube. The change in resonance frequency is now entirely due to the Δ-*E* effect, and Fig. 2 shows the frequency deviations.

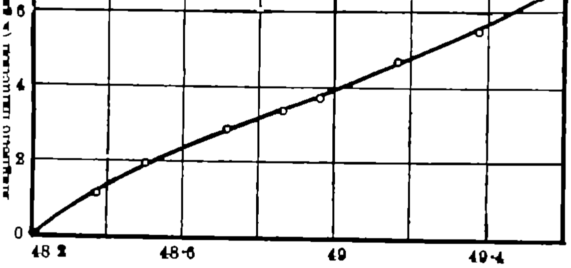

Fig. 2. Deviations of first harmonic frequency in nickel rod

Since the measurements of Giebe and Blechsmidt were carried out at high modes of vibrations, the coupling constant is negligible, and no measurable change would be detected when the impedance between the terminals of the coil is altered. Their results are therefore still valid. For the lower modes, however, the magnetostrictive effect must be taken into account when vibrations are studied.

No measurements were made of the vibrational losses in the rod. It is likely that these will also depend on any induction set up by the magnetostrictive effect, with resulting eddy currents. The present results are part of an investigation into vibrating magnetostrictive systems, and the phenomenon of coupling effects will be presented there in greater detail.

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Ultra-Violet Band System of Strontium Oxide (SrO)

THE investigations hitherto made have shown that three band systems belong with certainty to the strontium oxide molecule (SrO); the first of these is situated in the infra-red, the second in the blue and the third in the ultra-violet region. Mahanti made vibrational analyses of the blue and ultra-violet systems[1]. A vibrational and rotational analysis of the infra-red system, a $^1\Sigma - {}^1\Sigma$ transition, was communicated by us in 1949[2]. This analysis shows that the vibrational frequencies of the lower $^1\Sigma$ state coincide extremely well with those of the lower state of the blue system. Thus for $^1\Sigma$ we found $\omega_e'' = 653{\cdot}4_7$ and $x_e''\omega_e'' = 4{\cdot}0_8$, as compared with $653{\cdot}4_7$ and $4{\cdot}0_8$ for the lower state of the blue system. In our paper we mentioned this agreement and assumed that the infra-red and blue systems have the same lower state. Recently, Budó and Kovács have privately communicated to us that they have made a successful rotational analysis of the blue bands. The transition is $^1\Pi - {}^1\Sigma$, where the lower state is the same as for the infra-red bands.

The ultra-violet band system of strontium oxide, situated between λ 3200 and λ 3700 A., has been investigated with the 21-ft. grating of this institute. The rotational analysis of the 2,0, 1,0 and 0,0 bands shows that the system is a $^1\Sigma - {}^1\Sigma$ transition, where the lower state is the same as that of the blue and infra-red systems. The constants derived for the upper state are

$$B_0' \sim 0{\cdot}272 \text{ cm.}^{-1} \qquad B_2' \sim 0{\cdot}269$$
$$B_1' \sim 0{\cdot}271 \text{ cm.}^{-1} \qquad D' \sim 0{\cdot}3 \times 10^{-6}$$

No upper vibrational constants have yet been calculated. The bands contain several perturbations in the upper state.

From measurements of the band-heads (*R*-heads) of the ultra-violet system, Mahanti has calculated for the lower state of this system $\omega'' = 679{\cdot}13$ and $x''\omega'' = 9{\cdot}13$. At first glance these values do not suggest that the lower state is the same as that for the other systems. The deviations from these values and those obtained from origins are not greater, however, than may be expected.

A more detailed paper on the ultra-violet bands will appear in *Arkiv för Fysik*.

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Spectrum of the Compton Radiation from Solids

THE spectrum of the Compton radiation from *free* atoms has been calculated[1] and was found to consist of a band with a sharp limit towards short wave-lengths. At the same time some 'electronic Raman lines' are supposed to exist between the limit and the line of the primary radiation. In the case of *solids*, this picture should be modified because the discrete energy-levels are replaced by energy-bands. The form of the spectrum will depend on the density distribution of states in the highest occupied energy-zone and in the free zone above it. The sharp limit and the electronic Raman lines will be replaced by broad bands, possibly with a structure. If the highest occupied zone is filled and there is a forbidden zone above it—as in the case of insulators—the broad Compton band should show a limit towards short wave-lengths. The energy shift between this limit and the primary line will be equal to the breadth of the forbidden zone. Although most experiments on Compton scattering have been carried out on solids, such a structure has not yet been observed because of the short wave-lengths used. In the following an account is given of experiments showing the above effect.

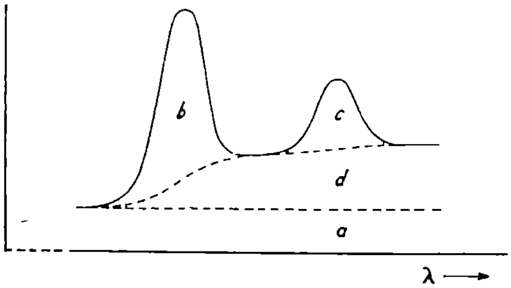
Unfiltered copper radiation is scattered on beryllium and carbon at angles between 17° and 45°. The scattered radiation is collected in a bent crystal spectrometer and is then investigated spectroscopically with a Geiger–Müller counter moved along the Rowland circle. The form of a typical spectrum obtained is shown in the accompanying graph. The surface under the curve can be divided into the following areas: (*a*) background, (*b*) line α_1, (*c*) line α_2, and (*d*) the Compton band.

(*a*) *Beryllium.* Experiments were carried out at angles of 20·5°, 25·5°, 30°, 35° and 40°. In all cases the Compton band starts near the primary line, showing that no limit towards short wave-lengths exists. Also in no position of the spectrum does it show an appreciable maximum.

(*b*) *Graphite.* The Compton band at 17° was found to have the same properties as that of beryllium.

(*c*) *Diamond.* At angles of 17° and 30° the Compton band has no appreciable intensity near the primary line. It could only be measured at longer wave-lengths than the α_2-line. At an angle of 35° its intensity is sufficient to show that it starts between the lines α_1 and α_2 at a position corresponding to a shift of 7·5 eV. from the primary line. A similar hump can be observed at a position of the spectrum that corresponds to a shift of 7·5 eV. from the α_2-line.

The spectra obtained agree fully with the current theory of solids. The electrical conductivity of beryllium leaves no possibility for the existence of a forbidden zone. Also, the fact that the absorption edge coincides with the high-energy limit of the emission line proves that this view is correct.



A graphite single crystal irradiated in such a way that the incident and the scattered radiation are contained in the basal plane should at $T = 0$ give a Compton band with a zero intensity at zero shift and with increasing intensity as the shift increases[2]. The present experiment does not show this behaviour because $T \neq 0$ and because the graphite was polycrystalline.

Diamond has a fully occupied zone that is separated from the next free zone[3] by a forbidden zone of about 7 eV. This has been found from absorption experiments in the ultra-violet. The present experiments also indicate the existence of such a forbidden zone.

A detailed report on the above experiments will appear in the *Arkiv for Fysik*.

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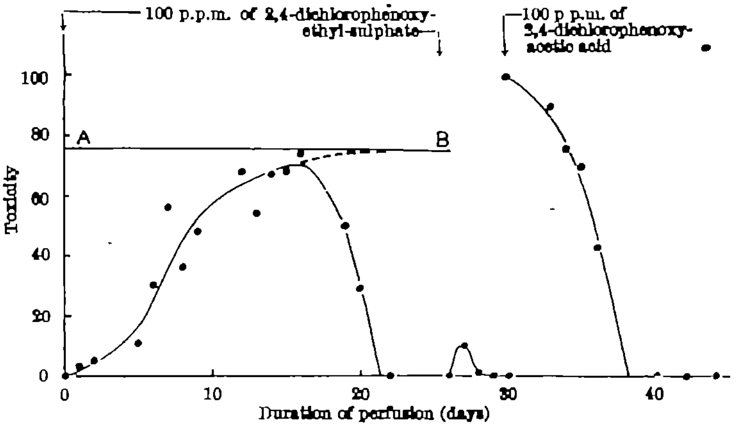
Fate of Sodium 2,4-Dichlorophenoxyethyl-sulphate in the Soil

SODIUM 2,4-dichlorophenoxy-ethyl-sulphate, a chemical of low intrinsic phytotoxicity, can be sprayed in relatively concentrated aqueous solutions on to plants normally sensitive to the hormone herbicides, without serious damage to them; but when it comes into contact with the soil, a high phytotoxicity is generated, sufficient to give satisfactory control of weed-seed germination in the surface layers of the soil[1]. The toxic compound arising from it has been assumed to be 2,4-dichlorophenoxyacetic acid (2,4-D).

To check this assumption, the behaviour of sodium 2,4-dichlorophenoxy-ethyl-sulphate in soil has been followed using the perfusion technique described for previous investigations on the herbicides 2,4-D and MCPA (2-methyl-4-chloro-phenoxyacetic acid)[2]. Solutions of 100 p.p.m. of the substance have been perfused continuously through garden loam and the changes in phytotoxicity of the perfusate followed by the cress root-growth assay technique[3]. The results of a typical experiment are shown in the graph, where toxicity is expressed in 2,4-dichlorophenoxyacetic acid equivalents (p.p.m.). Toxicity is generated slowly at first; but the rate increases up to about the eighth day, suggesting the proliferation of an organism adapted to bring about the interconversion. Later, the toxicity curve flattens out, probably due



Time course of toxicity in soil solutions on perfusing with 100 p.p.m. sodium 2,4-dichlorophenoxy-ethyl-sulphate (two successive perfusions) and then with 100 p.p.m. 2,4-dichlorophenoxyacetic acid

to the exhaustion of the dichlorophenoxy-ethyl-sulphate substrate, and becomes asymptotic to the line *AB*, corresponding to a concentration of 75·5 p.p.m. 2,4-dichlorophenoxyacetic acid, which is the theoretical concentration that would be generated in the perfusate by the complete conversion of the dichlorophenoxy-ethyl-sulphate.

After sixteen days, a rapid fall sets in and all toxicity is lost after twenty days. When 2,4-dichlorophenoxyacetic acid itself is perfused through fresh soil, no change in toxicity is noted for about fifteen days, after which a similar rapid detoxication occurs[1]. These almost identical time-relationships for the two detoxications is a strong indication that the dichlorophenoxy-ethyl-sulphate generates 2,4-dichlorophenoxy-acetic acid. During initial perfusion with dichlorophenoxy-ethyl-sulphate the accumulated 2,4-dichlorophenoxyacetic acid would induce the growth of a population of organisms adapted for its breakdown, giving, therefore, a lag phase characteristic of that organism[2].

The subsequent perfusion of fresh sodium 2,4-dichlorophenoxy-ethyl-sulphate solution (at twenty-six days in this experiment) fails to generate a similar high toxicity. In the first day only a small activity develops, but this disappears in the next twenty-four hours. Obviously the detoxicating organism is capable of destroying all the toxic compound as fast as it is produced. This indicates that the use of dichlorophenoxy-ethyl-sulphate may give satisfactory weed control only with the first application, and that the efficacy of successive treatments after short time intervals may be reduced to a very low level by the development of a population of detoxicating soil micro-organisms.

A solution of 100 p.p.m. 2,4-dichlorophenoxyacetic acid perfused at thirty days was afterwards detoxicated with only a slight lag of about two days, and the maximum rate of disappearance of toxicity was of the same order as that for the first perfusion with dichlorophenoxy-ethyl-sulphate. This means that the detoxicating soil organisms are definitely adapted to 2,4-dichlorophenoxyacetic acid, and this is further indication that the latter was itself the adapting molecule.

Lastly, samples of perfusate were taken during the first dichlorophenoxy-ethyl-sulphate perfusion and run on a one-way paper-partition chromatogram using propanol – ammonia as the developing solvent. The position of the spots of the phytotoxic compound were afterwards determined by sectioning the paper strip and subjecting these sections to a sensitive biological assay. Full details of this assay will be published later. The R_F value of the toxic compound generated from sodium 2,4-dichlorophenoxy-ethyl-sulphate was 0·7, which is identical with that given by 2,4-dichlorophenoxyacetic acid samples run from a fresh solution and also after prior perfusions through soil. Samples of dichlorophenoxy-ethyl-sulphate perfusate have been analysed during the whole of the perfusion period before detoxication sets in, and there is no indication that more than one toxic compound is generated.

There seems little doubt, therefore, that the toxic molecule is indeed 2,4-dichlorophenoxyacetic acid, and that it afterwards behaves in the same way as if added directly to the soil.

I wish to express my thanks to Dr. W. G. Templeman, of Imperial Chemical Industries, Ltd., for supplying me with the sodium 2,4-dichlorophenoxy-ethyl-sulphate, and also to Miss R. F. Thresh, of this Department, for carrying out the chromatogram analyses and the associated biological assays.

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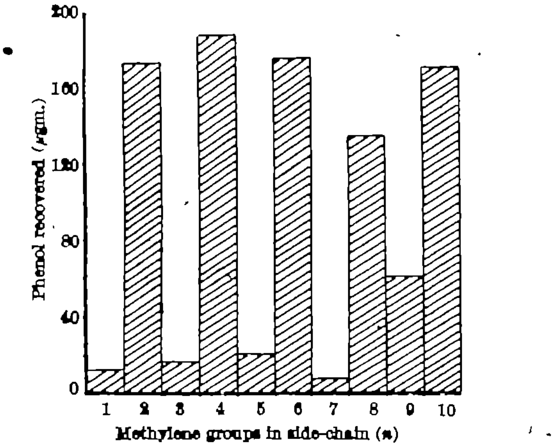
β-Oxidation of ω-Phenoxyalkylcarboxylic Acids in the Flax Plant

SINCE the classical work of Knoop[1] on the β-oxidation of long-chain fatty acids within the animal body, numerous investigations have been carried out in this field. It is now established that such an oxidative mechanism does, in fact, operate in the animal[2]. On the other hand, evidence that β-oxidation occurs within plant tissue is lacking. Synerholm and Zimmerman[3], however, studying a homologous series of seven ω-(2 : 4-dichlorophenoxy)-alkylcarboxylic acids, found an alternation in growth-regulating activity to occur with increasing length of side-chain. The results were consistent with the view that degradation of these acids by β-oxidation was taking place within the plant.

We have synthesized the series of ω-phenoxyalkylcarboxylic acids ($C_6H_5O(CH_2)_nCOOH$) from $n = 1$ to $n = 10$ and have studied their influence on plant growth. These biological results will be discussed elsewhere. Breakdown of the acids within growing flax seedlings has also been investigated, the whole series being included in each of five experiments. The solution of the ammonium salt of the acid ($2 \cdot 5 \times 10^{-3}$ *M*) was supplied through the roots to a uniform group of 200 seedlings during ten days growth in the glasshouse. The seedlings were then washed, macerated with water and the acidified mixture steam-distilled under standardized conditions. Phenol was estimated colorimetrically in the steam

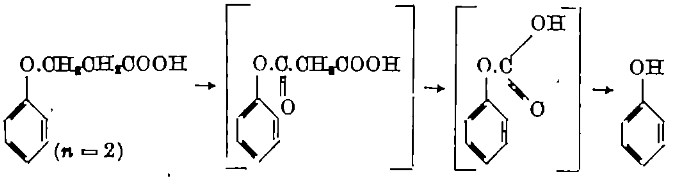


Phenol recovered from 200 flax seedlings following absorption of ω-phenoxyalkylcarboxylic acids ($C_6H_5O(CH_2)_nCOOH$) through the roots (average results from five experiments)

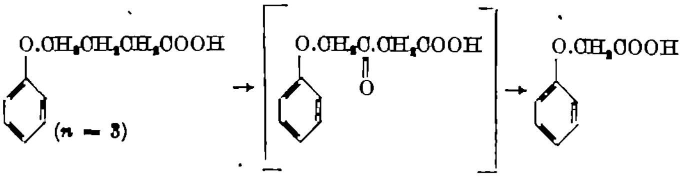
distillate[4]. No phenol was obtained from the compounds in absence of plant material following such treatment. Within the plant, acids with an even number of side-chain methylene groups gave rise to considerable amounts of phenol. No evidence is available on the form in which this phenol existed in the plant. From those acids in which n is an odd number only traces of phenol were obtained.

The results (see histogram) are consistent with the view that β-oxidation of the side-chain takes place as follows[3,5]:

(a)



(b)



Higher homologues might similarly be expected to suffer either repeated or alternating β-oxidation to yield phenol or phenoxyacetic acid. On this basis 9-phenoxynonane-1-carboxylic acid ($n = 9$) was not expected to yield phenol. In fact, in all five separate experiments appreciable phenol was produced. This apparently anomalous result, however, is of interest in connexion with certain animal metabolism studies, for example, the breakdown of β-hydroxyaliphatic acids in pigeon muscle[6], and of saturated triglycerides in human metabolism[7]. In both these investigations the compounds corresponding in chain-length to our phenoxy acids with $n = 8$, 9 and 10 showed different behaviour from the other homologues. These differences were ascribed to the occurrence of ω-oxidation[6,7], a mechanism which on spatial considerations would appear to be restricted to acids of these chain-lengths[2].

This chemical method for investigating degradation of phenoxy acids within living plant tissue is now being extended to the study of fungi and bacteria. In addition, further work involving enzyme preparations from the flax plant is in progress.

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Hydrolysis and Metabolism by Soil Bacteria of Benzoyl Derivatives of D- and L-Forms of some Amino-acids

In a previous communication[1] we have reported that two strains (*KT* 83 and *KT* 82) of soil bacteria were able to utilize benzoyl-D-phenylalanine as well as benzoyl-L-phenylalanine as a sole source of carbon and nitrogen, whereas one strain (*KT* 84) could utilize the L-form but not the D-form, and that benzoyl-D-phenylalanine was hydrolysed by a suspension of either *KT* 83 or *KT* 82, but not by *KT* 84.

We have now studied the hydrolysis and metabolism by *KT* 83 and *KT* 84 of benzoyl derivatives of D- and L-isomers of six amino-acids, phenylalanine, tyrosine, alanine, aminobutyric acid, p-methoxyphenylalanine and 3,4-methylendioxyphenylalanine. At the outset we confirmed that *KT* 84 grew luxuriantly at 25° C. in the synthetic medium containing each one of the benzoyl derivatives of racemic forms of the above six amino-acids as a sole source of carbon and nitrogen, and could be transferred more than three times in succession.

The hydrolytic activity of the bacterial suspension *KT* 84 was then tested upon benzoyl derivatives of the racemic forms of six amino-acids in the presence of toluene, at 37° C. and at pH 7·0–7·2 for five days. We were able to isolate benzoic acid (95–82 per cent, calculated from the L-forms), benzoyl-D-amino-acids (90–80 per cent) and L-amino-acids, which were identified as the benzoyl compounds.

The properties of the compounds obtained in this way were as follow:

Benzoic acid, m.p. 119°–120°	
Benzoyl-D-phenylalanine, m.p. 139°–140°	$[\alpha]_D^{13} = -14{\cdot}9°$ (5·2 per cent in sodium hydroxide)
Benzoyl-L-phenylalanine, m.p. 139°–140°	$[\alpha]_D^{18} = +14{\cdot}8°$ (5·1 ,, ,, ,, ,, ,,)
Benzoyl-D-tyrosine, m.p. 162°–163°	$[\alpha]_D^{14} = -36{\cdot}2°$ (1 6 ,, ,, ,, ,, ,,)
Benzoyl-L-tyrosine, m.p. 162°–163°	$[\alpha]_D^{18} = +35{\cdot}9°$ (1·5 ,, ,, ,, ,, ,,)
Benzoyl-D-alanine, m p. 147°–148°	$[\alpha]_D^{11} = -37{\cdot}2°$ (2·5 ,, ,, ,, ,, ,,)
Benzoyl-L-alanine, m.p. 146°–147°	$[\alpha]_D^{11} = +37{\cdot}0°$ (2 5 ,, ,, ,, ,, ,,)
Benzoyl-D-aminobutyric acid, m.p. 110°–111°	$[\alpha]_D^{15} = -30{\cdot}2°$ (1·2 ,, ,, ,, ,, ,,)
Benzoyl-L-aminobutyric acid, m.p. 110°–111°	$[\alpha]_D^{18} = +30\ 4°$ (3:2 ,, ,, ,, ,, ,,)
Benzoyl-D-p-methoxyphenylalanine, m.p. 135°–136°	$[\alpha]_D^{16} = -\ 7{\cdot}0°$ (5·0 ,, ,, ,, ,, ,,)
Benzoyl-L-p-methoxyphenylalanine, m.p. 135°–136°	$[\alpha]_D^{8} = +\ 6{\cdot}9°$ (5·0 ,, ,, ,, ,, ,,)
Benzoyl-D-3,4-methylendioxyphenylalanine, m.p. 126°–127°	$[\alpha]_D^{13} = +\ 9{\cdot}8°$ (1·4 ,, ,, ,, ,, ,,)
Benzoyl-L-3,4-methylendioxyphenylalanine, m.p. 126°–127°	$[\alpha]_D^{13} = -\ 9{\cdot}7°$ (1 4 ,, ,, ,, ,, ,,)

It was further ascertained that none of six benzoyl D-amino-acids was hydrolysed by the suspension of *KT* 84 even after seven days. In a cultivation experiment, none of six benzoyl D-amino-acids but all six benzoyl L-amino-acids were utilized by *KT* 84.

KT 83 had the power to utilize in cultivation and to hydrolyse in the form of bacterial suspension six benzoyl-D-amino-acids as well as six benzoyl-L-amino-acids. Previously it was reported that the bacterial suspension *KT* 83 had hydrolysed only 34 per cent of benzoyl-D-phenylalanine at 37° during seven days[1]; but, in the present work, we observed that 87–85 per cent, calculated from the benzoic acid isolated, of six benzoyl D-amino-acids was hydrolysed within three days. It seemed that *KT* 83 had become adapted to the substrate during the successive cultivations.

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Soil Bacteria and Chlamydospore Formation in *Fusarium solani*

CHLAMYDOSPORE formation and their numbers have been found to vary between species in the genus *Fusarium* and have been widely used in systematic nomenclature as a key character[1,2]. Nevertheless, no positive evidence has so far been adduced on the causes inducing the formation of this morphological structure, although it is generally presumed to be the result of unfavourable growth conditions. Control of soil-borne infection of various crop plants has been achieved by the addition of specific antibiotics[3] or by suspensions of soil bacteria and their toxins[4-6]. These observations, together with the more recent discovery[7] of plants absorbing antibiotics produced by soil micro-organisms, suggested the probability of this factor stimulating chlamydospore formation in *Fusarium* mycelia.

Two pure cultures of soil bacteria isolated from the black cotton soils of southern India, *B* I (not yet finally identified) and *B* II (*Bacillus licheniformis*), were employed in preliminary trials. Bacterial cells suspended in sterile distilled water were quantitatively added in seeding 2 per cent agar medium poured in Petri dishes. The bacterial-seeded and unseeded media (control) in Petri dishes were inoculated with a soil isolate of *Fusarium solani* and incubated for four days at 27°–29° C. Chlamydospore numbers in unit area were determined microscopically from uniform cork borer disks of the media cut in the centre of the colony surrounding the point of *Fusarium* inoculation (see table).

Both the bacterial isolates stimulated chlamydospore formation significantly. While 0·384 million cells of *B* I increased the number of chlamydospores over the control from 5 to 13, the corresponding figures in the case of *B* II were from 5 to 109. Number of chlamydospores from *A* to *B* to *C* to *D* to *E*, *seriatim*, increased approximately two-fold with each increase in the concentration of *B* I cells.

Series	*B* I		*B* II	
	No. of bacterial cells added (millions)	No. of chlamydospores formed per unit area	No. of bacterial cells added (millions)	No of chlamydospores formed per unit area
A	0·128	8	0·384	109
B	0·384	13	1·152	110
C	0·640	22	1·920	111
D	0·896	41	2·688	120
E	1·152	86	3·456	132
F	1·280	102	3·840	132
Control	—	5	—	5

C.D. at 1 per cent level = 0·4 C.D. at 1 per cent level = 9·0

F E D C B A CONT. *F E D C B A* CONT.

As to the *modus operandi* of bacterial stimulation of chlamydospore formation, it is probably due to antibiotics produced by the bacteria *in situ*, since in preliminary experiments even the addition of bacterial metabolites induced such stimulation in *F. solani*. These observations are of considerable interest, as many *Fusaria* are known to survive in soils under adverse conditions of microbial antagonism[8,9].

I thank Prof. T. S. Sadasivan for his suggestions and interest throughout the course of this work, and Dr. E. W. McCloy, of the London School of Hygiene and Tropical Medicine, for the identification of the bacterial culture.

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Growth-Factor Requirements of *Pellicularia koleroga* Cooke in Pure Culture

A PURE culture (isolate 1) of *Pellicularia koleroga*[1] (*Corticium koleroga*) was isolated from the basidiospores found on *Coffea arabica* leaves, following well-known methods[2]. The fungus grew well on a number of agar media containing fresh extracts of potato, onion, carrot, oat, bean and malt, whereas its growth was very poor on a dextrose nitrate medium. However, when small quantities of malt, yeast, coffee leaf or fungal mat extracts were added to the dextrose nitrate medium, the fungus made good growth. A culture of this fungus obtained from the Centraalbureau voor Schimmelcultures, Baarn, Holland, also behaved similarly, and its growth was even slower. It was therefore felt that *Pellicularia koleroga* may have certain growth-factor requirements.

That many of the filamentous fungi show growth-factor deficiencies when synthetic media are used is well known[3,4]. Pure growth-factors were added singly to flasks containing 20 ml. synthetic medium prepared from analytical quality salts (composition : 2 gm. KNO_3, 1 gm. KH_2PO_4, 0·5 gm. $MgSO_4.7H_2O$, 20 gm. glucose or sucrose, 1 litre glass-distilled water).

The *p*H value of this medium was 5·2; all cultures were incubated for 30 days at 20°–22° C. Both with glucose and with sucrose, a negligible amount of growth was made in the control medium to which no growth-factor was added, and in the media receiving any one of the following: riboflavine, pyridoxine hydrochloride, *d*-pantothenic acid (as calcium salt), nicotinic acid, and *p*-aminobenzoic acid at rates of 250 μgm. per litre; inositol at a rate of 100 mgm. per litre. The responses to thiamine hydrochloride and to biotin, which varied with the carbohydrate source, are shown in the accompanying table.

MYCELIAL DRY WEIGHTS (mgm.)

	With glucose	With sucrose
Thiamine hydrochloride (250 μgm. per litre)	129·5	89·9
(+) Biotin (100 μgm. per litre)	negligible	59·7
Control (no growth-factor added)	negligible	negligible

A further investigation of these interesting effects of thiamine and biotin is in progress.

I am indebted to Prof. T. S. Sadasivan, for his help and guidance during the course of this work.

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Influence of Mineral Nutrition on the Resin Content of the Hop Cone

THE influence of manuring on the resin content of the hop cone (strobile) has been the subject of a number of investigations. Doerell[1] concluded from German and Czecho-Slovakian experiments that the resin content rose when potassium and phosphorus were applied in excess of nitrogen, and more recently Zattler[2], in Germany, has stated that phosphorus has a beneficial effect on resin content, but that excess of potash, and especially of nitrogen, depresses the resins. The depressing effect of nitrogen has also been reported by Keller and Magee[3] in the United States.

Contrary results have, however, been found by other workers. In the Poperinghe district of Belgium, a detailed study of the chemical and physical composition of the soil and its influence on the resin content of the hop was made by de Koker, Verbelen and Van der Velde[4]; no relationship could be found. In England, Burgess[5], in a manurial trial carried out over a period of years, studied the effect of complete omission of nitrogen, phosphorus and potassium on hop growth. The yield of cones was markedly depressed by these treatments, and, in the case of nitrogen and potassium, the plants developed characteristic deficiency symptoms; samples of hop cones were taken from each treatment and from a plot receiving complete nitrogen–phosphorus–potassium manuring, but on analysis no appreciable difference in resin content was found which could be attributed to the manurial treatments.

In view of these conflicting results, and as part of a programme devoted to the study of the mineral nutrition of the hop now being carried out at Wye, the question is being further investigated.

In 1951, samples of cones were taken from a long-term factorial manuring experiment primarily designed to study the effect of different levels of nitrogen, phosphorus, potassium and magnesium on the yield of cones of the Fuggle hop. The samples were analysed for total soft resins and α-acid, and the β-fraction determined by difference. The results obtained are shown in the accompanying table, the figures representing the mean values for totals of sixteen plots.

Treatment		Resin content as per cent of oven-dry cones		
		α-Acid	β-Fraction	Total soft resins
Nitrogen (as N)	300 lb per acre	4·06	7·57	11·63
	400 ,, ,, ,,	4·09	7·46	11·54
Phosphorus (as P_2O_5)	200 ,, ,, ,,	4·15	7·55	11·70
	500 ,, ,, ,,	4·00	7·48	11·47
Potassium (as K_2O)	200 ,, ,, ,,	4·02	7·36	11·37
	400 ,, ,, ,,	4·13	7·67	11·80
Magnesium (as Mg)	28 ,, ,, ,,	4·01	7·40	11·43
	83 ,, ,, ,,	4·14	7·63	11·76

As will be seen from the table, the levels of nitrogen, phosphorus, potassium and magnesium applied to the plots differed widely; but the effect on resin content was negligible, none of the differences found being statistically significant.

Sand-culture experiments using the Fuggle variety were also carried out at Wye in 1951 to investigate the effect of nitrogen, phosphorus and potassium nutrition on resin production. As this was a pilot experiment, the nutrient-levels chosen were necessarily somewhat arbitrary, but they were selected to give wide differences in the levels of nitrogen, phosphorus and potassium as follows:

Nitrogen	50 p.p.m. and 500 p.p.m.
Phosphorus	10 p.p.m. and 200 p.p.m.
Potassium	25 p.p.m. and 500 p.p.m.

Under the low-potassium treatment, the hop plants produced no cones; but samples were taken from all the other treatments and these showed no appreciable differences in resin content with the exception of the high-phosphorus treatment; this produced cones which were low in resins, but which were abnormal in that they were small and underdeveloped.

To date, these experiments lend support to the earlier findings of Burgess and the Belgian workers that mineral nutrition has little influence on resin-production in the hop cone.

The experiments are being continued and will be reported in full elsewhere at a later date.

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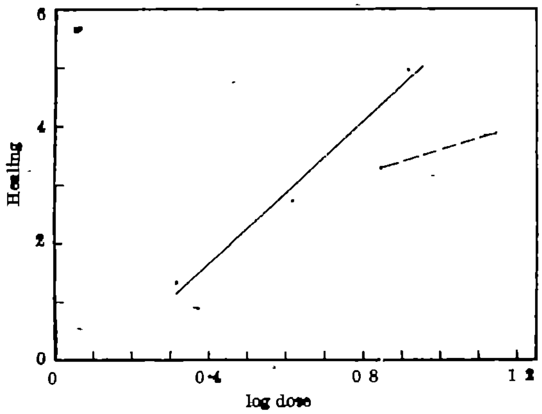
A Factor in Hay Inhibiting the Action of Vitamin D

During our investigation on the vitamin D content of hay in Holland, started in 1950, the impression soon arose that hay contains a factor antagonistic to vitamin D.

It was noticed repeatedly that the regression line, indicating the relation between recovery of rachitic rats and the logarithm of the dose of pure vitamin D, showed a higher—sometimes a substantially higher—regression coefficient than the analogous regression line of the fat from hay under examination (see graph). Doubling the dose of hay fat scarcely ever resulted in the recovery which would be anticipated from the initial dose applied.



———, Standard ; — — —, hay fat

Statistical calculation showed that the difference in slope of the lines for each individual experiment was not at all significant; in other words, the regression lines could be considered as running parallel.

As more experimental results became available, we were able to find out whether the two groups of regression coefficients indicated real differences. The results are summarised in Table 1. Only those experimental results have been inserted for which it could be assumed that they were on the straight part of the sigmoid curve indicating the relation between the log-dose and recovery.

Table 1

Exp. No.	Regression coefficient		Difference
	Standard	Hay fat	
1	3·87	1·46	− 2·41
6	6·12	1·99	− 4·13
7	5·31	2·99	− 2·32
	5·31	2·99	− 2·32
8	6·10	4·32	− 1·78
11	4·07	3·16	− 0·91
13	6·56	3·46	− 3·10
	6·56	7·65	+ 1·09
14	5·27	2·09	− 3·18

Mean difference, $\bar{d} = 2·12$; standard error, $s_{\bar{d}} = 0·50$; t(exp.) = 2·12/0·50 = 4·240; t(theor.) ($P = 0·01$) = 3·355.

It was evident from this that there was a highly significant difference between the regression coefficients of the standard and the hay-fat regression lines.

To prove in another way also that hay contains an anti-vitamin D substance, we have, from May to October 1951, added to hay fat definite quantities of vitamin D and investigated whether these could be recovered. We have noticed in the meantime that we have followed thereby the same course as Grant[1], and we arrived at exactly the same results.

During a fortnight, a few groups of eleven rats each were fed daily a quantity of hay fat, corresponding to 0·6 gm. of hay, contained in 0·2 c.c. of arachis oil. Other groups were given additionally 0·3 I.U. of vitamin D in the hay-fat solution. We were never able to recover the extra quantity of vitamin D supplied in that way. The quantity lost varied from 20 to 50 per cent. Neither was it recovered if the vitamin D and the hay fat were given separately at an interval of 8 hr., by supplying the vitamin D in the morning and the hay fat at night, and allowing the rats to take food during the day (Table 2). The inhibiting action of hay, therefore, cannot be attributed to a decreased absorption or destruction of vitamin D in the digestive tract, but is effective in the body after resorption from the gut.

Table 2

Exp. No.	Daily dose	X-ray healing	Vitamin D based on healing effect	Deficit (per cent)
10*A*	Fat of 0·6 gm. hay in 0·2 c.c. oil	1·56	1·98 I.U.	
	Fat of 0·6 gm. hay with 0·3 I.U. vit. D in 0·2 c.c.	3·32	5·28 ,,	21
10*B*	Fat of 0·6 gm. hay in 0·2 c.c. oil	2·80	3·96 ,,	
	Fat of 0·6 gm. hay with 0·3 I.U. vit. D in 0·2 c.c.	3·82	7·04 ,,	27
16	Hay fat in 0·2 c.c. oil	2·63	1·50 ,,	
	Hay fat with 0·4 I.U. vit. D given together	3·96	8·21 ,,	35
	Hay fat and 0·4 I.U. vit. D given separately	3·67	7·21 ,,	53

The antivitamin D factor (which we assume to be the same as that found by Grant) must be rather stable, as it has been found in hay as well as in dried grass. Furthermore, it is not only soluble in ether but also in petroleum-ether (b.p. 40–60° C.). The factor is resistant to saponification, as we could demonstrate it in the unsaponifiable fraction of hay fat.

The discovery of this factor inhibiting vitamin D may offer a partial explanation of the fact that some authors have not been able to find any vitamin D in fresh and artificially dried grass, whereas others could, and also of the unexplainable large differences in the vitamin D content sometimes noticeable in hay.

It is too early yet to offer an opinion on the importance of the anti-vitamin D factor as regards practical animal feeding. Our experiments with rats show in any event that the action of vitamin D can be diminished by 20–50 per cent by the factor. It is not at all certain that with cattle, for example, the effect will be exactly the same. That the existence of the factor can raise difficulties in practical feeding is clear from the observations on sheep recorded by Fitch[2] and Ewer[3] in New Zealand.

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Corticium praticola Kotila; an Interesting Basidiomycete occurring in England

The usual forms of *Rhizoctonia* when grown on agar culture remain sterile, and are differentiated mainly on the basis of vegetative characters. During a study of the occurrence of *Rhizoctonia solani* Kuhn in England, a number of isolates falling within the limits of the form genus *Rhizoctonia* regarding vegetative characters formed basidiospores freely on agar cultures. These isolates were afterwards identified as *Corticium praticola* Kotila[1], although the measurements of basidia, sterigmata and spores were all slightly larger than those given by Kotila.

This is the first record of this fungus from Great Britain, and the first confirmatory record of Kotila's original work. D. P. Rogers[2], in dealing with the genus in 1943, failed to accept the species due to absence of original material and lack of confirmatory isolations.

The fungus was obtained from four widely separated localities in England. At Slough and Bristol, soil was very heavily infested with the organism, and at Cheshunt and Leeds it was found causing foot rot of cucumber and rot of dahlia petioles and leaves respectively. It is probably of common occurrence and may have been isolated previously not only in England but also in other countries and included under *R. solani*. As supporting evidence for this suggestion, isolates closely agreeing with the English ones have been obtained from several soils in South Australia during 1951. Although these isolates have not yet been induced to form basidiospores, they have been temporarily classified as *C. praticola*.

C. praticola differs from *R. solani* in its thinner hyphal diameter (6–9 μ, *C. praticola*; 8–12 μ, *R. solani*), faster growth-rate (0·55 mm. per hour, *C. praticola*; less than 0·5 mm. per hour, *R. solani*), and by the white mealy appearance of its mycelium later turning greyish-brown, in contrast to the felt-like cinnamon-brown of *R. solani*.

C. praticola is pathogenic to sugar beet seedlings above 15° C. and to a wide variety of hosts, including lettuce, tomato, cabbage and dahlia, at temperatures of 23°–25° C. and above. This fact, together with its vigorous saprophytic growth, makes it a potential danger, particularly if it becomes established in vegetable-growing areas. In South Australia the organism has caused severe losses of tomato seedlings being raised under warm conditions in nurseries.

As a laboratory organism, *C. praticola* is useful for teaching purposes. When grown on a soil extract agar with 0·1 per cent added sugar, the fruiting structures can be clearly demonstrated with little visual interference from sterile hyphæ. In view of its close similarity to *R. solani*, it may also prove a useful tool in aiding our understanding of the various isolates of *R. solani* and their relationship with *Corticium solani*.

The fungus was isolated while working in Prof. W. Brown's laboratory at the Imperial College of Science and Technology, London.

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Isolation of Triploid *Saccharomyces cerevisiæ*

The production of tetraploids in a brewery yeast has been reported by Subramaniam and Krishna Murthy[1] and Mitra and Subramaniam[2], following treatment with acenaphthene and chrysene. These authors did not present genetic evidence to support their claim, which was based mainly on colony and other gross observations. Cytological evidence has recently been presented for a tetraploid with four chromosomes, derived from a "diploid two chromosome . . . strain"[3]. Tobias[4] studied a yeast isolated after acenaphthene treatment in terms of survival after X-irradiation, and concluded that the isolate was tetraploid. DeLong and Lindegren[5] have characterized certain strains of *Saccharomyces cerevisiæ* as triploid and tetraploid, based on the shapes of survival curves after ultra-violet irradiation. A paper by Lindegren and Lindegren[6] has recently appeared, describing the production of tetraploid yeast by crosses of diploids homozygous for complementary mating types. We wish to give a preliminary report on a procedure for the isolation of pure triploid clones of *S. cerevisiæ*.

A diploid clone was isolated (by the method of Pomper and Burkholder[7]) which required adenine and uracil for growth, that is, was homozygous for recessive alleles for adenine and uracil syntheses. This diploid was heterozygous for mating type (*a* and α of Lindegren and Lindegren[6]), and for genes involved in the syntheses of methionine and tryptophane. Haploid clones of both mating types, requiring methionine and tryptophane for growth (the same loci for which the diploid was heterozygous), were available to us. The diploid was mixed with both haploids (in separate tubes) by the 'mass mating' procedure of Lindegren and Lindegren[6]. After incubation for three days at 25° C., the cells were washed and plated on agar containing carbohydrate, nitrogen, vitamins and buffer, but lacking adenine, uracil, methionine and tryptophane. Under these conditions, neither the haploids nor the diploid should be able to grow, and, indeed, control plates had no colonies. However, a few colonies appeared on the plates from both 'crosses'. These were isolated as presumptive triploids. Since it was possible that we had merely isolated either doubly reverted diploids or haploids, it was necessary to carry out further tests to evaluate the assumption that these isolates were indeed triploids.

Neither the haploids nor the diploid employed in these crosses could themselves sporulate under ou test conditions. The observation that the 'triploid' isolates sporulated lent support to the belief that the test isolates were, at least, different from the origina components of the cross. Dissections were carried ou on asci from the 'triploids' arising from both crosses Examination of the mating-type behaviour of th ascospore isolates revealed that a number of them did not conjugate with tester stocks of either matin type.

In one ascus, two of the four spores mated and two did not. The latter pair were found t sporulate; the former did not. The sporulatin ascospores behaved as typical diploids and segregate for mating type, thus explaining the failure of th parental spores to mate. The conclusion appear justified that the parent culture had produced tw haploid and two diploid clones, and further, that th parent was probably a triploid or its nuclear equiv alent. Additional supporting evidence will be presented in a subsequent, more detailed, report. It should also be noted that tetraploids have been isolated by an analogous procedure.

It is a pleasure to acknowledge the assistance of Mrs. K. M. Daniels and Mrs. D. W. McKee. This work was performed under contract No. W-7405-eng for the Atomic Energy Commission.

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Apparent Fumigant Action of Non-volatile Insecticides in African Huts

DURING the course of experiments conducted by one of us (G. D.[1]) on the residual action of various insecticidal preparations applied to the interior of native-type African houses, a pronounced fumigant-type action was found in houses treated with preparations of DDT and dieldrin.

Since then, tests have been done (G. F. B.) by filtering the air in a hut sprayed with dieldrin wettable powder five weeks previously. The apparatus used consisted of fumigant chambers made from 1-lb. glass jars fitted with waxed bungs. Air was removed from the top of the jar through a tube by means of a filter pump; fresh air entered through an upright funnel and was delivered at the bottom of the jar. The funnel had a screwed ring by means of which a disk of filter paper cut to size could be firmly stretched over the mouth of the funnel. The whole apparatus was sealed with paraffin wax. To reduce control mortalities, the jars were lined with a rough-surfaced paper and a piece of moist cotton-wool was put in the jar, the air passing over this as it was delivered. The jars were also covered with a dark cloth. Owing to a breakage in transit, the control could not be run at the same time as the test, and was carried out separately in the field laboratory.

Air was sucked through the single jar at 90 litres/hr. for forty minutes, and as a filter one thickness of Whatman No. 1 filter paper used. The house to be tested had been sprayed five weeks before (November 26, 1951) with dieldrin wettable powder to give an estimated deposit of 40 mgm. dieldrin per square foot.

Twenty to forty female *A. gambiae* and *A. funestus* mosquitoes were used in each test. Of the four trials carried out in the treated house, two were done with the funnel leaning against the wall in the darkest and the quietest corner, and two with the jar suspended just beneath the roof. In each of these positions one trial was made with the filter in position. The two other trials were done without filters; for the one near the wall, the filter-paper was simply removed, but when the jar was hung close to the roof the bung and funnel were taken off and the jar covered with mosquito gauze, the suction tube passing through this to the bottom of the jar.

Deaths 18 hours after exposure are given in the accompanying table.

		Number dead	Total	Percentage dead
Dieldrin with filter	(*a*) Wall	3*f*	9*g* + 5*f*	21
	(*b*) Roof	2*f*	8*g* + 22*f*	7
Dieldrin without filter	(*a*) Wall	2*g* + 21*f*	5*g* + 37*f*	55
	(*b*) Roof	2*g* + 23*f*	2*g* + 23*f*	100
Control		5*f*	5*g* + 29*f*	15

g = *A. gambiae*. *f* = *A. funestus*

Thus the apparent fumigant action is due to solid particles too large to pass the filter paper.

Further laboratory trials indicated that DDT and dieldrin wettable powders sprayed on to mud, plywood and glass all produce lethal particles. Thus an important source of such particles in a mud-walled hut may be the roof. However, mosquitoes caged close to the wall usually suffer higher mortalities than those suspended in the middle of the hut. The presence of lethal particles may help to explain why the efficacy of DDT insecticides on a practical scale, for example, against *A. gambiae* and *A. funestus* in Mauritius[2] and *A. darlingi* in British Guiana[3], has been greater than might be expected from laboratory and semi-field trials[4,5]. Insects activated to flight by contact with DDT[6] either on the substrata or as airborne particles would pick up more airborne particles in a given time than if they remained at rest[7]. Dr. G. Giglioli has recently informed us that in British Guiana he has been able to detect airborne particles of DDT for up to two years after spraying a house with non-absorbent walls.

There remains the question of any possible danger to health from these particles when those of the newer insecticides are breathed in for a period of years. The manufacturers of dieldrin now take a more optimistic view than they originally did of its toxicity to human beings (information supplied by the Shell Chemical Co. of Africa). DDT has already been used for many years without reported cases of ill-effects from inhaling drifting particles in houses. Dieldrin is applied at 20 per cent or less of the rate at which DDT is used. Unless it is correspondingly more toxic, the risk of using this exceptionally efficient preparation appears small.

Our thanks are due to the Colonial Insecticide Committee for permission to publish this note.

G. DAVIDSON

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G. F. BURNETT

Colonial Insecticide Research Unit,
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Aug. 5.

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An Extended Orcinol Test Specific for Ketose Sugars

The formation of coloured products when sugars are heated with orcinol and mineral acids has long been known[1,2], and the reaction has been used for the detection and estimation of various sugars and related compounds. Thus Vasseur[3] states that the absorption curves for the products formed from pentoses, aldo- and keto-hexoses and methyl pentoses all differ from each other, but that the colours are not stable. According to Nozoe[4], the colours formed are due to the formation of furfural derivatives, and several pigments are formed successively, the final result being dependent on the acid concentration employed.

It has now been found that ketoses or ketose-containing sugars yield products which are soluble in aqueous alkalis with an intense orange-brown colour; by carrying out the reaction in the manner described below, it is possible to distinguish between ketoses and other sugars, and even between ketoses and keto-aldonic acids.

The most satisfactory procedure was found to be as follows: In a test-tube are mixed 5 c.c. of a 0·5 per cent solution of orcinol in *n*-butanol, 1 c.c. of concentrated hydrochloric acid and about 0·2 c.c. of a 5 per cent solution of the sugar to be examined. The mixture is heated to boiling, allowed to stand for five minutes and then diluted with 10 c.c. of water. The diluted mixture is shaken, allowed to separate into two layers and the upper butanol phase removed. The colour of the latter is noted; the butanol layer is then shaken with 10 c.c. of 4 per cent caustic soda solution, the mixture allowed to separate, and the colour of the two phases noted.

The colours obtained by this procedure, with various types of sugar, are given in the accompanying table.

Sugar	Type	Colour in acid butanol phase	Colour in alkaline butanol phase	Colour in alkaline aqueous phase
Xylose Arabinose	Aldopentose	Pale blue	Nil	Nil or very pale brown
Glucose Galactose Maltose Lactose	Aldose C_6 or C_{12}	Pale yellow	Nil or very pale yellow	Yellow
Fructose Sucrose Raffinose	Ketose or ketose-containing compound	Emerald green	Yellow with green fluorescence*	Deep orange-brown
2-Ketogluconic acid 5-Ketogluconic acid	Ketoaldonic acid	Nil Greenish-yellow	Nil Orange†	Nil Yellow-orange
Galacturonic acid	Uronic acid	Nil	Nil	Nil

* Aqueous phase much more strongly coloured than butanol phase.
† Aqueous phase less strongly coloured than butanol phase.

Since 5-hydroxymethylfurfural was found to give the same colour reactions as fructose, and furfural the same reactions as the pentoses, it seems probable that these aldehydes are intermediately involved in the test, as claimed by Nozoe[4]. In the case of 5-ketogluconic acid, 5-carboxyfurfural is the most probable intermediate, while with uronic acids and 2-ketogluconic acid the conditions of the test are not sufficiently drastic to effect their conversion into furfural.

I am indebted to Prof. L. F. Wiggins for his interest in this work.

J. Howarth Williams

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Imperial College of Tropical Agriculture,
Trinidad.

May 9.

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[1] Bial, M., *Deut. Med. Woch.*, 28, 253 (1902).
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A Sparing Effect by Formate or Methanol on the Impairment of Creatine Metabolism in Folic Acid Deficiency

In a recent communication[1] we reported on an involvement of dietary folic acid and vitamin B_{12} in creatine metabolism. The observations suggested that deficiencies of these vitamins were interfering with the economy of labile methyl groups. It has been established that the methyl groups of choline and methionine may undergo oxidative degradation to formate[2,3] and that the utilization of such metabolically derived formate for serine synthesis[4] and possibly in other single-carbon addition reactions such as nucleic acid formation[5] involves mediation of folic acid; this vitamin is also directly concerned with formate production from glycine[6]. It seemed possible, therefore, that the influence of folic acid on creatine formation might in part at least be due to a check on the drain of methyl to formate resulting in its increased availability for transmethylations (cf. ref. 6). A direct proof of this postulate was sought in the studies reported here on the influence by mass effect of administered formate on *in vitro* and *in vivo* creatine synthesis in mice suffering from folic-acid deficiency and in normal mice. Methanol was also used in place of formate since it functions better (see ref. 2) in the reverse step of formate reduction to methyl[2,3].

Twenty-four adult mice (inbred Swiss strain) were maintained on a folic acid-free purified ration[1] with 15 gamma per cent of vitamin B_{12} and 0·3 per cent iodinated casein. At the end of five weeks, when folic-acid deficiency could be inferred from observations on red and white cell counts and hæmoglobin contents, the animals were divided into groups of four (see table) receiving as supplements folic acid (10 gamma/mouse/day, orally) and sodium formate or methanol (1 mgm./mouse/day, intraperitoneally) with corresponding controls. Animals from each group were sacrificed at the end of 5, 8 and 9 days from the commencement of this grouping, for determinations of *in vitro* and *in vivo* creatine formation by earlier procedures[1]. The data for creatine

Group	Creatine		
	In vitro synthesis (γ per gm. of liver)	Per cent in wet muscle	In 24-hr. urine (mgm. per 100 gm. body-weight)
Basal diet (no folic acid)	116	0·257	1·57
Basal diet + formate	135	0·260	1·08
Basal diet + methanol	184	0·270	1·73
Basal diet + folic acid	203	0·288	1·80
Basal diet + folic acid + formate	210	0·293	1·80
Basal diet + folic acid + methanol	225	0·312	1·88

synthesis *in vitro* are exclusive of any Jaffe-reactive product that may have been formed from the added methionine by the D-amino-acid oxidase of the liver homogenates[7], since necessary controls[1] were run concurrently; creatine synthesis was further confirmed on paper chromatograms. Typical results are presented in the table and were essentially similar in the three periods of sampling.

It can be seen that the impairment in creatine metabolism brought about by folic-acid deficiency is partially restored by the administration of methanol; the effect due to formate is less pronounced. Similar results have been obtained in other studies on the N¹-methylation of nicotinamide[8].

The relatively less significant effect of methanol or formate supplementation in the groups receiving folic acid suggests that, if these compounds were functioning as methyl precursors, folic acid does not exert any direct effect on this synthetic step. This is in harmony with other observations (unpublished) on the probable direct non-participation of folic acid in methyl neogenesis from administered methanol and serine.

This work is supported by a grant from the Indian Council of Medical Research.

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March 18.

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Response of the Vaginal Epithelium of the Ovariectomized Mouse to the Systemic and Local Administration of Œstrone

IN the ovariectomized mouse, vaginal cornification follows the administration of œstrogens systemically (for example, by subcutaneous injection), or locally by their direct application to the vaginal epithelium. However, the median effective dose for all 'true' œstrogens is considerably lower for the local method of administration than for the systemic method[1].

Histological and histochemical observations on the process of cornification elicited by the two routes of administration have been made. No qualitative differences were noted. Freud[2], in a similar investigation with rats, also failed to detect any differences. However, there are temporal differences in the onset of cornification, and also its duration, between the two methods of administration. Emmens[1] has already reported that cornification is attained about a day earlier with local administration. His observations were obtained in assays in which the doses used were not expected to produce cornification in all animals. The phenomenon has been reinvestigated using two dose-levels both of which were calculated to elicit a positive response in all animals.

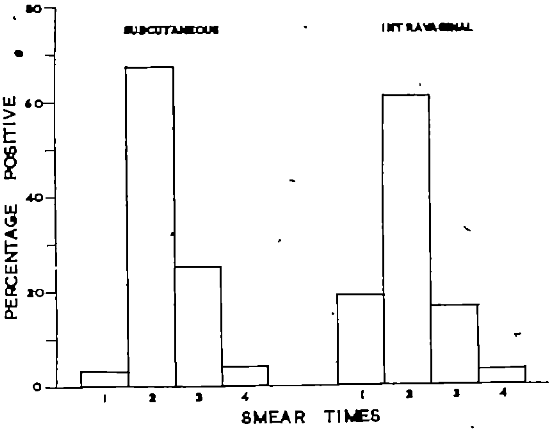
(1) *Onset of cornification.* 240 mice were used in two batches, the first of 95 and the second of 145. The mice were housed in boxes, five animals in each box. The boxes of each batch were divided at random into four approximately equal groups corresponding to the four experimental treatments shown in Table 1. Half the animals received œstrone in nut oil administered subcutaneously, and the remainder received œstrone in distilled water administered intravaginally. Two dose-levels were used for each route of administration (see Table 1). The lowest doses in each case are about 7–10 times the median effective doses reported elsewhere for this strain of mice[3]. A two-injection technique was used as described by Emmens[1]. Smears were taken night and morning, commencing the night after the second injection. The establishment of cornification was determined by the appearance of the first positive smear, that is, one consisting predominantly of cornified cells, and no leucocytes. Each smearing time was given a number to provide a basis for classification. The results from each experiment were combined and are shown in Table 1.

Table 1. TIME OF ESTABLISHMENT OF CORNIFICATION BY THE SUBCUTANEOUS AND INTRAVAGINAL METHOD, EACH AT TWO MAXIMAL DOSE-LEVELS OF ŒSTRONE

Smear time	Subcutaneous			Intravaginal		
	Low dose (0·5 µgm.)	High dose (2·5 µgm.)	Total	Low dose (0 005 µgm.)	High dose (0 025 µgm.)	Total
1	2	2	4	12	11	23
2	38	42	80	38	36	74
3	17	13	30	12	8	20
4	2	3	5	1	3	4

The results obtained with each route of administration were as follows: (i) *Subcutaneous.* Owing to the low group numbers at smearing times 1 and 4, adjacent groups must be combined for the statistical analysis. This gives a 2 × 2 contingency table. No statistically significant differences were found between the groups ($\chi^2_{[1]} = 0{\cdot}44$, $P > 0{\cdot}05$), showing that the dose-level makes no difference to the time of onset of cornification. (ii) *Intravaginal.* In this analysis the results from smearing times 3 and 4 were grouped, giving a 2 × 3 contingency table. No statistically significant differences were found between the groups ($\chi^2_{[2]} = 0{\cdot}06$, $P > 0{\cdot}05$), again showing that the dose-level makes no difference to the time of onset of cornification.

Since the dose-level was without influence on the time of cornification, the results for each method of administration were added together for each smearing time. This gives a 2 × 4 contingency table allowing a comparison to be made between each method of injection. The combined figures are given as marginal totals in Table 1. A statistically significant difference was found between the two methods ($\chi^2_{[3]} = 15{\cdot}70$, $0{\cdot}01 > P > 0{\cdot}001$). The results are illustrated graphically in the accompanying histogram. They show that the onset of cornification in the intravaginal method is approximately twelve hours in advance of the onset in the subcutaneous method. This confirms the finding of Emmens[1].



(2) *Duration of cornification.* Emmens[4] showed that the duration of cornification with the subcutaneous route of administration depends on the dose of œstrogen administered. The effect of dose on the duration of cornification in the intravaginal method has been investigated. Smears were taken from the intravaginal groups in the second batch of animals throughout the period of cornification. Table 2 shows the times when negative smears returned.

Table 2. Time of Reappearance of Negative Smears in the Animals Receiving Two Maximal Dose-levels of Œstrone Intravaginally

Smear time	Low dose	High dose
4	18	9
5	11	11
6	11	15

Although there might be a slight tendency for the effect of the high dose to persist for a longer period than the effect of the low dose, on statistical analysis no significant difference between the two distributions was detected ($\chi^2_{[1]} = 3·30$, $P > 0·05$). On the evidence available, therefore, there is no reason for supposing that dose-level influences the duration of cornification by the intravaginal method. However, it is possible that with wider dose intervals, such as those used by Emmens, differences in the duration of cornification would become apparent; this question requires further examination.

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April 28.

[1] Emmens, C. W., "Hormone Assay", Chapter 16 (Academic Press, New York, 1950).

[2] Freud, J., *Acta brev. neerl. Physiol.*, 9, 11 (1939).

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Two Forms of 1 : 2 : 3 : 5 Tetra-Acetyl D-Ribofuranose

In a recent communication, Davoll, Brown and Visser[1] have described two forms of 1 : 2 : 3 : 5 tetra-acetyl D-ribofuranose. The form first obtained had melting point 56°–58° and was probably identical with the compounds of Howard, Lythgoe and Todd[2], and of Bredereck and Hoepfner[3]. This substance changed spontaneously into another, melting point 85°, proved to be identical with the 1 : 2 : 3 : 5 tetra-acetyl D-ribofuranose of Zinner[4]. The transformation was reported to be accompanied by a change in specific rotation from $[\alpha]_D^{20} - 3·6°$ to $- 13·5°$ (in methanol).

Some time ago, I prepared this compound (using the method of Zinner[4]) in the lower-melting form (melting point 56·5°–57°). When a comparison with the higher-melting form (generously provided by Dr. Zinner, of Jena) was attempted, the whole of the material isomerized, and the form of melting point 56·5°–57° can no longer be prepared in this laboratory. This isomerization, however, proceeded without any significant change in specific rotation; $[\alpha]_D^{22}$ for the low-melting form $- 13·2 \pm 1°$; for the high-melting form $- 12·0 \pm 1°$ (both in chloroform). The case thus seems to be a simple (though very striking) one of dimorphism, and the speculations of Davoll *et al.*[1] regarding structural isomerism are probably unnecessary.

It would be of great interest, however, if workers in some laboratory uncontaminated with the higher-melting form would re-examine the transformation polarimetrically, since there is a definite contradiction between the results of Davoll *et al.*[1] and those I have obtained.

Kathleen R. Farrar

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July 29.

[1] Davoll, J., Brown, G. B., and Visser, D. W., *Nature*, 170, 65 (1952).

[2] Howard, G. A., Lythgoe, B., and Todd, A. R., *J. Chem. Soc.*, 1052 (1947).

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Disadvantages of Race Mixture

In the modified Unesco statement on the nature of race, issued at the Fourth International Anthropological Congress in Vienna on September 7, we find the incautious affirmation that "there is no evidence that race mixture produces disadvantageous results from a biological point of view". To cite a single case, there is recent evidence[1] that sickle-cell anæmia, a fatal disease, occurs with much higher frequency in American Negroes having some white ancestry than in African Negroes of pure descent, although the latter show a much higher frequency of the sicklæmia trait, which is without symptoms.

Similarly, the *Rh*-negative gene, which is responsible for the death of countless Caucasian infants and fœtuses, has been traced to prehistoric crossing between the Basques and peoples speaking the Indo-European languages. These crosses probably began at least as early as the Neolithic; but their effects on the death-rate of European infants and fœtuses (erythroblastosis) are still unabated. Here is ample evidence that race mixture can be disadvantageous in its racial effects.

R. Ruggles Gates

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Sept. 9.

[1] Lehmann, H., *Nature*, 167, 931 (1951).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, November 24

Society of Chemical Industry, Plastics and Polymer Group (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Discussion on "Polymer-Solvent Interaction".*

Chemical Society, Oxford Section (in the Physical Chemistry Laboratory, South Parks Road, Oxford), at 8.15 p.m.—Dr. D. A Dowden . "Industrial Catalysis" (Alembic Club Lecture). (All Fellows are invited)

Tuesday, November 25

Royal Institution (at 21 Albemarle Street, London, W.1), at 5.15 p.m —Mr. W. A. Allen and Mr. P. H. Parkin . "The Acoustic Design of Auditoria". (Further Lectures on December 2 and 9.)

Royal Society of Arts, Commonwealth Section (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p m.—Dr. C. F. Hickling . "The Expansion of Fisheries in the Colonial Empire".

Society of Public Analysts and Other Analytical Chemists, Physical Methods Group (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 6 p.m —Annual General Meeting ; at 6 30 p m —Papers on "Forensic Science".

Society of Instrument Technology (joint meeting with the Control Section, at Manson House, 26 Portland Place, London, W.1), at 6.30 p m —Symposium on "Control Valves".

Tuesday, November 25—Wednesday, November 26

Institution of Gas Engineers (at Church House, Westminster, London, S.W 1), at 10 a.m. each day —18th Autumn Research Meeting

Wednesday, November 26

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2 30 p m —Mr George F. Underhay : "Raw Materials for Paper".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Institution of Electrical Engineers (joint meeting of the Supply and Measurements Sections, at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p.m —Mr. D. McDonald . "The Electrolytic Analogue in the Design of High-Voltage Power Transformers" . Dr. K F Sander and Mr. J. G. Yates : "The Accurate Mapping of Electric Fields with an Electrolytic Tank".

Illuminating Engineering Society (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m —Discussion on "Home Lighting".

Society of Chemical Industry, London Section (joint meeting with the Food Group, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6 30 p.m.—Rt. Hon. the Earl of Halsbury : "Science, Industry and Society".

Wednesday, November 26—Thursday, November 27

Iron and Steel Institute (at 4 Grosvenor Gardens, London, S.W.1), at 10 a m. each day.—Autumn General Meeting.

Thursday, November 27

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p m.—Prof. S. E. Hollingworth "Hunting Sulphur in the Andes".*

University of London (at the Institute of Psychiatry, Maudsley Hospital, Denmark Hill, London, S.E.5), at 3 p.m.—Prof. J Elkes : "Some Uses and Limitations of Pharmacological Method in Psychiatric Research".*

University of London (in the Chemistry Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. N. F. Mott, F.R.S. "Dislocations and the Properties of Solids".* (Further Lectures on December 4 and 11.)

Royal Aeronautical Society (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S W.1), at 6 p.m. —Colonel H. T. Jessop : "Photoelasticity and Aircraft Research".

Friday, November 28

Physical Society (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Presentation of the 29th Duddell Medal and Prize to Mr. C. Waller, and the presentation of the 8th Charles Vernon Boys Prize to Dr. B. Bleaney ; Mr. C. Waller : "Some Topics concerning the Production and Application of Nuclear Emulsions" ; Dr. B. Bleaney : "Paramagnetic Resonance at Low Temperatures".*

Institution of Mechanical Engineers (at Storey's Gate, St James's Park, London, S.W.1), at 5.30 p.m.—Mr. Herbert Addison "Instruction and Research in Hydraulic Laboratories".

Royal Institution (at 21 Albemarle Street, London, W 1), at 9 p.m —Dr. Derek J. Price . "Chaucer's Astronomy".

Saturday, November 29

Botanical Society of the British Isles (at the British Museum (Natural History), Cromwell Road, London, S.W.7), at 2.30 p.m.—Annual Exhibition Meeting.

British Psychological Society, Scottish Branch (in the Psychological Laboratory, 12 University Gardens, Glasgow), at 2.30 p m.—Dr. Sarah S McIntyre : "A Study of National Prejudices" · Mr. John H. Chaplin and Mr. Robert C. Vallance · "Scientific Curiosity and Interest in relation to Ability and Achievement in School".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned .

Lecturer in Mathematics (preferably with a good honours degree and able to take lectures to honours degree standard)—The Registrar, Technical College, Sunderland (November 29).

Assistant Teacher (Grade B) in Botany—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (December 1).

Censor and Tutor in Science in University College and Part-time Lecturer in the University—The Secretary, The University, 38 North Bailey, Durham (December 1)

Lecturer in Mechanical Engineering, and an Assistant (Grade B) in Engineering, at Constantine Technical College—The Director of Education, Woodlands Road, Middlesbrough (December 5)

Junior Observer (with a good honours degree in astronomy, physics or mathematics)—The Director, The Observatories, Cambridge (December 6).

Scientist (with a degree in engineering and M.I.M E.) to take charge of a group responsible for applying the results of scientific research to the design of experimental machines in connexion with the underground mining of coal (Ref. TT/506), and a Scientist, Grade II (preferably with a good geological background) to assist in research on basic underground mining processes involving the structure and physical properties of coal measure rocks (Ref. TT/507), at the Central Research Establishment, Isleworth, Middx—The National Coal Board Establishments (Personnel), Hobart House, Grosvenor Place, London S.W.1, quoting the appropriate Ref. No. (December 8).

Senior Lecturer or Lecturer in Mathematics at Fourah Bay College, Sierra Leone (University of Durham)—The Secretary Advisory Committee on Colonial Colleges, 15 Victoria Street London, S.W.1 (December 8)

Established Geologist in the Geological Survey—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (December 9).

Senior Geophysicist in the Bureau of Mineral Resources, Geology and Geophysics, Melbourne, principally to edit and attend to publication of geophysical reports, maps and plans , also to supervise the work of the drafting and library staffs—The Deputy High Commissioner, Australia House, Strand, London, W C 2, endorsed for attention of 'The Senior Representative, Division of Industrial Development' (December 11)

Assistant (with honours degree in biochemistry, agricultural chemistry, or equivalent qualifications) in Agricultural Biochemistry—The Secretary, The University, Aberdeen (December 12)

Assistant Lecturer in Chemistry—The Registrar, University College of North Staffordshire, Keele, Staffs (December 15)

Experimental Officer (woman, with a University degree with chemistry or microbiology as a principal subject, or equivalent qualification) in the Domestic Preservation Section—The Secretary, Long Ashton Research Station, Bristol (December 15)

Agricultural Economist and Assistant Agricultural Economists, at Newton Abbot—The Registrar, The University, Bristol 8 (December 29).

Lecturer in Electrical Engineering at Canterbury University College, Christchurch, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (December 31).

Lecturer in Biochemistry (graduate in medicine or science) at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W C.1 (January 3).

Assistant Lecturer in Botany—The Registrar, The University, Manchester 13 (January 5)

Principal—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C 2 (January 10).

Reader in Social Anthropology at the Australian National University—The Administrative Officer in the U K , 27 Russell Square, London, W.C 1 (January 19).

Lecturer or Senior Lecturer in Botany at the University of Otago, Dunedin—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C 1 (January 30).

Scientific Assistant (Veterinary Officer) (M R C V.S or its equivalent and a knowledge of languages essential)—The Director, Commonwealth Bureau of Animal Health, Veterinary Laboratory New Haw, Weybridge, Surrey (January 31).

Professor and Head of the Department of Organic Chemistry, Professor and Head of the Department of Power Engineering Professor and Head of the Department of Chemical Technology and Chemical Engineering, and a Professor of Mechanical Engineering—The Registrar, Indian Institute of Science, Bangalore 3, India (February 1).

I.C.I. Research Fellowships in Biochemistry, Chemistry, Engineering, Pharmacology or Physics—The Secretary, The University, Edinburgh (February 28).

Assistant Lecturer (with an honours degree in agricultural chemistry, biochemistry or physiology) in Agricultural Chemistry at the School of Agriculture, Sutton Bonington—The Registrar The University, Nottingham

Assistant Lecturer (with an honours degree, and interested in the physical aspects of biochemistry) to teach Chemistry and Physics, and to co-operate in the research work of the Department—The Secretary, Royal Technical College, Glasgow

Biological Assistant (with a B.Sc. in either biology or physiology) in the Courtauld Institute of Biochemistry—The Secretary, Middlesex Hospital Medical School, London, W.1.

Chemist of B.Sc. (Special) standard, to take part in an investigation of urinary steroids in clinical cases—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1.

Electrical Engineer for design work on large capacity 11 KV and LT factory installations, and for work associated with steam boiler plant, compressed air installations, cranes and machine tools—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, quoting 390.

Experimental Officers at R.A.F. Signals Establishments.—at Ruislip, for general experimental work and tests in connexion with design of radio communication and radar systems (three posts); at Medmenham, for installation design of airfield communications and landing aid systems, equipment investigations and siting problems (six posts), for design of installations for large radio receiving and transmitting stations (one post), for design of aerial and feeder systems (one post), for design, development or test of prototype mobile and portable radio and radar installations (six posts), for reconstruction of a radar landing aid and organization of associated experimental investigations (one post); at Watton, Norfolk, for development of highly specialized radio and radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.416/52A.

Head Statistician for the supervision of the Association's varied statistical and mathematical work, and carrying out and reporting on anthropometric work, field trials of footwear, etc., and a **Chemist** (young) and a **Physicist** (young) for work on footwear production and wear problems, and shoe materials and other products used in the industry—The Director, British Boot, Shoe and Allied Trades Research Association, Rockingham Road, Kettering, Northants.

Lecturer in Chemistry—The Acting Registrar, University College, Exeter.

Metallurgists to study problems in the casting, fabrication and joining of non-ferrous metals—The Research Manager, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

Physical Chemist for research on surface activity and other phenomena related to detergents, etc. (ability to apply experimental results to practical wool scouring problems is of importance)—The Wool Industries Research Association, Torridon, Headingley, Leeds 6.

Physicist for work on physical problems related to biological effects of high energy neutrons—The Director, Radiobiological Research Establishment, Harwell, Didcot, Berks.

Research Assistants (with a degree in metallurgy or chemistry) to work on a study of slag inclusion in steels, or other agreed chemical or metallurgical problem—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

Scientific Assistant (University degree in natural science and knowledge of languages essential)—The Director, Commonwealth Bureau of Animal Health, Weybridge, Surrey.

Senior Experimental Officer for development of calibration procedure for radio test equipment and preparation of calibration publications, and **Assistant Experimental Officers** for the calibration of transfer standards involving (*a*) frequency and pulse measurements or (*b*) bridge and miscellaneous measurements, at an R.A.F. Signals Experimental Establishment in Bedfordshire—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.415/52A.

Senior Scientific Officer at London headquarters of the Ministry of Supply, for the assessment of the performance of supersonic aircraft projects—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.296/52A.

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A COMMONWEALTH INSTITUTE IN LONDON

It is clear from the Minister of Education's foreword to the report of the committee of inquiry into the Imperial Institute* that no immediate action on the report is contemplated by the Government. Mr. K. G. Bradley (see p. 912) has been appointed director in succession to Sir Harry Lindsay, who retires at the end of this year, and one of the new director's first tasks will be to consider, in consultation with the Board of Governors and with the Government, in the circumstances then prevailing, on what lines the Institute should be carried on. The Minister gives no indication as to whether the Government is prepared to accept the essential conclusion and recommendation of Lord Tweedsmuir's Committee that the aims and organisation of the Imperial Institute need drastic revision, in order to bring them into line with present-day conditions in the Commonwealth; and to reflect the recent transfer of responsibility for the Institute from the Board of Trade to the Ministry of Education, with its corollary that the major responsibility for financing the Institute must be assumed by the United Kingdom Government. The publication of the report should enable those immediately concerned to consider the proposals at leisure and to make appropriate representations in good time if necessary.

It will be remembered that when, in 1949, by Order in Council, the control of the Institute was transferred to the Ministry of Education and its purposes redefined on a mainly educational basis, the scientific and technical work of the Institute was transferred to the Colonial Office. The Institute accordingly no longer has the direct interest of the scientific worker or technologist which it formerly possessed, particularly during the period 1907–49. It is clear from this report, however, that in its adaptation to meet the new needs and conditions, the reconstituted Institute, particularly in its exhibitions in the galleries and in the cinema, and in its work as a centre for the dissemination of information and the discussion of problems relating to Commonwealth affairs, should continue to serve certain of their needs.

The Tweedsmuir Committee believes that the emphasis should shift from economic to social and cultural interests, and that the most important function the Institute could fulfil is to serve as a Commonwealth forum for the furtherance of mutual understanding among the members of Commonwealth countries by providing facilities for the presentation and exchange of ideas and information. To mark the change in outlook, it recommends that the name be changed to "Commonwealth Institute". To attain the new objective, it states that comprehensive reorganization of the exhibition galleries is necessary. The galleries, it is thought, should be divided into two main sections, one regional and national, the other illustrating the most important products and problems common to a number of

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* Ministry of Education. Report of the Committee of Inquiry into the Imperial Institute. Pp. vi+40. (London: H.M. Stationery Office, 1952.) 1s 6d. net.

Commonwealth countries. Besides special displays in the entrance hall and elsewhere, and periodic exhibitions illustrating topics of current Commonwealth interest, there should also be development on the fine arts side and a considerable extension of the existing provision for cinema and related displays. Further, a programme department should be established to co-operate with the exhibitions and social staff of the Institute in a discriminating expansion of the programme of lectures, classes, conferences and projects for adults as well as for school children.

The lecture services contemplated here include extension of the travelling lecture scheme outside London in collaboration with the other agencies in this field, and, on the social side, provision of various amenities, including restaurant facilities, reference library and reading room, as well as the establishment of a social club for students and regular users of the Institute. Careful consideration has convinced the Committee that even when such well-sponsored plans like that for the International House for the University of London have been carried out and hostel accommodation also becomes available for all Commonwealth students through schemes concerted by the British Council with the support of the Colonial Office, the need will remain for a place or places where Commonwealth students can spend their leisure or carry on their wider studies, in comfortable and attractive surroundings. The reorganization of accommodation recommended by the Committee should also make possible the offering of accommodation and facilities for meetings and discussions to outside responsible groups concerned with Commonwealth problems.

The Committee's proposals are imaginative as well as practical; and while the Committee is convinced that the provision of social amenities on a generous scale is vital to the success of the plan that is proposed, the main argument for it, and for continuing the Institute, is the urgent need for attracting and enlisting the interest of the ordinary citizen in the Commonwealth and its affairs. For this reason, the greatly improved publicity which is listed as the last of the Committee's proposals may well be the most urgent, and some steps to develop this side may be imperative in order to obtain public support of the new proposals. Even as it is, the Committee has been disturbed by the widespread ignorance of the aims and intentions of the Imperial Institute. The execution of the Committee's plans will involve a considerable amount of goodwill and co-operation which will scarcely be secured without full understanding of their purpose and the reasons for the Committee's recommendations, which are virtually for a new Institute.

The proposals of the Committee involve strengthening the technical and administrative staff, with a consequent increase of about £12,000 in the salary bill: the longer opening hours, including Sundays, and the higher standard of cleanliness, which are recommended, also involve considerable additions to the number of attendants and cleaners, with a further increase estimated at £3,000. This estimate ignores any substantial economies in caretaking and general upkeep which may well accrue from the modernization of the building and equipment, nor does it take account of increased cost of heating, lighting, etc., due to the use of a larger area and the longer hours of opening. It is anticipated that a loss of income of approximately £13,000 through discontinuance of the present practice of letting accommodation, which the Committee strongly condemns, will be partly offset by receipts from persons or bodies who avail themselves of accommodation or facilities offered in accordance with the Committee's proposals.

The Tweedsmuir Committee's proposals thus envisage an increased contribution from the Government, which is put at no more than £15,000, but which might rise to £20,000–£25,000 per annum if the expectation regarding revenue proved unfounded. This is not a large sum for purposes such as the Committee indicates; but whether at the present time of financial stringency it will be forthcoming is doubtful, unless more imagination and foresight are shown than has marked post-war government intervention in Commonwealth affairs. There is also a matter of capital expenditure for which the Committee recommends an initial five-year programme. The modernization of the existing premises, some of the equipment of which is regarded as more appropriate for a museum of antiquities, will have to be put in hand in the near future, whoever may be the new occupants. Besides this, it is recommended that the re-conditioning of the entrance hall, the regrouping and reorganization of the galleries, the equipment of the Jehangir Hall, and the provision of amenities should be put in hand at the earliest possible date and completed within three years at the latest.

The Minister of Education's foreword to the report does not suggest that any urgency is attached to the matter by the Government; but it would not be right to infer from this that the comparatively small amount required to support so important a project will not be forthcoming. The proposals, however, in regard to accommodation may well involve major difficulties, for they require the return to the Institute, for use for its own purposes, of accommodation which has for long been in the hands of other bodies; and from its restrained criticism it is evident that the Committee is dubious as to the validity, let alone the desirability, of some of the arrangements made. The release by the University of London of the Central Entrance Hall and the Jehangir Hall is regarded as essential to the scheme, and could not wait on the re-building and re-organization already proposed when the University vacates the part of the premises it now occupies. Nevertheless, the Committee hopes that, in view of the amount of new accommodation acquired elsewhere by the University in recent years, it will regard with sympathy any request for re-adjustment of floor space, and that the whole of the west wing will revert to the Institute in the near future.

Finally, on the financial side, the Tweedsmuir Committee adds its own voice to those that in the past year or so have pleaded for some continuity of support for bodies engaged in research or in cultural and educational activities. Any system of grant to the new Commonwealth Institute should be placed on a quinquennial basis. The scheme advocated in this report will be prejudiced from the start if those responsible for its execution only know from year to year what amount of money they can count upon from official sources, and are limited to budgeting expenditure on a rigid annual basis. There is no surer means of ensuring waste of public money than to adopt such a practice where research, cultural and educational activities are concerned. Nothing will indicate more clearly the sincerity of its belief in the value of promoting Commonwealth understanding and relations than the way in which the Government responds to this particular recommendation of the Committee; and on its main thesis, should the Government decide not to adopt the scheme, a reasoned statement and no mere *non possumus* is demanded by this carefully argued report.

ATOMIC COLLISION PROCESSES

Electronic and Ionic Impact Phenomena

By Prof. H. S. W. Massey and E. H. S. Burhop. (International Series of Monographs on Physics.) Pp. xviii+670. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 70s. net.

In this volume, Prof. H. S. W. Massey and Dr. E. H. S. Burhop have provided an extremely complete compendium of results on the collisions of electrons and atoms. High-energy collisions and neutron collisions are deliberately omitted; but such problems as inter-atomic collisions, continuous X-ray production, and the collisions of electrons and atoms with solid surfaces are included, together with the more basic problems of the elastic and radiative collisions of electrons with atoms and molecules. The subjects are treated from an essentially experimental point of view, although considerable theoretical material is also included.

These topics were in the forefront of physical research in the 1920's and '30's. Indeed, a good deal of the material is that which did so much to help conventional spectroscopy to establish the quantum theory of atoms and atomic processes to its present state of completeness. Nowadays research on these subjects is out of fashion. We tend to think that if we took the trouble to work out the answers, we could explain the results of any fundamental atomic experiment. It is open to question whether such an attitude is sound. Among all the detail about the fundamental collision processes, not everything by any means has been satisfactorily explained. The book shows that there are a good many loose ends to be cleared up by some tidy-minded person. It will do a great service if such work is encouraged, for, in this field, good experimental work in atomic physics can be carried out comparatively cheaply. Such research is also an excellent training in accurate thinking on problems which are often basically simple.

I worked on electron collision problems in the late 1920's and early '30's, and it is a great pleasure to see work which I had almost forgotten (on the polarization of radiation excited in a gas at low pressure by a directed stream of electrons, and other problems of light-excitation) faithfully recorded in the volume. The work, though seeming elegant at the time, did not prove to be of any far-reaching importance, and is mentioned here merely as illustrating the by-ways into which the authors have strayed. In the context of the book, experiments of this type are seen in proper proportion as a part of the whole subject.

The work, besides presenting the fundamentals of a large part of atomic physics, also forms the basic raw material of applied work in gas discharges, in ionospheric problems and in astrophysics. The authors have been in the forefront of research in some of these subjects. This is probably the reason why they have taken the trouble to put all the scattered experimental results on collision problems into so comprehensive a form. Others may now have the benefit of their labours, and I am sure the book will be of great value to all those doing research in these applied fields. H. W. B. Skinner

THIRD EUROPEAN BREWERY CONVENTION

European Brewery Convention

Proceedings of the Congress, Brighton, 1951. Pp. x+352. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1951.) 45s.

It is the custom at the European Brewery Conventions to have one or more major themes for discussion: at the first Convention, which was held in Scheveningen, the subjects were of a general character; but at the second, which took place in Lucerne, the two highly important brewing problems of proteins in beer and the production of sterile beer by means other than pasteurization were the principal matters discussed. At the third Convention, which was held in Brighton in 1951 and the proceedings of which are here under review, the two main subjects chosen for discussion were: primary fermentation in the brewery, with special regard to the flocculation of yeast; and various aspects of the economic functioning of a brewery. The quality of the various papers read at Brighton was, on the whole, of a high standard, and some of the discussions animated and vigorous.

The subject of yeast flocculation is one of the utmost importance to brewers. In either top- or bottom-fermentation systems, unless a yeast is of a good flocculating type—that is, purges itself from the wort—the brewer may well be confronted with a number of harassing anxieties. This is especially the case with the brewing of draught beers with top-fermentation yeasts. If a yeast does not flocculate well, an unduly large and undesirable amount may be left in suspension in the beer, and thereby cause difficulty in fining and subsequent 'frets' in cask. So far as bottled ales are concerned, this question of yeast flocculation is not of such paramount importance, because the beer is submitted to a drastic process of filtration. Even so, when a poorly flocculating yeast is used for the fermentation of bottled beers, heavy 'bottoms' in the storage tanks can lead to serious losses.

The whole question of flocculation is bound up with the physical behaviour of a yeast in the fermentation vessel, whether the yeast be a top or bottom strain. Thus, a yeast which tends to come out of suspension rapidly is termed a flocculating yeast, whereas a yeast which separates slowly and tends to remain in suspension is called a non-flocculating or 'powdery' yeast.

The two most outstanding papers which were read in this part of the Convention were given by R. S. W. Thorne (Brewing Industry Research Foundation) and R. B. Gilliland (Arthur Guinness, Son, and Co., Ltd.), and it is difficult to do them adequate justice in a short review. Thorne, using the hybridization technique devised by Winge, showed that flocculation is under genetic control, having found that flocculation is dominant to non-flocculation. The genetic control of flocculence, however, is complex and, apparently, no less than three pairs of polymeric genes are concerned in the process, any one of which is sufficient to confer flocculence on a yeast which happens to possess it. Thorne claimed also that the genes controlling flocculence apparently mutate spontaneously at an astonishingly high rate to the non-flocculating type. Gilliland's contribution to this subject was more concerned with flocculence under brewery conditions, and he was able to distinguish four types of yeast isolated from a mixture used in top-fermentation brewing, which differ in various characteristics—for example, times of flocculation in worts. Gilliland claimed that a single gene segregation controls flocculence. There is, however, no real conflict between this observation and that of Thorne, because it may well be that these apparently conflicting results are due to differences that exist between different strains of yeast. On the other hand, there was a real difference of opinion between these two workers on the question of the incidence of mutation, Thorne holding the view that mutation is rapid and Gilliland that his strains are stable.

The foreign visitors to the Convention, which included such distinguished brewers and brewing chemists as Dr. B. D. Hartong (Holland), Prof. J. de Clerck (Belgium) and Dr. B. Trolle (Denmark), naturally enough discussed the question of yeast flocculence from the angle of bottom-yeast fermentations. Unfortunately, it has not proved possible up to the present time to hybridize bottom yeasts, and therefore the question of genetical control of flocculence in bottom-yeast strains has not been elucidated.

The economic functioning of a brewery forms no part of a review of this nature, but a number of interesting papers on miscellaneous subjects connected with brewing were also read. Two outstanding papers of general scientific interest were given in this section of the Convention. Prof. I. A. Preece (Edinburgh) dealt with the non-starchy polysaccharides of barley and their influence on wort composition, and Drs. G. Biserte and R. Scriban (France) discussed the proteins of worts. According to Preece, the bulk of these non-starchy polysaccharides are derived from the endosperm of the grain, and the proportion of cold-water soluble material obtained from barley appears to be a varietal character. Biserte and Scriban have made an elaborate study of the amino-acid and peptide fractions of wort, and have been able to separate by differential electrophoresis of the sodium chloride extracts of barley and malt a number of protein fractions which are also present in wort.

In conclusion, it can be said that this was a very good Convention indeed, and worthily maintained the high standard set by its two predecessors.

E. BARTON-WRIGHT

GMELIN'S HANDBOOK OF INORGANIC CHEMISTRY

Gmelins Handbuch der anorganischen Chemie

Achte völlig neue bearbeitete Auflage.

Herausgegeben vom Gmelin-Institut in Clausthal-Zellerfeld. System-Nummer 3: Sauerstoff. Lieferung 2, Vorkommen; Technologie. Pp. 83–300. 65 D. marks. Herausgegeben vom Gmelin-Institut fur anorganische Chemie und Grenzgebiete in der Max-Planck-Gesellschaft zur Forderung der Wissenschaften. System-Nummer 27: Magnesium. Teil A: Geschichtliches, Vorkommen, Bildung und Darstellung, Physikalische Eigenschaften, Elektrochemisches und chemisches Verhalten, Nachweis und Bestimmung, Legierungen; Lieferung 4: Legierungen von Magnesium mit Zink bis Rhenium, Oberflachenbehandlung. Pp. xiv+483–818. 100 D. marks. System-Nummer 41: Titan. Pp. xxii+481. 113 D. marks. System-Nummer 17: Arsen. Pp. xv+475. 140 D. marks.

(Weinheim/Bergstrasse: Verlag Chemie, G.m.b.H., 1951–52.)

THE steady progress in the publication of "Gmelin" is a praiseworthy and pleasing event. The work has proved of the very greatest value, and new volumes are always welcome. A detailed review here of such a work is impossible, and only a few main features of the parts named above can be sketched. This should not be regarded as minimizing its importance; but since the treatise is so well known and highly regarded, it seems superfluous to enlarge upon its merits.

The volume on oxygen, which deals with its occurrence and technology, includes the occurrence of free oxygen and ozone in the atmosphere at all levels, and the distribution of combined oxygen in the lithosphere. There is also a section on water from the same points of view. These will interest many kinds of readers besides chemists. The technological part deals not only with oxygen but also with ozone and with the purification of water and the production of hydrogen peroxide. Much patent literature is covered. The information on the technical production of pure hydrogen peroxide may be singled out for special mention.

The volume on magnesium alloys includes a long section on surface treatment. This field is of great technical importance; but a remark made in a previous review as to whether the completion of the purely chemical part of the book should be delayed by the issue of metallurgical and technical volumes may be repeated.

The volume on titanium, which is preceded by a portrait of Roger Adams and a dedication of the book to him in recognition of his timely support, deals with a subject of great present interest. Whether the claims made for the technical future of titanium will be justified, time alone can show; but to the chemist the volume, which appears to be complete, will be of great interest. The occurrence of the element, the preparation of the pure metal and its compounds, and details of their physical and chemical properties, are all covered to the end of 1949. The treatment is modern. The reader will perhaps be struck with the small space occupied by the descriptions of the chemical properties as compared with the physical, and this tendency should not be carried too far. A book on chemistry should lay special emphasis on the purely chemical aspects of its subject. On titanium monoxide, for example, there are five and a half pages on physics, including nearly three on spectra, and only nine lines on its chemistry. On titanium dioxide there are twenty pages on physical properties and only four on the chemical. The writers should see if they cannot find something more to say on chemistry.

The volume on arsenic is very detailed and complete. The sources are given fully, and as much space is given to some of little importance as to the main ones. Some attempt should be made to condense in such sections. There are eighty-three pages on occurrence, which is too lavish. A little more could have been said on the allotropic forms, although pages 116–122 are good so far as they go. The physical properties again occupy much more space than the chemical throughout, but the latter are given in more detail than in some other volumes. The hydrates of arsenic pentoxide are adequately considered. The action of light on arsenic disulphide is not sufficiently emphasized, and museum curators, for all they will find here, can still wonder why their specimens do not keep. Optical properties such as principal refractive indices and axial angles do not seem to be given where they might have been expected.

STUDIES OF SEVEN CENTRAL AFRICAN TRIBES

Seven Tribes of British Central Africa

Edited by Elizabeth Colson and Max Gluckman. (Published on behalf of the Rhodes–Livingstone Institute, Northern Rhodesia.) Pp. xx+410+28 plates. (London, New York and Cape Town: Oxford University Press, 1951.) 37*s*. 6*d*. net.

THE book consists of the following seven essays: Prof. H. M. Gluckman on the Lozi, Dr. E. Colson on the Plateau Tonga, Dr. Audrey Richards on the Bemba, Mr. J. A. Barnes on the Fort Jameson Ngoni, the late Godfrey Wilson on the Nyakyusa, Dr. J. C. Mitchell on the Yao, and Dr. J. F. Holleman on the Hera, Rowzi and Mbire of the Zezuru tribal cluster of central Mashonaland. The tribes are Central African in a vague geographical sense, and all speak Bantu.

"Our plan," the editors write in their preface, "was to produce a general description for each tribe which might be useful to officers working in the region and which could be used by students of anthropology who wished for some knowledge of the types of social organization to be found in the area." This collection of essays, which is intended to serve as a monument of the first eleven years of research planned and carried out by the Rhodes–Livingstone Institute, addresses itself primarily to two small groups of specialists and not to the general reader with sociological interests; the latter would find himself insufficiently equipped to deal with these, at times, severely technical essays in African tribal structure. As exceptions must be noted two essays which are slightly altered reprints of articles by Dr. Audrey Richards and the late Godfrey Wilson—the only essays which are not written by the Rhodes–Livingstone research team, and its successive leaders since the Institute's expansion. The editors must be congratulated on having departed from a programme of uniform presentation so far as to include these studies, the omission of which would have deprived the collection of its two fullest ethnographic accounts. Dr. Richards's essay (first published in 1935), in its admirable economy of exposition, is perhaps the best study of the Bemba, a tribe living on the plateau-land of north-eastern Rhodesia, to the study and description of which she has devoted many years.

By far the longest contribution is that of Prof. Gluckman on the Lozi, the ruling tribe of the Barotse nation (in the author's use of the two terms) of the Barotse Plain in North-western Rhodesia, a semi-pastoral group, who have marked cultural affinities both with the Southern Bantu and the peoples of the southern Congo basin, and who, living in the curious habitat of a Central African flood-plain, developed a very complex horticultural economy. The essay is divided into three chapters—Barotseland and the Barotse people (which includes class and tribal divisions); kingship, nation and land; and land, state, village and kinship—from which it can be seen how much the essay concentrates on the tribal political institutions. The centre of these is kingship, the main theme of the essay. Prof. Gluckman has written on several levels of analysis what surely is one of the most important sociological monographs on Bantu kingship.

Tonga as a linguistic term implies a main division of the zone of Central Bantu languages. Apart from the Ila- and Tonga-speaking population, "written material on any of these peoples is lacking". As in the case of the latter this material was scanty, information is very welcome. Dr. Colson, Prof. Gluckman's successor at the Institute, has selected for her research a part of these Tonga-speaking peoples, the Plateau Tonga, a population which has never formed a political group and which can be distinguished only in terms of their location and of the units of the present administration. They are one of the three matrilineal societies dealt with in this book, along with the Bemba and Yao. The description of the village unit is sketchy, that of the family and kin groups informative, and the analysis of the linking of matrilineal groups has many points of interest.

The Ngoni migrated north from Natal in 1820. Their state, of the type familiar from Zululand, was defeated by British forces in 1898, and this caused the decline of the central authority and of the regimental system, and some segmental autonomy. The breaking-up of political institutions, work on European farms and migrant labour are the background against which Mr. Barnes had to study Ngoni life. Dr. Mitchell's Yao, too, represent a "changing culture" in that sense. His investigation, that of the matrilineal system in particular, seems such a solid and imposing achievement that his book will be awaited with impatience.

Dr. Holleman's report on the Shona lacks the definiteness of the other contributions and might more suitably have appeared in a periodical. The report directs the reader's attention to the fact that little is known about this group of tribes, even on the ethnographic level to which the report keeps.

Each essay is followed by a most useful bibliography.

The collection is dedicated to Dr. Edwin W. Smith, co-author of the classic on the Ila-speaking peoples. The editors' few and dignified words of gratitude will be appreciated by all Africanists. The book seems worthy of bearing such a dedication.

F. B. STEINER

NEW STUDIES ON DEFECTIVE COLOUR VISION*

By Prof. W. D. WRIGHT

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DURING the past few years, there has been a very lively interest in the subject of colour. This has derived in part from its increasing technical importance in the colour industries, while the introduction of the fluorescent lamp and the development of colour television have brought out new problems to be solved and new groups of scientific workers and engineers anxious to solve them. At the same time, there has been a great deal of interest in colour vision as a subject worthy of study in its own right, and speculation is still rife regarding the visual processes responsible for colour perception.

There is, unfortunately, plenty of room for speculation, since we are still ignorant of the visual mechanism by means of which an observer can distinguish one coloured light from another. When an image is focused on the retina, the reaction in the receptors must vary qualitatively when the wave-length of the light is changed; only thus can the brain receive signals which can be interpreted in terms of different colour sensations. It is generally believed that the characteristic messages to the brain originate in different types of receptor in the retina, one type being most sensitive to one part of the spectrum, another type to another part of the spectrum, and so on. The pattern of activity in the receptor types would then provide an effective means for differentiating one coloured stimulus from another.

So far, however, it has been impossible to complete this picture with objective information about the receptors. The three main methods of attack—histology, photochemistry and electrophysiology—have provided clear distinctions between the rods and the cones; but although Granit has recorded a variety of spectral sensitivity curves on various retinæ using a micro-electrode technique, it has not been possible so far to link these up with different photo-sensitive substances in the cones or with different cone structures. It is not impossible, as Willmer has suggested, that the division of the receptors into rods and cones may itself form the basis of a colour-discriminating mechanism; but the orthodox view is that colour perception is a purely cone function. We must hope that in due course the physiologists will be able to find ways and means of identifying different types of cone; but we have to recognize that their task is extraordinarily difficult and will require very refined techniques.

Since we are ignorant about the processes responsible for normal colour perception, we can scarcely hope to explain its abnormalities; but a curious position exists in that a great mass of quantitative data has been recorded on the characteristics of normal and defective colour-vision. In some respects, indeed, a very clear relationship has been established, and it is baffling not to be able to link this relationship to its physiological counterpart.

Various kinds of colour vision test can be carried out, and my own experience has been largely concerned with measurements made on a colorimeter in which two halves of the field of view are illuminated by monochromatic radiations selected from two spectra. In experiments on wave-length discrimination, for example, both fields are illuminated with single monochromatic lights of the same wave-length λ; one of the wave-lengths is then changed by a small amount $\Delta\lambda$ until a difference in hue can just be detected by the observer, the luminosities of the two beams having been kept equal. Or again, the sensitivity of the observer to lights of different wave-length can be tested by finding the energy $e\lambda$ required in one half of the field to produce a light sensation of constant magnitude as judged by making a luminosity match against a constant stimulus in the other half of the field, or by some other equivalent technique. In colour matching, one half of the field can be illuminated by a mixture of three monochromatic radiations taken from the red, green and blue parts of one of the spectra, and their proportions can be varied to give a colour match of the test colour in the other half of the field derived from the other spectrum.

Measurements of this type can take a considerable time and are unsuitable for the routine testing of large numbers of people; but they have the very great advantage that the light stimuli in the experiment are physically simple, and it is possible to study each variable of colour vision in turn.

When the results for those with normal and defective colour-vision are compared, one of the most important distinctions that is noticed is the relatively poor wave-length discrimination of the defectives. In an instrument in which the observer views a 2° field, the normal subject can distinguish some 150 different hues through the spectrum, whereas the defective may see only half this number or less, depending on the degree of his defect. This is not, however, due to a general lowering of colour discrimination, but to a reduction or total absence of discrimination in some parts of the spectrum, while in other regions discrimination is virtually unimpaired. Thus in the so-called red–green defect, radiations from the red–yellow–green spectral region may appear identical when luminosity differences are eliminated.

While poor colour-discrimination is perhaps the feature which is pre-eminently characteristic of defective colour-vision and is also the cause of most of the practical disabilities associated with the defect, other significant characteristics also emerge from experiments with a trichromatic colorimeter. The most striking is that, while a normal observer has to mix three radiations in order, in general, to make colour matches, it is found that some defective observers need to operate only two controls, while a very small number of persons exist who can do all their colour matching by operating a single photometric control. These three types of observer are known as trichromats, dichromats and monochromats respectively; and, while a considerable proportion of colour defectives have vision intermediate between dichromatism and normal trichromatism, it is with the dichromats that this article is especially concerned.

The natural explanation of these three forms of colour vision is that the normal retina possesses three kinds of colour receptor, the dichromatic retina two, and the monochromatic one. If one of the three receptors were inactive, we should expect that the dichromat would show an abnormal spectral sensitivity, and indeed in protanopia (the defect which is usually attributed to the absence of red receptors) the sensitivity curve is very low at the long-wave end of the spectrum. In deuteranopia, the sensitivity curve is very similar to the normal curve, and the defect can be explained on the assumption of a fusion of the red and green processes at some stage in the visual pathway from retina to brain.

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* Substance of a Friday Evening Discourse given at the Royal Institution on May 2.

This explanation of these two forms of defect is supported by a more detailed study of the protanopic and deuteranopic colour confusions. The usual method of specifying a colour for a normal observer is based on the Maxwell colour triangle, which in its modern form has rectangular co-ordinates and is termed a chromaticity chart. A colour is specified in this chart by the proportions in which defined red, green and blue stimuli have to be mixed additively to match it; but for dichromatic vision the chart has one variable too many. Helmholtz investigated this subject theoretically and showed that, for an observer whose red receptors were missing, there should be a series of isochromatic zones across the colour triangle radiating from the red corner and that, for such an observer, all colours lying in a given zone would be confused, while colours from different zones would be distinguished. Many years later Pitt showed experimentally that the protanope confusion zones do radiate from a point in the red corner of the chromaticity chart, whereas the deuteranope zones are more nearly parallel, a result that provides some of the strongest evidence that the former defect is due to a missing red process and the latter to a red–green fusion.

Theoretically, various other forms of dichromatism might exist; but only a form in which the blue process is believed to be inactive, and to which the name of tritanopia has been given, has received much attention. A few cases of tritanopia have been reported in the literature, but, as they have usually been associated with some pathological condition of the eye, the existence of congenital tritanopia has been a matter of doubt. Certainly no data on tritanopia comparable to the information on protanopia and deuteranopia have been available.

I should, however, mention here that in a sense we are all tritanopes, since, for some reason not yet understood, small-field vision—that is, vision when viewing objects subtending 20′ arc or less and especially when imaged on the fovea—tends to become tritanopic. Some interesting data on small-field tritanopia have been recorded during the past few years, following the rediscovery by Willmer in 1944 of the phenomenon which had first been investigated by König fifty years earlier. Nevertheless, there is still great theoretical and practical interest in the investigation of congenital tritanopes, if such are to be found.

That was the position in May of last year, and if tritanopes were as rare as one in a million, as had been suggested, normal methods of testing were unlikely to produce many of them in any reasonable space of time. Unexpectedly, however, an opportunity for mass testing presented itself through an article on colour blindness which Mr. D. Wragge Morley was preparing for the magazine *Picture Post*. He intended to include some coloured reproductions of the well-known Ishihara charts which are widely used for detecting the red–green defect, and it happened that Lieut.-Commander D. Farnsworth, from the Medical Research Laboratory of the United States Naval Submarine Base, had in 1947 given me a chart designed on the same principles as the Ishihara charts but in colours that would demonstrate small-field tritanopia. It seemed that this chart might also serve to detect congenital tritanopia, and, at my suggestion, Mr. Morley kindly included a reproduction of it in his article.

Readers were invited to report any difficulty they had in reading the Farnsworth chart, and, out of a *Picture Post* readership said to be more than nine million, some nine hundred letters were received. As it turned out, these letters were in many cases from red–green defectives who were unable to read the ordinary Ishihara charts, while many more were from persons who were probably partial tritanopes. About forty, however, were from people who appeared to be genuine tritanopes.

The selection of the tritanopes was based partly on the way they described their reaction to the Farnsworth chart and partly on other evidence they supplied about their defect. For example, a number of the letters mentioned that, when playing the game of snooker, the writers tended to confuse the brown, green and red balls; these people were evidently red–green defectives. One correspondent, on the other hand, reported that he sometimes confused the blue and green balls and sometimes, too, the yellow and pink; these are just the confusions associated with tritanopia, and subsequent tests proved that he was, in fact, a tritanope.

For various reasons, in particular that of distance from London, not all the suspected tritanopes could make confirmatory tests in the laboratory, but seventeen cases were confirmed, and, of these, seven made a number of visits during the next few months for a series of observing sessions. Records were made of their curves of spectral sensitivity, colour mixture, wave-length discrimination and confusion loci in the chromaticity chart, the details being later published by the Optical Society of America (*J. Opt. Soc. Amer.*, 42, 509; 1952). The results confirm that tritanopes can do all their colour matching by the additive mixture of a red stimulus with either a green or a blue stimulus, wave-length discrimination disappears in the green to blue spectral region, and the colour-confusion zones tend to radiate from the blue corner of the chromaticity chart. All this is in agreement with the hypothesis that the defect is due to the absence of blue receptors, although the mean spectral sensitivity curve did not appear to be significantly lower than the normal at the short-wave end of the curve.

The incidence of tritanopia was evidently rather higher than one in a million; but, if an estimate were to be made, it was necessary to guess at the fraction of tritanopes who had bothered to reply to the article in *Picture Post*. After discussion with Mr. A. J. Burkart, of Hulton Research, I felt it was safe to assume that probably at least 5 per cent and at most 25 per cent of the tritanopes might have been expected to respond, which would put the incidence of tritanopia somewhere between 1 in 13,000 and 1 in 65,000. This is very much less than 2 per cent of red–green dichromats found among men and even the 0·12 per cent of women.

Another interesting feature was the proportion of men to women tritanopes, which worked out at 1·6 to 1·0, whereas in the red–green defect men outnumber women by 16 to 1·0. Here the large number of red-green defective correspondents were of value, for among them were 354 men and only 27 women, showing that the higher proportion of women tritanopes was not an artefact arising from any disinclination of men to write in and report on their vision. Evidently the transmission of tritanopia from one generation to another must differ from that for protanopia and deuteranopia.

I should like finally to refer to the social aspects of defective colour vision, since the very interesting correspondence which I had as a result of the *Picture Post* article confirmed that a real social problem exists. A few years ago the Physical Society Colour Group published a report on defective colour-vision in industry in which a survey was made of the occupations in which good colour-vision is necessary. If a colour-defective person enters such an occupation, he may later find himself barred from promotion or even relieved of his job altogether—a misfortune which could have been avoided by a pre-vocational test. The industries affected are not merely the colour industries, such as dyeing, paint and printing, but many others, like radio and electrical engineering, where colour codes are used extensively. Or again, in occupations such as agriculture and horticulture, the picking, and judging the quality, of tobacco, tomatoes, apples, cotton, bananas, etc., has been shown to need surprisingly good colour-vision.

My recent correspondence has re-emphasized the desirability of colour tests, not merely from the point of view of industrial efficiency, though this aspect should not be ignored, but rather as a form of vocational guidance to avoid personal distress and economic hardship. If testing of the colour-vision could be included as a regular item in the school medical inspection, as the Physical Society Report advocated, most of the difficulties could be anticipated and avoided.

Many people have been fascinated by the subject of colour, and since the basic problems of colour perception are still unsolved, its scientific attraction is likely to be maintained for a long time to come. Its social implications make its study even more worth while.

THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA

By R. S. WIMPENNY
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ON the twenty-fifth anniversary of the International Council for the Exploration of the Sea, the late Mr. H. G. Maurice, then in the mid-period of his long and lustrous presidency, said that the Council was a plant sown in Sweden, which had germinated in Norway and flowered in Denmark. It is therefore worth casting back to the origins of the distinguished and long-established international body which celebrated its jubilee early in October.

To begin with, it must be recalled that, throughout the 'eighties and 'nineties of the past century, there had been a great increase of fishing by the nations bordering the North Sea. Men like Thomas Huxley had earlier expressed views on the inexhaustibility of fish stocks, and these opinions were widely held. In spite of this, however, the fishermen working nearest the shore had reason to disagree, and their doubts were beginning to reach their Governments. It was, then, this feeling of the possibility and even likelihood of impoverishment of the North Sea that provided the convenient seed-bed for the flower referred to by Mr. Maurice.

The initial step in the Council's formation was taken by King Oscar II of Sweden, who called an international conference in Stockholm in June 1899 to consider international exploration of the Arctic, the North Sea and the Baltic, in the interests of the fisheries. Largely based on the King's suggestions, a programme dealing with hydrography, biology and the organization of a central bureau was agreed. At a further conference held in Christiania in May 1901, the Stockholm programme was confirmed and extended.

The first establishment took place at Copenhagen in July 1902, when Germany, the United Kingdom, Denmark, Finland, Norway, Holland, Sweden and Russia were the founder members. With the exception of Russia, all these countries are members to-day; but in addition there are France, Belgium, Spain, Portugal, Iceland and Ireland. The Council was constituted of two delegates from each country and an executive committee, called the 'Bureau', consisting of the president (Dr. W. Herwig), the vice-president (Dr. Otto Pettersen) and the secretary-general (Dr. P. P. C. Hoek). Nowadays, the Bureau has a 'first vice-president' and three other vice-presidents; otherwise the constitution remains much the same.

Under the Bureau at Copenhagen, there was appointed a hydrographical assistant, Dr. M. Knudsen, and a biological assistant, Dr. H. M. Kyle, while at Christiania there was set up a central laboratory under Prof. Fridtjof Nansen. The Christiania laboratory was to close down in 1907, but the post of hydrographic assistant continues to this day under Dr. J. Smed, successor to Dr. Knudsen.

The first working committees were three in number, one under the chairmanship of Prof. J. Hjort to study the migrations of fish, the second under Dr. W. Garstang to study the question of over-fishing, and a third under Dr. O. Nordqvist to study the biology of the Baltic. In the course of time, however, the increase in the area covered and the subjects investigated has brought about a considerable increase in these committees, so that at the last meeting there were in session sixteen committees and sub-committees, not to mention a steering committee called the Consultative Committee. This latter is composed of the chairmen of the other committees and was established after the First World War in order to secure an orderly arrangement of business at the Council's annual meeting.

From the start, or soon afterwards, the Council has been responsible for the issue of a number of publications. These were the series *Bulletin Hydrographique*, *Bulletin Statistique* and *Bulletin Planktonique*, *Publications de Circonstance* and *Rapports et Procès Verbaux*. The *Bulletin Planktonique* no longer appears, and the *Publications de Circonstance* were replaced in 1926 by the *Journal du Conseil*, but the remainder continue.

Between the date of foundation and the outbreak of the First World War was a period of great and well-integrated international effort in the North Sea. This consisted of regular hydrographic, plankton and trawling surveys of great descriptive value. The trawling work in particular resulted in a knowledge of the natural history of the plaice, to which little has been added since.

While up to that time no great advance had been made in our ideas on over-fishing, the confirmation that the European coastal grounds were nursery areas for plaice resulted in a proposal for their closure in the interests of the plaice fishery. A more striking result was the demonstration that young plaice from the coastal grounds grew up to three times as fast when transplanted to the Dogger Bank. Although there have been repeated demands for putting plaice transplantation into effect on a commercial scale, to make a substantial alteration to the fishery would involve doubling the population density on the Dogger Bank by moving about 15,000,000 small plaice. Up to the present, the practical difficulties of transport, particularly that of avoiding mortality in transport, have not been solved. Large-scale experiments have, however, been made by Denmark and are contemplated by Britain.

As there was no agreement on conservation by the closure of young plaice grounds between the two World Wars, the idea of sparing young fish by using larger meshes gained ground. A special meeting dealing with mesh experiments was held by the Council in 1934, and at another in 1932 an old argument against the conservation of young fish, which held that their removal produced a compensating greater growth of those that were left, was demolished.

Shortly before these meetings, Dr. E. S. Russell published in the *Journal du Conseil* a simple formulation of the factors responsible for the behaviour of an exploited fishery as they had been described by earlier workers. This was followed in 1935 by a more mathematical exposition of these factors by Mr. Michael Graham, who deduced that in the year in which he wrote the same yield could have been taken out of the North Sea by substantially less effort.

As a result of this and other work, international conventions to regulate the sea fisheries were drawn up in 1937 and 1946. Both recommended increased minimum sizes of the mesh for trawls and seines, and that of 1946 would doubtless have gone further had it been possible to give equivalents for the various and different offers of relaxations on fishing made by the different nations. In order to help to provide some of this necessary information, the Council arranged a special meeting in 1948 on the comparative efficiency of fishing vessels, their gear and parts of gear. Thereafter, a special sub-committee was set up to deal with the subject, and extensive and appropriate programmes were initiated, which are being carried out by several countries.

A part of the programme just mentioned involved under-water photography of trawls and seines, and one of the most important features of the Council's jubilee meeting in 1952 was the display of two films. One of these was from the Ministry of Agriculture and Fisheries and showed the behaviour of trawls under water near Malta. The other showed the behaviour of plaice about to be caught in the mouth of a Danish seine net used by the Fisheries Research Section of the Scottish Home Department in the shallow water of the Moray Firth.

Of more than sixty papers presented at this meeting, one of the most relevant to the Council's work was a contribution by Mr. R. J. H. Beverton on the principles of fishery regulation. This brought the mathematical formulation of rational fishing up to date with the inclusion of the post-war work of Beverton and Holt, and it is clear that more than a good guess as to how to obtain the biological optimum from the sea is now available. For the rest of the story of rational exploitation, shore economics and administrative policy will be responsible.

It is now quite clear that relaxations of fishing effort can be weighed and made equivalent, so that any proposals made by North Sea nations on the new Permanent Commission, designed to be set up as soon as the 1946 Convention is ratified, will be understood and transformable into the means of getting the same or a greater yield from the area with less effort.

There was much other material in the 1952 meeting which was in support of the main biological theme, but it is perhaps more profitable to notice that the greater part of the hydrographic contributions were offered to biological committees. This represents a desirable convergence between the long-established hydrographical and biological aims of the Council, which has become evident in the past few years.

In the early days hydrography had much of its own story to establish and describe; although, even then, the long-term cycles of the Baltic herring fishery were thought to have a direct hydrographic cause. However, as time went on, the relation with biology became closer and more obvious.

Slowly, in the period between the two World Wars, we had evidence of the warming up of the waters of the northern hemisphere, one of its consequences being the establishment of our great cod fishery in the Barents Sea, which only dates from 1928. Since the Second World War we have seen the cod spread and increase in Greenland waters so that, in the North Western Committee of the Council, Dr. Paul Hansen has been able to report that this species now breeds in west Greenland waters and does not rely on recruitment from Iceland.

It is with matters of this sort, and also in the detailed analysis of water movements, such as those responsible for the distribution of plaice eggs and young fish from their spawning grounds in the south-west North Sea to the nursery grounds on the Dutch, German and Danish coasts, that the hydrographers of the Council are at present engaged. They will doubtless have much similar work in the future, and there is no doubt that the series of synoptic charts of the monthly salinity, temperature and wind values for the waters of north-west Europe, which the Hydrographer of the Council took over from the Ministry of Agriculture and Fisheries at the last meeting, will be of great help to fisheries biologists.

Of special importance, however, will be the possibility of obtaining from the hydrographers information on winds, currents and temperatures which will enable fishery biologists to obtain not only forecasts of good fish broods and their distribution, but also the long-term prospects of a fishery.

Will the newly established Arctic fishing area continue to grow in extent, or have we to anticipate its recession ? What are the hydrographic conditions in the sea that govern the shoaling and migration of fish ? If we lose a commercial species in one area, can we find it again elsewhere or replace it by another ? These are the sort of questions related to hydrography to which we expect to see complete or partial answers given at future meetings of the Council, as well as the biological ones as to the behaviour of a stock of fish in relation to its degree of exploitability by man.

Most of the great names associated with the Council's inception are those of men who are now only memories; but it is happy to be able to record that Prof. H. H. Gran, who was responsible for much of the plankton work in the early days, was present at the jubilee meeting. The retiring president, Dr. K. A. Andersen, of Sweden, laid down his office as president after many years of close association with the Council's work.

The new president is Mr. A. T. A. Dobson, of the United Kingdom, and the new Bureau includes Prof. Jean le Gall (first vice-president, France), M. Lienesch (Holland), Prof. H. U. Sverdrup (Norway) and Dr. Vedel Tåning (Denmark). Mr. Michael Graham (United Kingdom), who resigned the chairmanship of the Consultative Committee for reasons of health, has been succeeded by Mr. R. S. Wimpenny (United Kingdom).

FOOT-AND-MOUTH DISEASE RESEARCH IN GREAT BRITAIN

An interim report on the research work carried out on foot-and-mouth disease at the Research Institute, Pirbright, has recently been published by the Agricultural Research Council*. The report deals only briefly with the many researches already done and the activities now in progress; this publication, however, is timely for, although some excellent scientific papers have been published from the Institute, they may not be available to the general public in Great Britain, who, naturally, are much interested in research work on foot-and-mouth disease. On this point the Lord President of the Council, in the foreword, says, "I have instructed that this Report be published and widely circulated in the hope that public interest may be informed and stimulated about a problem to which scientists are earnestly seeking a solution". We are promised a comprehensive report in the spring of 1953.

The position now held by the Pirbright Institute, the reliance placed on its work, the services rendered to other countries and the knowledge which is being built up, amply justify the existence of the Institute, which is generally conceded to be the most important centre in the world at which research work is carried out on this widespread disease. Mention may be made of only a few of the results of past and present work to justify this claim. It was at Pirbright that the complement-fixation test, now acknowledged widely as a reliable and rapid method of determining the immunological types of virus strains, was developed. Improvements have been made on the test to an extent that "it is now possible by this method to determine the type of virus involved, within a few hours of the receipt of material from a suspected outbreak". The value of this work cannot be overestimated, especially for countries in which a vaccination policy is in operation, for the vaccine to be used will depend upon the type of virus recovered from the infected animals. The occurrence of variant strains or sub-types of foot-and-mouth disease virus was established at Pirbright when the Institute was assisting a Mexican – U.S.A. Commission some years ago in studying the widespread outbreaks in Mexico. The control of the recent outbreaks of the disease in Europe has been made difficult by the appearance of variant strains which show significant differences when vaccination is being considered. It was at Pirbright that carefully controlled experiments on cattle showed that vaccine produced from virus cultured in tongues of healthy cattle slaughtered for food produced results as satisfactory as those with vaccine prepared from virus obtained from the tongues of cattle artificially infected with the virus. Although this more recent method of preparing vaccine was not worked out at Pirbright, but in Holland, it was the workers at the Pirbright Institute, using the facilities there, who showed quite definitely the value of the vaccine. This method obviates to a large extent the use of living cattle, and thereby results in a very considerable reduction in the costs of vaccine production.

The Pirbright Institute holds stocks of freeze-dried, diagnostic and typing sera and sends them on request to any country; since 1949 the income from the sale of these sera has been 10,000 dollars. The provision of such sera is an important part of the Institute's work. They are not easily produced, and their value to a country for purposes of diagnosis is great. In addition, it is possible by the use of reliable sera to differentiate not only between types and strains of foot-and-mouth disease virus, but also between these viruses and the agents causing diseases presenting somewhat similar clinical symptoms. It was, for example, by using Pirbright methods and sera produced there that a recent outbreak of disease in Canada was shown to be foot-and-mouth disease and not vesicular stomatitis, as was originally suspected.

Work on the preparation of vaccines for the prevention of foot-and-mouth disease is also carried out at Pirbright. In all, 135 vaccines have been prepared there during the past ten years, by eight different methods. Although vaccination is not practised in Great Britain, any improvement on foot-and-mouth disease vaccines is of value and interest to other countries. The more efficient the vaccine, the better will be the control of the disease in countries which adopt a vaccination policy, and, therefore, the reduction of the risk of infection being introduced from them into Great Britain. It is of much interest to note that, from experiments at Pirbright, it can now be said that "Present evidence suggests that full protection could be given for about four months. After this period an increasing proportion of vaccinated animals would become susceptible to the disease".

A finding of much practical importance by the Pirbright workers concerns the survival of the virus in meat and offal. Precise experiments have shown that some early observations that infection in an affected animal was largely confined to bone marrow have had to be revised, for "there is an equal risk of other tissues, including the lymph nodes, blood in the large vessels, liver, kidneys and the rumen, remaining infective for long periods". The significance of these findings is of the greatest importance to countries which import meat and offal from areas in the world in which the disease is endemic.

The latest research work at Pirbright is the use of unweaned mice as experimental animals in the study of these viruses. Their use will obviate to a large degree the need for using cattle in some of the work.

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* Agricultural Research Council. Foot-and-Mouth Disease Research Interim Report. Pp. iv+12. (London: H.M. Stationery Office, 1952.) 6d. net.

Foot-and-mouth disease research can be carried out successfully only in a country relatively free from the disease and under elaborate conditions of isolation. Pirbright is ideally situated for this purpose. The results fully justify the existence of the Institute, and it is encouraging to read that "a large expansion of the buildings and facilities is planned" and that "When the additional facilities are available, the staff will be strengthened and the number of animals used for experiments at one time can be increased, with a corresponding speeding up of all the investigations".

TECHNICAL AIDS IN ARCHÆOLOGY

FOLLOWING the practice adopted at Edinburgh in 1951, a session on "Technical Aids for Archæology" was organized by Section H (Anthropology and Archæology) of the British Association at the meeting this year in Belfast. Being on the opening morning of the sectional sessions, however, and held in duplicate with one on Irish archæology, attendance was disappointing.

Mr. G. F. Mitchell, Fellow and lecturer in Irish archæology at Trinity College, Dublin, spoke first on vegetational environmental studies. It is now generally accepted that the palæobotanist can be the archæologist's most valuable collaborator, giving him some chronological framework in earlier periods, and at all periods an insight into early man's environment. The classical work in this field in Denmark[1] has related the earliest appearance of plantain pollen in Neolithic levels in peaty deposits to the development of agriculture at that period, for plantain is a weed of cultivation. In Denmark also, the appearance of beech pollen at a *Grenz-horizont*, or recurrence surface, in the raised bogs demonstrates a change in climatic conditions about 500 B.C.[2], and of rye and cornflower pollens at levels formed about A.D. 1200 indicates a change in agricultural activity[3]. In Ireland also, the rise of plantain pollen demonstrates the beginning of agriculture in Neolithic times, confirmed by the grain impressions on Neolithic pottery. There is also a well-marked recurrence surface, which, though not yet precisely datable in pollen terms, may lie at about 500 B.C.[4], although there is a second, higher surface, datable perhaps to about A.D. 400.

In evaluating climatic changes the natural sequence of pollen proportions is required, and this must be sought so far as possible from man's activities at that period, for these tended to destroy the natural woodlands and, in some places, produced heaths which invaded abandoned fields. Study of the ratio of herb to tree pollen makes possible some estimate of early agricultural activity, and the shrinking of forests may be traced as more skilled methods of agriculture were developed.

The seeds, charcoals and woods associated with early human activity show that the wood of all native trees was used in some way, that blackberries, elderberries, raspberries, strawberries and hazel-nuts were collected[5], that barley, oats, wheat and flax were cultivated, and that weeds were very abundant in prehistoric fields. The stomach of a Beaker period burial in the submerged clay of the Essex coast contained a pint of seeds, mostly blackberry[6], and in that of an Iron Age corpse recently found in a Danish bog seeds of pale persicaria, white goosefoot, corn spurry and black bindweed predominated. These plants were formerly cultivated, and, as they also occur in deposits of the early centuries of the Christian era in Ireland, they may have been cultivated for food there also.

Mr. E. M. Jope, lecturer in archæology in Queen's University, Belfast, spoke next on "History, Archæology and Petrology". During the past fifteen years the value of petrological examinations, especially of stone axes, has become fully appreciated by prehistorians. A number of axe factory sites are now known in the British Isles, and the petrologically determined distribution of their products is revealing wide, and sometimes unsuspected, contacts in Neolithic times. A lead was given by the Stone Axe Sub-Committee of the South-Western Group of Museums, which has published three reports[7], and a more general view is emerging as studies appear from other areas[8]. But the petrological demonstration that the Stonehenge 'bluestones' were brought from the Presely mountains in Pembrokeshire[9] nearly four thousand years ago still remains one of the most outstanding facts of British prehistory.

The study of building materials, particularly those in medieval buildings, can illuminate the economics and organization of the building trade; and as the material is bulky, when it is shown in use at a distance from its source reasonable transport facilities are implied, in many cases by road. Some valuable studies are already available[10], but the rate of such work is usually determined by the availability of reliable petrology, without which it is valueless, and much remains to be done in this field largely ignored by architectural historians. Some materials are, however, recognizable macroscopically with small chance of error, and systematic study of some of these is now showing the possibilities of this approach. Thus, Purbeck marble was extensively used throughout the civil zone of Britain in Roman times[11] and, after a lapse of about 750 years, was again even more extensively used throughout the Middle Ages. The marble industries of the Mediterranean area in Roman times are being studied at the British School at Rome[12]. Granite began to be commonly used in Devon and Cornwall churches during the fifteenth century, particularly as monolith arcade piers weighing often as much as five tons; and in a recent survey these have been found in nearly three hundred churches, some of them twenty miles or more from the granite outcrops, requiring land transport, in some documented instances by cart. The medieval export of blue slate from Wales[13], and from Cornwall and Devon[14], has also been studied. A survey of the medieval use of fine-quality building stone from the area of Great Oolite extending up the Cotswolds from Bath to Burford is now in progress, and it is already clear that such work can supplement surviving building accounts to give a more balanced estimate of the economic importance of such a stone industry[15].

An understanding of the variety of stones used for different purposes in historic buildings is of the utmost importance as basic data for the architects and others responsible for maintenance, if the buildings are to be preserved in a condition as near as possible to the designers' and builders' intentions[16]. This aspect has, in the past, been much neglected, as many historic buildings, particularly in Oxford, bear witness.

The third paper, by Mr. L. Biek, of the Ancient Monuments Laboratory, Ministry of Works, was on "Antiquities, Ancient Monuments and Research on Materials". In it he discussed first the relation between the scientific worker and the world's heritage of material culture[17]. A study of antiquities and ancient monuments by laboratory methods not only helps field archæologists by correlating the condition of finds with their environment, but also leads to better preservation and a fuller understanding and appreciation of objects by presenting them as nearly as possible in their original forms, as they were conceived by their makers. The benefits of such collaboration may, moreover, be mutual, for men of science working in some fields, such as corrosion studies, may gain a new insight into their own problems. Such work requires properly staffed laboratories which are specially intended for the problems involved[18].

Numerous illustrations of the results of such work, some with excellent coloured slides, were then given by Mr. Biek. Much new knowledge of early craftsmen's techniques comes from the detailed laboratory examination of their handiwork. Thus, the use of mercury in gilding sixth-century Merovingian brooches has been established, the mercury still being traceable microchemically. X-ray shadowgraphs have been invaluable in the study of antiquities, showing up even before cleaning, and without in any way altering the object, many details of their structure and decoration.

Recent studies in the Ancient Monuments Laboratory have shown that many of the rings used in making chain-mail of Roman times, found at Richborough, were punched out of cast sheet bronze. From a purely scientific point of view, the extreme fragility of similar rings, which must on internal evidence be taken to have been cold-worked, suggests that some ageing factor, as distinct from corrosion, may be operative under certain conditions. The survival on such rings of traces of suspension fibres (bast fibres, probably flax[20]) may possibly have been aided by the presence of corrosion products. But the most definite pointer of scientific interest provided by archæological finds was given by some excellently preserved iron objects of Roman and Saxon origin recently found at Hungate, York. Here research[21] showed that corrosion had been inhibited by phosphate and tannate, and the latter's suppression of sulphate-reducing bacteria was demonstrated for the first time. Such work is of potential value in the protection of present-day buried pipelines, for it has been estimated that the cost to England and Wales is £5 million a year due to corrosion losses in water mains alone.

Mr. Biek discussed the detailed collaboration of the laboratory staff with the archæologists in the field, not only on excavations but also in the study and preservation of buildings. Preservation of stonework has been much discussed in the past, and the study of masonry and brickwork in relation to their environment and the mortars used remains of greatest importance. It is also possible to learn something about early timberwork in buildings, and evidence of 'soft rot', a condition only recently recognized[22], has now been detected in the cavities left by bonding-timbers in the medieval masonry at Framlingham Castle, Suffolk. Apart from one very small piece of wood carrying this information, no trace of woody material was found in any of the several cavities, which originally contained timbers 15 ft. long by 1 ft. in diameter. In more modern buildings, the copper roof at Lancaster House and the century-old cast-iron tiles on the Houses of Parliament have recently been studied.

It is in the nature of things that references to such work should be widely scattered among many journals over a number of years, and only if there is direct systematic contact between archæologists and other scientists can the difficulties arising from such a state of affairs be reduced.

These three papers demonstrated selected aspects of collaboration between the natural sciences and archæology, and emphasized how the whole scope of inquiry into the past is being widened by this approach to the material. More laboratory facilities are required, such as are already operating at the British Museum, the Courtauld Institute, the Ministry of Works Ancient Monuments Branch, or Dr. H. Godwin's Sub-Department of Palæobotany at Cambridge, and in them workers are needed who by inclination are interested in archæological and historical problems as well as in those of the natural sciences. Neither are surely unreasonable requirements. It was encouraging to see that all three speakers at this session ranged widely in time, treating the study of material remains in both prehistoric and historic times as a continuum, and emphasizing what is generally accepted in classical studies, that in the Middle Ages, and even in more recent periods, a complete historical picture is not to be derived from written sources alone.

E. M. JOPE

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OBITUARIES

Prof. H. E. Roaf

WE regret to record the death of Herbert Eldon Roaf, professor emeritus in the University of Liverpool, on September 21 at the age of seventy-one.

Roaf was a Canadian who graduated at the University of Toronto and went to Liverpool to work under the direction of Benjamin Moore as Johnston Colonial Research Fellow. This early association with the famous biochemist is probably responsible for the interest in the chemical and physical aspects of physiology which Roaf sustained throughout his life, and which showed itself particularly in his earlier papers and in the work on biological chemistry which he published in 1921.

In 1906 Roaf was appointed assistant lecturer in the Department of Physiology under Sir Charles Sherrington, with whom he collaborated in research on the central nervous system. In 1911 he left Liverpool to become a lecturer in physiology at St. Mary's Hospital Medical School, London, and in 1920 was appointed to the chair of physiology at the London Hospital Medical College. He returned to Liverpool in 1932 as George Holt professor of physiology—a post which he held until his retirement in 1944. His chief interest in physiological research was colour vision, in which field he made many important contributions; but he was a man of wide and deep learning in his subject, and his "Text-book of Physiology" showed this clearly. He was a gentle, modest man, well loved by his colleagues and students, to whom he was devoted. During the War he undertook research on vision for the Admiralty, besides bearing a heavy burden of teaching and administrative work, in a department considerably denuded of staff.

He married Beatrice Sophie, daughter of Sir William Herdman, who survives him with two sons and two daughters.

Dr. William Brown

Dr. William Brown, founder of the Institute of Experimental Psychology in the University of Oxford, died in the early spring. Educated at Collyer's School, Horsham, at Christ Church, Oxford, and in Germany, he had a wide preparation for psychological work, having taken Mathematical Moderations, final honours in physiology, and Greats. He was John Locke Scholar in mental philosophy in 1908 and received his M.D. in 1918. In 1930 he was made a Fellow of the Royal College of Physicians. His first psychological work was done with Spearman at the University of London. This association produced what is now known as the Spearman–Brown formula, widely used in assessing the reliability of mental tests. In 1914 he was appointed reader in psychology at the University of London, which post he held until 1921. From 1921 until 1946 he was Wilde reader of mental philosophy at the University of Oxford, and during 1925–31 psychotherapist at King's College Hospital. In 1936 he became director of the Institute of Experimental Psychology at Oxford, which was founded with the assistance of a friend and patient of his.

Apart from his early work on the statistical treatment of mental measurement, which was of a high order, Dr. Brown's main achievement was, on one hand, to have brought about the recognition of experimental psychology at Oxford; on the other hand, his clinical work was unusually successful in that he obtained within the medical profession the reputation for meticulous care in excluding all physical causes before making a psychiatric diagnosis.

William Brown was very much interested in scientific societies. He was a member of the Mind Association, of the Royal Medico-Psychological Association and of the Royal Institute of Philosophy, and was president of Section J (Psychology) of the British Association for the Advancement of Science in 1927. He was president of the Society for the Study of Addiction, and associate foreign member of the Société Française de Psychologie. He had been a major in the R.A.M.C. during the First World War. Barely three months before his death, at the age of seventy-one, he delivered an astonishingly vigorous presidential address to the British Psychological Society.

NEWS and VIEWS

Nobel Prize for Physics, 1952

The Nobel Prize for Physics for 1952 has been awarded jointly to Prof. E. M. Purcell, of Harvard University, and Prof. Felix Bloch, of Stanford University, California.

Prof. E. M. Purcell

Prof. E. M. Purcell, who was born in 1912, graduated from Purdue University with a B.Sc. in 1933 and spent the succeeding year at the Technische Hochschule, Karlsruhe. In 1935 he went to Harvard, where he obtained his Ph.D., and joined the teaching staff as instructor in physics. During the Second World War he was associated with microwave work at the Massachusetts Institute of Technology. In 1945 he returned to the Lyman Laboratory of Physics at Harvard, and it was there that he made his discovery on magnetic absorption effects. Many physicists had been looking for dispersion or absorption effects of the magnetic properties of matter similar to those observed in the case of dielectrics, but it remained to Prof. Purcell to find the right conditions under which they manifest themselves. The first experiment was performed by putting a lump of paraffin wax contained in a resonant cavity into a magnetic field and observing the change of the Q-value when the magnetic field, H, passed through the resonance point ($h\nu = 2\mu H$). This absorption effect is very intimately connected with the mechanism by which the spin system transfers energy to the crystal lattice, a point which is very clearly emphasized in his first paper. The method is also of great sensitivity and has been used for measuring the proton magnetic moment of hydrogen gas. Since the first observation, many papers have been published by Prof. Purcell and others on details of great importance, such as line shapes and the use of the method for structural studies of crystals.

Prof. Felix Bloch

Prof. F. Bloch, who is professor of theoretical physics in Stanford University, was born in 1905 in Zurich, Switzerland, where he obtained his training (1924–27) in theoretical physics at the Federal Institute of Technology. He was awarded his doctor's degree in Leipzig (1928), where Prof. W. Heisenberg was pursuing his fundamental studies on quantum mechanics, and the following years were spent in Holland and in Copenhagen with Prof. Niels Bohr. In 1933 Bloch became *Privatdozent* under Heisenberg and was awarded, in the same period, a Rockefeller Fellowship which led him to Prof. E. Fermi in Rome.

During these years Bloch published papers on quantum theory, the electrical and magnetic properties of crystals, and produced his basic contribution to ferromagnetism. Also into this period falls his work on the energy losses of fast charged particles, a paper the results of which are still of great use to nuclear physicists.

When the intellectual climate in Germany became intolerable, Bloch emigrated, in 1934, to Stanford University, California, where he became associate professor of mathematical physics. He continued his theoretical studies, mostly on problems about interaction between radiation and matter and on nuclear physics, but became also interested in experimental physics. In 1940, in collaboration with Alvarez, he was the first to determine the magnetic moment of the neutron. War research at Stanford University, at the Los Alamos Laboratory and at Harvard University occupied the years 1942–45. As soon as conditions permitted, Bloch returned to Stanford, taking up theoretical and experimental research in physics. Papers on neutron polarization by ferromagnetic media and studies of the behaviour of atoms in a time-varying magnetic field followed. In 1946 Bloch published his theory, and also, in collaboration with the late W. W. Hansen and M. Packard, the experimental method, which he called nuclear induction, of measuring nuclear magnetic moments with greatest precision. The method resembles that of Rabi, of Columbia University, in so far as transitions are induced by a radio-frequency field between the sub-levels of a nucleus placed in a magnetic field. The great advantage of Bloch's method lies in the fact that one can use bulk material and pick up the induction signal with a coil. The sharpness of the resonance has permitted the attainment of a very high accuracy of the measurement of nuclear magnetic moments, and the sensitivity of the method permits the study of nuclear species available in only small quantities, such as tritium. The nuclear induction method has spread to a great many laboratories, and its use for measuring magnetic fields in terms of the proton nuclear moment is now a standard technique. Many new and unexpected features have been discovered, such as the fine structure of the proton lines in organic compounds, an observation which may well open up a new tool for organic chemists.

Principal of University College of North Staffordshire: Sir John Lennard-Jones, K.B.E., F.R.S.

It has been announced that Sir John Lennard-Jones, Plummer professor of theoretical chemistry in the University of Cambridge, has been appointed principal of the University College of North Staffordshire, in succession to the late Lord Lindsay of Birker, formerly Master of Balliol College, Oxford, who was principal from the foundation of the College in 1950 until his death in March this year. Born in 1894, Sir John studied in the University of Manchester and Trinity College, Cambridge. During the First World War he was first a pilot in the Royal Flying Corps and then an experimental officer in the Armament Experimental Station at Orfordness. His first academic post was as a lecturer in mathematics in the University of Manchester, and then he moved to the University of Bristol as reader, and later professor, of mathematical physics. Since 1932 he has been Plummer professor of theoretical chemistry in Cambridge. During the Second World War he served in a scientific capacity in the Ministry of Supply, being for three years chief superintendent of armament research and later director-general of scientific research (defence). Since 1947 he has been chairman of the Scientific Advisory Council of the Ministry. He has been president of the Faraday Society, and is now a member of the Scientific Advisory Committee of the National Gallery. Sir John, who is distinguished for his work in various branches of theoretical physics and chemistry, particularly the electronic structure of molecules, was elected to the Royal Society in 1933 and was made K.B.E. in 1946. He thus takes to his new post in North Staffordshire a wide experience of universities, scientific research and administration.

The Imperial Institute: Sir Harry Lindsay, K.C.I.E., C.B.E.

Sir Harry Lindsay retires at the end of January 1953 from the Imperial Institute, where he has held the post of director with great distinction since he succeeded Sir William Furse in 1934. The major qualification for this post is a living and working knowledge of the British Commonwealth overseas. Prior to his appointment, Sir Harry had been a member of the Indian Civil Service, serving in India during 1905–22 and finally as Indian Trade Commissioner in London until 1934. Incidentally, his father, grandfather and great-grandfather had all served in India in various capacities, both civil and military. Recognizing that the scientific side of the Imperial Institute was in good hands, Sir Harry devoted his main attention to improving the exhibition galleries and publicizing by lectures the importance of the Commonwealth countries, both the Dominion and the Colonies. He himself has given many of these lectures, and his personal experience, gained by visits to South Africa during 1936–37 on the occasion of the Empire Exhibition and on a lecture tour of Canada in 1938, made them particularly valuable. The development of the Imperial Institute Galleries has always been handicapped by lack of funds; but Sir Harry has managed to obtain much support from many of the Dominions and Colonies and also from industrial firms. As a result the galleries have been enriched by a valuable series of dioramas studied with pleasure and profit by the parties from schools which regularly visit them. During recent years, Sir Harry has maintained an active interest in the work of societies which have strong Commonwealth and educational ties. He was chairman of the Council of the Royal Society of Arts during 1947–49 and edited the "British Commonwealth Objectives" for the Society. He was president of the Royal Geographical Society during 1948–51, of the Geographical Association in 1949 and of Aslib in 1940, and for many years served on the Councils of the Royal Empire and Royal India, Pakistan and Ceylon Societies.

Mr. Kenneth Bradley, C.M.G.

Mr. Kenneth Bradley, who succeeds Sir Harry Lindsay on February 1, has had wide and varied experience in the Colonial Empire. He served in Northern Rhodesia as an administrative officer during 1926–39 and then as information officer until 1942. He laid the foundations of the present department, including the inauguration and development of a broadcasting service to the African population. In 1942 he went as Colonial Secretary and Financial Secretary to the Falkland Islands and, while there, took part in the establishment of bases for the Falkland Islands Dependencies Survey in the Antarctic. He received the C.M.G. in 1946 and early in that year was promoted to the post of Under-Secretary in the Gold Coast. He served there, acting as Colonial Secretary for most of the time, until 1948. In 1947 he was chairman of the Gold Coast Committee which recommended the establishment of the present Gold Coast University College. In the following year he retired from the Colonial Service in order to become the first editor of *Corona*, the professional journal of the Colonial Service. Mr. Bradley has, since he came to London, particularly interested himself in the task of spreading knowledge about the Commonwealth and has given many broadcasts and lectures and contributed widely to periodicals in Britain and throughout the Commonwealth. He is a recognized authority on African affairs. He has published several books on African subjects, of which the two best known are "The Diary of a District Officer" (Harrap, 1942; Nelsons, 1948) and "The Colonial Service as a Career" (H.M.S.O., 1950), and has in the press a history of the Roan Antelope and Mufulira copper mines and of the early development of Northern Rhodesia as a whole under the title "Copper Venture".

The Oxford Synchrotron

THE Oxford 140-MeV. synchrotron has recently been undergoing preliminary trials at 60 MeV. This machine was built with funds supplied by the Department of Scientific and Industrial Research. During the past year much trouble has been encountered owing to the charging-up of the orbit tube wall, but these difficulties are now being overcome. The X-ray yield so far obtained is moderate, a thin copper target irradiated to saturation at a metre from the target showing a copper-62 activity of about 10,000 counts per min. per gm.

Science in the University of Glasgow

FOR the present session there have been 225 new admissions to the Science Departments of the University of Glasgow, compared with 232 a year ago. There are about 179 research students. In all sections of the University the total number of matriculated students is now about 5,820. A new feature of the teaching of bacteriology in the University (under Prof. J. W. Howie as its Gardiner professor) is that it now ranks as a science subject for degree courses. It may be taken either as a single or double qualifying course for the ordinary degree, or as a principal subject of an honours curriculum, which includes courses in botany, zoology, chemistry and biochemistry. There is also a combined honours curriculum in bacteriology and biochemistry.

The following appointments have recently been made in the University: Dr. F. E. Moon has been appointed senior lecturer in agricultural chemistry; Imperial Chemical Industries Fellowships have been awarded to Drs. M. F. Grundon and H. J. E. Loewenthal (for work in the Chemistry Department on curare and in the polycyclic field, respectively) and to F. C. Flack (gamma-ray spectroscopy in connexion with the high-tension set in the Natural Philosophy Department).

Synthesis of Vitamin B_{12} by *Rhizobium meliloti*

IT has been shown by M. O. Burton and A. G. Lockhead (*Canad. J. Bot.*, 30, 5, 521; 1952) that, of seventy strains of six species of *Rhizobium*, *R. meliloti* is sharply distinguished from the others by its ability to synthesize significantly larger quantities of vitamin B_{12}, one strain producing 1,000 mμ gm. per ml. of liquid culture medium. No correlation was observed between the vitamin-synthesizing capacity of individual strains and their effectiveness in nitrogen fixation.

Bristol Museum

THE annual report for 1951 of the City Museum, Bristol, is a good example of how provincial institutions accepted the challenge presented to them by the Festival of Britain. In Bristol it was decided to stage an exhibition portraying to some extent the topography and natural history of the city in 1851. One part of the large gallery was arranged realistically with lay figures and furniture to simulate the essential features of a drawing room. In addition, material and lay figures showed a hatter's and a sailmaker's workshop, while side panels depicted aspects of the railways, shipping, natural history and geology of the Bristol area in 1851. The report also describes new developments at the Museum during 1951, chief of which was the opening of a room specially for children making use of the Museum's service to schools. In addition, seventeen temporary exhibits were arranged as well as a series of winter lectures and conducted summer walks.

Proceedings of the Glasgow Mathematical Association

DURING the past fifty years the numbers of those engaged in research in pure mathematics has increased many times; but there has been no corresponding increase in the number of British journals available for the publication of their work. We therefore heartily welcome the appearance of a new journal, entitled *Proceedings of the Glasgow Mathematical Association*, but actually containing papers not only from Glasgow but also from England, Canada and South Africa. Manuscripts from all parts of the world are invited, primarily, but not exclusively, on pure mathematics, and should be sent to the Editor, Glasgow Mathematical Association, Department of Mathematics, University, Glasgow, W.2. The *Proceedings* will be published each January and July, the first part having appeared in January 1952. Four parts will make up a volume of about two hundred pages. The prepaid subscription for each volume is £2 (or 6 dollars) post free, and single parts may be obtained for 10*s.* 6*d.*, from the publishers (Edinburgh and London: Oliver and Boyd, Ltd.) or from any bookseller.

Plant Breeding Institute, Cambridge

THE Plant Breeding Institute at Cambridge, for many years part of the School of Agriculture, University of Cambridge, which was responsible for its administration with the aid of grants from the Ministry of Agriculture and Fisheries, has now been constituted as an independent research institute. It will continue to be financed by grant-aid from the Ministry and to come under the scientific supervision of the Agricultural Research Council. The Institute now takes the form of a company limited by guarantee, and without share capital. The membership of the governing body is as follows: Sir Frank Engledow (chairman); Prof. G. E. Briggs; Prof. W. Brown; Mr. E. Cave; Prof. S. C. Harland; Prof. H. Ian Moore; Prof. J. W. Munro; Prof. T. G. B. Osborn; Mr. R. W. Ward.

Earthquake near Kamchatka

On November 4 at 16h. 58m. 20s. G.M.T., an earthquake occurred with epicentre, according to calculations made at the U.S. Coast and Geodetic Survey in Washington, at lat. 52¼° N., long. 159° E., near the east coast of Kamchatka. It was recorded strongly at seismological observatories throughout the world and had a magnitude of 8¼ on the Gutenberg–Richter logarithmic scale. This is a smaller magnitude than that of the great Sikang–Assam earthquake of August 15, 1950; but had the Kamchatka earthquake happened on land it would undoubtedly have occasioned great damage. Faulting probably took place in the sea bed near the epicentre, since a great tsunami or seismic sea wave resulted, and spread throughout the Pacific Ocean. It arrived at the coast of northern Japan about 20h. G.M.T. on November 4. The Hawaiian warning system was used, and the coastlands of several islands, including the Oahu coast, were evacuated in anticipation of the wave. When the wave arrived at Hawaii itself, it is reported to have been several feet high, and would have caused much damage had not precautions been taken. Waves from one to three feet high arrived at the Whangarei beaches in the north of New Zealand about 7 p.m. local time on November 5. When these waves arrived at Wellington, they were 6–8 in. high. No news has yet been received from the nearest town to the epicentre—Petropavlovsk on the Kamchatka Peninsula—nor from the International Seismological Association central station at Strasbourg. Immediately following the main shock, there were more than a hundred aftershocks. Further news is awaited.

Provisional readings, all in G.M.T., of seismograms at Pasadena were: *eP*, 17h. 08m. 23s.; *iP*, 17h. 08m. 37s.; *e*(*PP*), 17h. 11m. 0s.; *eS*, 17h. 16m. 39s.; *iS*, 17h. 16m. 48s.; *i*(*ScS*), 17h. 18m. 11s.; *eG*, 17h. 23·2m.; *iG*2, 19h. 22m.; max. *H*, 2,000 ± μ; and at Stuttgart: *iP*, 17h. 10m. 12·0s. compression; *i*, 17h. 10m. 14·6s. compression; *i* !, 17h. 10m. 21·0s. compression; *i* ! (*PcP*), 17h. 10m. 24·0s. dilatation; *iPP*, 17h. 13m. 20s.; *iS*, 17h. 20m. 10s.; *eG*, 17h. 31m. (*T* = 80 sec. !); *MQ*, 17h. 40m.; *MR*, 17h. 41–42m. (*Z* = 5,400 μ); *MR*, 17h. 50m.

The Night Sky in December

Full moon occurs on Dec. 1d. 12h. 41m., U.T., and new moon on Dec. 17d. 02h. 02m. The following conjunctions with the moon take place: Dec. 12d. 20h., Saturn 8° N.; Dec. 15d. 14h., Mercury 7° N.; Dec. 20d. 08h., Venus 2° S.; Dec. 21d. 02h., Mars 2° S.; Dec. 26d. 20h., Jupiter 7° S. Mercury is too close to the sun at the beginning of December for favourable observation, but at the middle and end of the month its times of rising are 6h. 05m. and 6h. 50m., respectively, and it can be seen for a short time before sunrise; owing to its large southern declination, it will not rise far above the horizon. Venus is an evening star, setting at 18h. 25m., 19h. 05m. and 19h. 50m. on December 1, 15 and 31, respectively. The visible portion of the illuminated disk varies from 0·75 to 0·65, and the stellar magnitude averages − 3·7. Mars, an evening star, sets at about 20h. 20m. throughout the month, stellar magnitude about 1·1. It is easily recognized during the middle of December close to γ and δ Capricorni. Jupiter is visible throughout the night, setting in the morning hours at 5h. 15m., 4h. 15m. and 3h. 10m. on December 1, 15 and 31 respectively, stellar magnitude about − 2·3. Saturn, a morning star, rises at 3h. 25m., 2h. 40m. and 1h. 40m. at the beginning, middle and end of the month, respectively, stellar magnitude 0·9, and is visible for some hours before sunrise in the constellation of Virgo. Occultations of stars brighter than magnitude 6 are as follows, observations being made at Greenwich: Dec. 4d. 1h. 55m., 37 Gemi. (*R*); Dec. 6d. 5h. 11·7m., δ Canc. (*D*); Dec. 6d. 6h. 15·9m., δ Canc. (*R*); Dec. 28d. 1h. 24·3m., 16 Taur. (*D*); Dec. 28d. 1h. 31·4m., *q* Taur. (*D*); Dec. 28d. 1h. 50·7m., 20 Taur. (*D*); Dec. 28d. 1h. 53·7m., 21 Taur. (*D*). *R* and *D* refer to reappearance and disappearance, respectively. Winter solstice takes place on Dec. 21d. 22h. Observation of the Geminid meteors during the first week in December will be difficult owing to moonlight.

Announcements

The conference this year of the Universities of Great Britain and Northern Ireland, convened by the Committee of Vice-Chancellors and Principals, will be held in the Senate House of the University of London during December 12–13. There will be three sessions on the following subjects: halls of residence and student amenities; success and failure at the university; and vacation employment. The Conference is only open to delegations appointed by the universities and to specially invited guests. Further details can be obtained from the secretary of the Committee, J. F. Foster, at 5 Gordon Square, London, W.C.1.

On the occasion of the twenty-second annual general meeting of the Printing, Packaging and Allied Trades Research Association, an exhibition of the Association's work will be held at the Connaught Rooms, Great Queen Street, London, W.C.2, on December 4. The displays will illustrate the work carried out in the Association's laboratories on the chemistry and physics of printing inks, papers, the testing of packages and containers, bookbinding, and the protection of packages against insect attack. New apparatus and new wash-up solvents will be shown, and the manner in which the Association endeavours to place its findings before its members will be illustrated. Further details can be obtained from the Association at Patra House, Randalls Road, Leatherhead, Surrey.

The National Science Foundation and the University of Rochester are sponsoring a conference on high-energy nuclear physics to be held in Rochester, N.Y., during December 18–20. The conference will be financed by a 2,000-dollar grant from the Foundation and contributions from several industrial firms in Rochester. The conference will bring together about seventy nuclear physicists from the United States, Canada and Mexico to discuss recent research findings on high-energy particles and to plan future studies in this field. Further information can be obtained from the National Science Foundation, 2144 California Street, N.W., Washington 25, D.C., or from the Department of Physics, University, Rochester, N.Y.

In the April and May issues of *L'Astronomie* there are two accounts of the eclipse of the sun at Khartoum on February 25, with a number of photographs taken by J. Leclerc and E. Geneslay. The first account is by several authors, and the second by L. D'Azambuja, of the Paris-Meudon Observatory. These detailed descriptions will prove very helpful to everyone interested in solar eclipses.

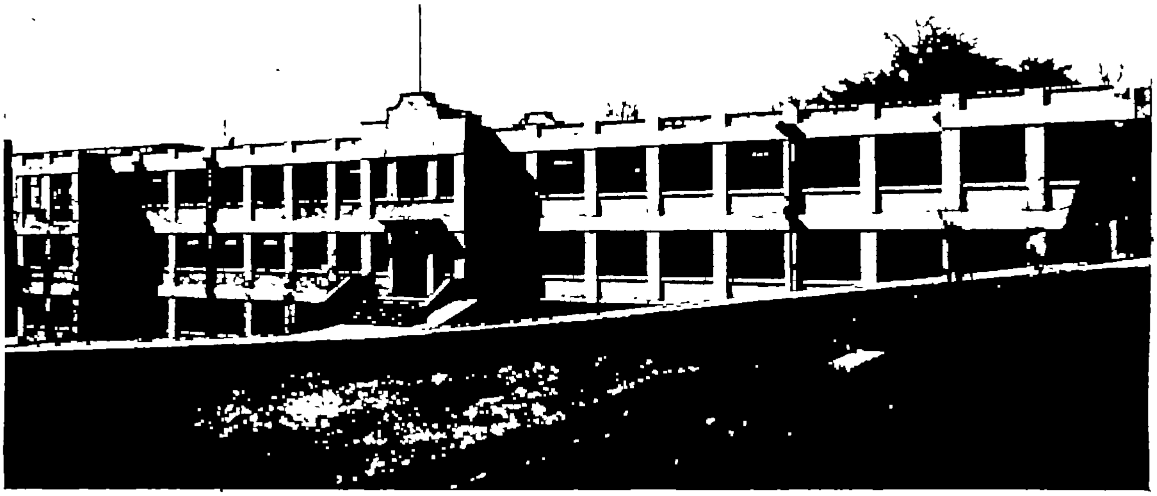
WOOL INDUSTRIES RESEARCH ASSOCIATION

EXTENSION TO LABORATORIES

POST-WAR extensions of the laboratories at Torridon, Leeds, of the Wool Industries Research Association were opened on October 17 by Viscount Swinton, Chancellor of the Duchy of Lancaster and Minister of Materials. The nucleus of the Research Association was formed in 1915 when a 'West Riding Research Committee' of interested industrialists, under the guidance of the late Sir Michael Sadler, vice-chancellor of the University of Leeds, initiated co-operative research which was financed by the local industry. This Committee was able to take full advantage of the Research Association scheme which was put forward by the Department of Scientific and Industrial Research in 1918. Indeed, the Wool Industries Research Association was the second to be formed under the ægis of the Department. The work of the Research Association was originally undertaken at the University of Leeds; but the need for separate laboratories soon became apparent, and in 1920 Torridon, a large residence standing in about four acres of ground, was purchased, and this provided reasonable accommodation for a limited number of laboratories and offices. In 1925 a shed was erected for woollen plant and later another was added for worsted plant, and in 1928 the adjoining estate of Longfield was purchased with a capital grant from the Empire Marketing Board. A new block was built for wet processing in 1939, and looms were installed in some of the original outbuildings.

In 1947 a progressive building plan was started. The wet-finishing block was extended to provide laboratory accommodation together with more extensive facilities for pilot-scale dyeing. This and three large new blocks have now been completed. The first contains pure and applied physics laboratories, including two large physical-testing laboratories where the atmosphere is controlled to 65 per cent relative humidity and 68° F. (20° C.), a drawing office and machine shop. As fibre properties are so sensitive to atmosphere changes, the whole of the block, other than the testing laboratories, is supplied with air maintained at 50 per cent relative humidity and 65° F., except when these conditions require the use of refrigeration. The second block to be finished houses woollen-carding and -spinning machinery, together with a raw-wool scouring plant in the basement. This block is also fitted with humidifying plant. The third block is for research on weaving and is equipped with a full range of preparatory machinery in addition to looms and with laboratory facilities. One room is humidified so that weaving can be done under a range of atmospheric conditions. The new buildings provide roughly sixty thousand square feet of floor area and with their equipment have cost about £250,000.

Research in the past has tended to be fundamental rather than applied, due largely to the big floor areas needed to house processing equipment. The new buildings were designed primarily to overcome this difficulty, and it should now be possible to undertake much more extensive research in fields that lead directly to increased industrial efficiency. As Lord Swinton said in his opening speech: "Research is the eyes of industry, and corporate research, industry combining for research, is the best of all; here in the Wool Industries Research Association you are, I think, a model because it is in very truth a partnership enterprise of a multitude of firms large and small. And those combined operations in the common interest have proved in this industry, as indeed in



New physics block at the Wool Industries Research Association others, to be no bar to individual initiative and competition." The new buildings are visible evidence of confidence in the success of corporate research because co-operation from all member firms will be essential if these facilities are to play their full part in promoting progress within the industry.

Wool is a most versatile fibre; there are in reality four wool industries—woollen, worsted, pressed felt and mechanical cloth, and the shoddy industry. The facilities now available provide for research ranging from the biology of wool growth to the finishing of fabrics, and although it is impossible to have even one example of every type of machine used in each of these separate industries, the methods and processes that are common to most of them can be fully investigated.

Perhaps the biggest expansion has been on the weaving side. Hitherto, facilities for work in this field have been negligible; but it is now possible to follow every process in preparing yarns for the loom and in weaving them on any of a representative range of looms. This is almost a virgin field for research so far as wool is concerned, and one that is likely to lead to fruitful results because much of the appearance of a finished wool fabric depends on the care with which the yarn is handled and wound between spinning and weaving.

Another aspect of the Association's work which has been increased and will benefit further from the extensions is operational research. The Association has undertaken this work in a small way for very many years, and as far back as 1947 it published to members a booklet on quality control in worsted spinning. The surveys now being made in mills, together with appropriate laboratory and pilot-plant work, provide information to members on the limits that can and should be worked to if optimum productivity and high-quality output are to be maintained with a proper economy in the use of consumable materials. The success of this work is shown by the increase in use of testing facilities in mills. It is worth noting that members installing these facilities often remark that only within recent years have test methods become available which are suitable for use in mills; and most of the examples they quote are the direct result of the Association's work.

The fundamental work of the Association, which has been so strikingly successful in the past, is continuing. Paper partition chromatography[1] was invented and developed in the Association's laboratories to determine the amino-acid composition of wool hydrolysates, work for which Dr. A. J. P. Martin and Dr. R. L. M. Synge have been awarded the Nobel Prize for 1952 (see *Nature*, November 15, p. 826). It continues to be used in the laboratories and has been improved in a number of respects, particularly with regard to the use of radioactive tracers to give a quantitative rather than a qualitative result[2]. Radioactive tracers are also in use to follow the diffusion of ions in keratin membranes, work which aims at elucidating the mechanism of dyeing. It has already yielded the result that hydrogen ions diffuse more slowly than those of bromine at low concentrations of hydrogen bromide[3]. This result is consistent with measured membrane potentials which previously seemed to be anomalous, and it can be quite simply explained on the theories of multimolecular adsorption and diffusion which have been developed for polymers at Torridon[4]. The earlier work of the Association on the importance of moisture absorption for clothing comfort and on the propagation of temperature and humidity changes through masses of textile materials[5] is now universally accepted and used throughout the world, as are the theory of water repellency of porous structures[6] and the theory of the effect of salts on ionic detergents[7].

A subject more recently studied, which has both practical and theoretical importance, is the dissipation of static electricity on fibres or polymer sheets. A solution has been found for the distribution of charge and the distribution of electric field in such systems, and the distribution of the field shows that conductivity in a liquid coating is much more effective in dissipating static charges than is conductivity of the fibre or sheet. Another subject of academic and practical interest is the friction between fibres or polymeric surfaces. Recent work has shown that, in contrast to the behaviour of metals, elastic rather than plastic deformation determines the frictional force; recognition of this difference between the two processes has explained many apparently anomalous features in the behaviour of polymeric materials during rubbing[8]. Thus, although the Association has planned for a large extension of work in the applied field, it has not lost sight of the need for fundamental research which so often inspires new ways of looking at practical problems, leading to their successful solution.

Finally, it might be mentioned that the Association's shrink-resisting process has been used by the Ministry of Supply since 1940 for Service socks and underwear. The Association has received £25,000 in royalties, and the increased life of the garments so treated has provided a saving to the Ministry of at least £5 million, which is several times the total expenditure of the Association since it was formed in 1918.

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BRITISH STANDARD OF RADIOACTIVE IODINE (^{131}I)

In the autumn of 1948, at the request of the Medical Research Council, provisional British standards of certain therapeutically important radioactive isotopes were set up. The Atomic Energy Research Establishment[1] undertook the maintenance of standards of cobalt-60, sodium-24, and phosphorus-32; the maintenance of the iodine-131 standard was undertaken by the Radiotherapeutic Research Unit of the Medical Research Council at Hammersmith[2]. It was intended that these standards should serve for one year; their use has, in fact, continued until the present time.

Following an agreement between various interested bodies in 1950 that the National Physical Laboratory should be formally responsible for standards of this kind in Great Britain, workers from the Radiotherapeutic Research Unit, the Atomic Energy Research Establishment, the Royal Cancer Hospital and the National Physical Laboratory have met regularly to discuss standardization and to compare measurements on a number of isotopes. As a result of the improvements in standardizing techniques and of the more precise information now available about the iodine-131 disintegration scheme, it has been agreed that a revision of the 1948 standard for the substance is necessary.

In general, an isotope emitting β- and γ-rays may be standardized by counting methods which measure almost directly the number of nuclei disintegrating per second, that is, the number of curies present. An alternative method is the measurement of the γ-ray ionization in air under conditions which permit the result to be expressed in röntgens per hour at 1 cm. from a sample of radioactive material; which result can be converted to curies per gram of the sample by means of a factor (r./hr. at 1 cm. from 1 mC.) deduced from a knowledge of the disintegration scheme, of the γ-ray absorption coefficients in air, and of the energy required to produce an ion pair in air. The 1948 standard of iodine-131 was based on this latter procedure, which gave a conversion factor of 2·54 r./hr. at 1 cm. from 1 mC. of the isotope. Using subsequent information[3] about the disintegration scheme, and assuming that the energy required to produce an ion pair in air is 32·5 eV., the factor is deduced to be between 2·27 and 2·29 r./hr. These, and all other values of this factor quoted, exclude the small contribution due to X-rays arising from internal conversion and to bremsstrahlung which is of the order of 1 per cent of the total. (Experimentally, virtually complete elimination of the X-rays and bremsstrahlung can be achieved by absorption in 0·5 gm./cm.^{2} of copper.)

Recently, samples of iodine-131 have been distributed among the above-mentioned laboratories for measurements by counter methods, which include the defined solid-angle method using end-window β-counters, the 4π solid-angle Geiger–Müller counter, the 4π liquid scintillation counter and the β–γ coincidence method. The results by different laboratories, different counter techniques and different equipment varied by ± 5 per cent. The samples were also measured by three of the laboratories using the γ-ray ionization method. For this purpose, graphite chambers were used which were calibrated with γ-rays from standard radium sources, for which it was assumed that the dosage-rate at 1 cm. from 1 mgm. radium screened by 0·5 mm. platinum was 8·3 r./hr. The results obtained by the three laboratories varied over a range of ± 2·5 per cent. The measurement by the ionization method and by the counter methods were consistent with a value 2·25 r./hr. at 1 cm. from 1 mC. of iodine-131. Accordingly, it is now proposed that a figure of 2·25 r./hr. for the dosage-rate at 1 cm. from 1 mC. of iodine-131 (excluding the contribution due to X-rays and bremsstrahlung) should be adopted as the new standard. This differs from the previous standard in that a quantity of iodine-131 hitherto estimated as 1 mC. will now be 1·13 mC. The maintenance of the standard will be undertaken by the National Physical Laboratory; measurements will be made in terms of γ-ray ionization in graphite chambers, calibrated against a standard radium source (and using the conversion factor of 8·3 r./hr. already quoted), because of the greater convenience of this type of measurement compared with the direct counting methods. It is believed that values based on the new standard will not differ by more than ± 5 per cent from the true values.

A more detailed account is being prepared of the intercomparisons on which this new figure is based.

The mean energy emitted by iodine-131 in the form of β-rays and internal conversion electrons has been re-determined by the Radiotherapeutic Research Unit, using the lined-chamber method[1]. The value based on the new standard is 0·197 MeV. Taking into account all sources of error, this value is regarded as correct within 5 per cent.

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FOLLOWING the review described above of the British standard of activity for the radioisotope iodine-131, the new standard will be used for dispensing this substance supplied by the Atomic Energy Research Establishment, Harwell, as from January 1, 1953. The provisional Medical Research Council standard, set up by Gray, which has been used for the assay of all consignments supplied by the Establishment from the beginning of 1949 until the present time, will be used for supplies dispensed up to midnight on December 31, 1952.

It should be noted that, whereas 1 mC. of iodine-131 measured by the provisional standard (1949) emits gamma-radiation at the rate of 2·54 r./hr. at 1 cm., 1 mC. of iodine-131 by the new standard gives 2·25 r./hr. at 1 cm. A factor of 1·13 therefore exists between the two standards, and the new standard millicurie will contain less activity than the old one.

No official intercomparison of standards for iodine-131 has yet been made between Great Britain and other countries. However, a series of unofficial measurements, relating standards from Chalk River, Canada, National Bureau of Standards, U.S.A., and Oak Ridge, U.S.A., indicate that the new British standard is in agreement with these, at least within experimental error.

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STRUCTURAL FEATURES OF ANTITUMORIGENIC CORTICOIDS

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THE antifibromatogenic action of steroids is not related to any other known physiological action of the latter; it is an independent faculty[1,2]. Thus it seems likely that 'screening' of antitumorigenic steroids may be based, tentatively, on the assumption that the antitumorigenic potency is concomitant with certain structural features of these compounds.

Progress has recently been achieved on these lines in our work on the antifibromatogenic potency of various corticoids in castrated female guinea pigs receiving, during a period of three months, œstradiol as absorbed from a subcutaneously implanted tablet.

Control experiments with œstradiol alone. Of twenty-three animals with an absorption of 16–70 μgm. of œstradiol a day, nineteen had abdominal fibroids (fibrous tumoral effect = 3·9). (This control series is not identical with that of our earlier paper[1]. Any series in which the antifibromatogenic potency of steroids is tested is always accompanied by a new control series.)

Deoxycorticosterone (acet.; m.p. 159). Deoxycorticosterone has long been known as one of the most potent antifibromatogenic steroids, being inferior only to progesterone[3,4]. In a new series of experiments, prevention of abdominal fibroids was again obtained in all the eight animals in which 135–200 μgm. of deoxycorticosterone acetate per day was absorbed from one tablet (2·9 ± 0·1 μgm. per 1 sq. mm.) subcutaneously implanted. Only fibrous strands and some tiny nodules on the spleen were present (fib. tum. effect = 1·4). In a group of four animals with an absorption of 97–118 μgm. of deoxycorticosterone acetate per day from half a tablet, the average fibrous effect was still considerably diminished (= 2·5).

17-*Hydroxy-deoxycorticosterone* (Reichstein's compound *S* acetate; m.p. 233)[5]. This substance differs from deoxycorticosterone solely by $\mathrm{OH}--\mathrm{C}_{17}$. In a group of ten animals, absorption from one to three tablets was as much as 150–750 μgm. per day (2·9 ± 0·14 μgm. per 1 sq. mm.). All animals had abdominal fibroids (fib. tum. effect = 5·8).

One may infer from these results that the antifibromatogenic potency of deoxycorticosterone is considerably diminished by the substitution $\mathrm{OH}--\mathrm{C}_{17}$.

Dehydrocorticosterone (Kendall's compound *A*, acet.; m.p. 176°). This differs from deoxycorticosterone solely by $\mathrm{O}=\mathrm{C}_{11}$. In earlier experiments of shorter duration (two months only), it was found to be antifibromatogenic, though probably less than deoxycorticosterone[6]. In a new series of nineteen animals, this was corroborated, though the difference between deoxycorticosterone and compound *A* was found to be more considerable than in former experiments. Fibromatogenesis was greatly diminished (fib. tum. effect = 1·7) by about 356–417 μgm. of *A* acetate per day absorbed from half a tablet (7·2 ± 0·4 μgm. per 1 sq. mm.; this rapid absorption makes it necessary to implant a new tablet six weeks later); but there were fibroids with a dose of 90–110 μgm. of *A* acetate per day (fib. tum. effect = 4·9; 1–3 tablets containing but 40 per cent of *A* acetate and 60 per cent of cholesterol, permitting non-selective absorption[7,8]; figures not exact on account of the breaking up of the tablets).

The above results show that the antifibromatogenic potency decreases due to $\mathrm{O}=\mathrm{C}_{11}$, though in a much less pronounced degree than with $\mathrm{OH}--\mathrm{C}_{17}$. Cortisone is of considerable interest here, because it differs from deoxycorticosterone by both these substitutions.

Cortisone, or 17-hydroxy-dehydrocorticosterone (*E* acetate; m.p. 237°). In former experiments, abdominal fibroids were not prevented with 138 μgm. of *E* acetate per day absorbed from subcutaneously implanted tablets[9,10]. In a new group of three animals, there was again no prevention with 125–225 μgm. of *E* acetate per day (fib. tum. effect = 3·9; 6–8 tablets containing 40 per cent of cortisone and 60 per cent of cholesterol; absorption figures not exact). In a group of ten animals, as much as 457–1,050 μgm. per day were absorbed from 1–2 tablets (6·5 ± 0·14 μgm. per 1 sq. mm.; a new implantation was made six weeks later). Some prevention took place (fib. tum. effect = 2·3); but there were fibroids even with as much as 1,000 μgm. per day (2 tablets).

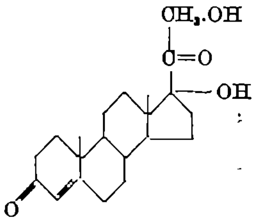
The difference between the antifibromatogenic potency of cortisone and deoxycorticosterone is very striking. But cortisone is also much less active than compound *A*. These findings are in full agreement with the statement that antifibromatogenic potency is diminished by $\mathrm{OH}--\mathrm{C}_{17}$. However, contrary to expectation, cortisone was seemingly somewhat more potent than compound *S*, with which it shares $\mathrm{OH}--\mathrm{C}_{17}$. That is to say, $\mathrm{O}=\mathrm{C}_{11}$, which by itself certainly diminishes the antifibromatogenic potency (*A* is less potent than deoxycorticosterone), appeared to counteract, or to reduce, the negative influence of $\mathrm{OH}--\mathrm{C}_{17}$ when simultaneously present with the latter. In view of very considerable variations as to the fibrous tumoral effect in a group of animals, it would seem wise not to attribute too much importance to the difference between compound *S* and cortisone. However, the unexpected phenomenon of reduced negative effect was shown in an even more striking way when compound *S* (17-hydroxy-deoxycorticosterone) was compared to compound *F* (17-hydroxycorticosterone).

17-*Hydroxy-corticosterone* (compound *F*, acetate; m.p. 218°). In two animals, 160–235 μgm. of *F* acetate per day were absorbed from one tablet (a new implantation six weeks later); in three animals 467–518 μgm. per day were absorbed from two tablets (2·6 ± 0·4 μgm. per 1 sq. mm.). There were no fibroids, only fibrous strands and small nodules being present (fib. tum. effect = 1·2). On the contrary, in five animals with 67–95 μgm. per day absorbed from ten tablets containing 40 per cent of *F* acetate and 60 per cent cholesterol, there was no prevention of fibroids (fib. tum. effect = 3·6).

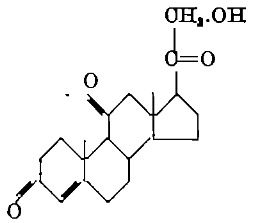
It would thus seem that, thanks to $\mathrm{OH}--\mathrm{C}_{11}$, compound *F* diverges as to antifibromatogenic potency from compound *S* and approaches deoxycorticosterone.

Suppression of the negative influence of a substitution by another one can be paralleled by older observations of ours. Whereas progesterone is the most potent antifibromatogen, pregnanedione and allo-pregnanedione, in which Δ^4 is lacking, are not antifibromatogenic[7]. On the other hand, dihydrotestosterone and methyl-dihydrotestosterone are as potent as testosterone and methyl-testosterone, or are more potent than these[11,12]. One may speculate that the interference of Δ^4 is no longer necessary when the side-chain of two carbons in C_{17} is eliminated or reduced to CH_3. (The OH in C_{17} in these antifibromatogenic androgens is in the beta position; on the contrary, the isomer of testosterone with $\mathrm{OH}--\mathrm{C}_{17}$ (formerly called cistestosterone) is not antifibromatogenic[10]. This is in full agreement with the above findings with compound *S*.)

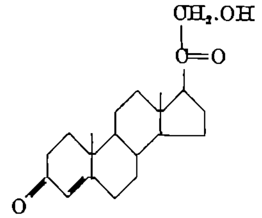
Our finding of a difference in antifibromatogenic potency between compounds *E* and *F* can be compared also to the statement that the latter is thirty times more active than compound *E* in inhibiting the growth of the chicken embryo and a hundred times more active than compound *E* in inhibiting the growth of the newly hatched chick[13]. The fact that such considerable functional differences exist



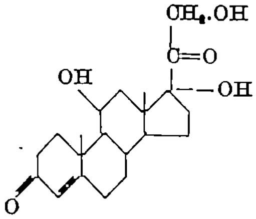
(S)



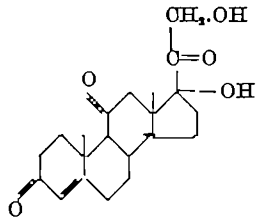
(A)



Deoxycorticosterone



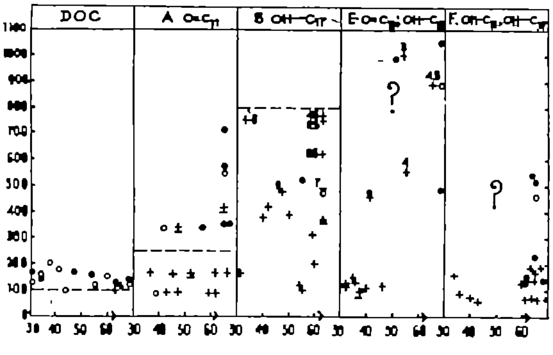
(F)



(E)

between these compounds is of great interest by tself; the recent suggestion that the steroidal output of the adrenal cortex consists predominantly of compounds *F* and *B* (corticosterone) also should be mentioned here[14]. We are fully aware of variations of the fibrous tumoral effect one meets with in similar experiments even when prolonged for a period of three months, and which may lead to contradictory results. Comparative work with compounds *S* and *F* is continuing in this Department.

The accompanying diagram summarizes the experiments discussed above and also additional experiments with Reichstein's compound *S* and Kendall's compound *F*. Whereas the negative influence of OH -- C_{17} (compound *S*) has been fully confirmed, the 'protective' action of OH - C_{11} against OH -- C_{17} compound *F*) remains so far doubtful.



+, Animals with tumours; O, animals without tumours, only fibrous strands being present; ±, animals with not more than one tumoral note grade 1. Abscissa: absorption of œstradiol per day (μgm.); ordinates: absorption of 3-keto steroids per day (μgm.)

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PASSAGE OF THE SPERM AND THE PENETRATION OF THE EGG IN MAMMALS

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THE wealth of detail in a recent comprehensive review of this subject[1] bears witness to the large volume of information which is available on fertilization and associated phenomena in mammals. Although much of the information is rather disconnected in form, some underlying principles are becoming more clearly defined. In particular, it seems possible now to derive a logical concept of those processes which lead up to the fertilization of the mammalian egg, and it is with this object in mind that the present communication has been prepared. The specific aspects to be considered include the time relations of œstrus, ovulation and coitus, the distribution and rate of travel of sperms in the female genital tract, and the mechanism of sperm penetration into the egg.

Number of Sperms in the Female Tract

The number of sperms in a single ejaculate varies with the species of mammal but generally is of the order of 100 million–1,000 million. The semen may be ejaculated into the uterus, as in the rat, mare and sow, or into the vagina, as in the rabbit, ewe, cow and bitch.

In striking contrast, the number found in the Fallopian tube, and particularly the ampulla, which is the usual site of fertilization, is relatively very small. Mean figures for sperm counts, mostly at the time of ovulation, are available for several species: from 5–43 in the ampulla of the rat[2-4]; 2,000 and 3,000 in the whole tube of the rabbit[4,5]; 5,300 in the whole tube of the ewe[3]; and in the ferret about 200 in the ovarian capsule, which is the probable site of fertilization in this animal[7].

The wide difference which exists between the number of sperms present in the uterus or vagina on one hand and the Fallopian tube on the other, can be imputed to the properties of the female tract and particularly to the utero-tubal junction. The influence of the utero-tubal junction on the distribution of sperms in the genital tract of the rat is clearly shown by the results obtained by Blandau and Odor[4]. The mean number of sperms found in both uteri soon after mating was 58 million, whereas the mean number in the tubes soon after ovulation was 882.

Similarly in the rabbit, Braden (unpublished data) has found that the ratios of the numbers of sperms in the vagina, uteri and tubes of twelve mated rabbits about the time of ovulation was 350 : 450 : 1.

A remarkable degree of selectivity has been demonstrated for the utero-tubal junction of the rat[8]. When rat sperms were mixed with those of the bull, mouse or guinea pig and placed in the uterus, passage into the Fallopian tube was almost completely restricted to the rat sperms.

Time Relations of Sperm Travel

The interval between coitus and the arrival of the first few sperms at the site of fertilization is difficult to establish with certainty, and authorities vary widely in their estimates. The indications are that in many species this interval is remarkably short: times in the neighbourhood of 15 min. or less have been reported for the mouse[8], rat[10], bitch[11], ewe[12] and cow[13]. The brevity of the interval suggests that, at least in these species, the passage of the sperm is effected mainly by the movements of the genital tract, and that the motility of the sperm is of secondary importance.

The interval between coitus and ovulation also varies with species. A few animals, such as the rabbit, ferret and cat, exhibit the phenomenon of copulatory ovulation; the shedding of the egg is controlled by a neuro-hormonal mechanism for which the stimulus is the act of coitus. In most species, however, ovulation occurs independently of mating, though the period of sexual receptivity begins some hours before ovulation. In either circumstance, and where full opportunity exists, there will normally be an interval between coitus and ovulation which may be as short as 10 hr. (rat and rabbit) or as long as 30 hr. (cow and ferret) or several days (mare). Owing to the rapidity of sperm travel, sperms may be present at the site of fertilization for the greater part of these periods before the eggs become available for penetration.

It may happen that, through mischance or experimental intervention, the opportunity for mating is lacking for the early part, or for most, of the period of receptivity. In these circumstances the females of many species will permit coitus shortly before or even a little after ovulation. It has been observed, however, in the rabbit[14], cow[15], ewe[16] and sow[17] that such delayed mating or late artificial insemination results in a reduced incidence of pregnancy and number o young. The effect becomes the more evident th longer the delay; but is noticeable well before th end of the fertile life of the egg.

Penetration of the Egg

The mammalian egg consists of a vitellus enclose by a thick transparent membrane, the zona pellucida In the ovary the mature egg is surrounded by a mas of follicle cells, in which two layers are distinguished an inner layer of densely packed, radially arrange cells, the corona radiata, and an outer layer o sparsely distributed cells, the cumulus oophorus. Th cells of the cumulus are embedded in a hyaluroni acid gel which also fills the spaces between the cell of the corona. For a period after ovulation the eg continues to be surrounded by a variable proportio of the follicle cell mass; the amount is large in th rodents and rabbit, moderate in the bitch and cat and small in the ewe, cow and mare.

To enter the egg, the sperm must traverse th cumulus, corona, zona, and the surface of the vitellus It appears to be well established now that the sperm penetrates the gel matrix of the first two layers wit the aid of the enzyme, hyaluronidase, which i carries[18-20]. The sperm is known to pass through th apparently intact cumulus in the mouse, rat an rabbit, so that actual denudation of the eggs is not necessary preliminary to penetration[4,9,21,22]. Denudation does occur, but not until later stages o fertilization[9]. Passage through the zona may also b effected by an enzyme, possibly associated with structure on the leading surface of the sperm head[23,24] A small slit in the zona of the rat marks the poin at which a sperm has entered[25]. The penetration o the vitelline surface, on the other hand, seems rathe to be a function of the vitellus which, observed *i vitro*, appears to absorb the sperm[25].

It has long been known that in most invertebrate and lower vertebrates only one sperm normally enter the vitellus and takes part in the process of fertilization. In these species, the entry of more than on sperm into the vitellus, 'polyspermy', has been foun to result in early degeneration of the egg. Polysperm is rare in the mammalian egg, though no detaile study of the incidence or ultimate results of this stat appears to have been made. In a recent investigatio on the cytology of fertilization[9], only four polyspermic rat eggs were seen among a large series. Th bar to polyspermy in mammals is thought to involv a change in the surface of the vitellus. It is certai that the zona offers no protection against polyspermy for supernumerary sperms are common in the thickness of the zona or in the perivitelline space. Hensen[2] reported the presence of about fifty supernumerar sperms in the rabbit egg, and numbers of the orde of 20–30 have been noted recently in a more detaile study[5]. In the rat, it has been found that 23 per cen of eggs contain from 1 to 5 supernumerary sperms[25] The smaller number seen in rat eggs is consisten with the smaller number of sperms in the Fallopia tubes of this species.

There is no unequivocal evidence of chemotaxi between egg and sperm in animals[27,28]. The chance of penetration may, however, be improved by othe mechanisms: the radially arranged coronal cell would tend to direct the movements of the approaching sperm towards the egg; the adherence of the sperm head to the surface of the zona, very eviden with the rabbit egg *in vitro*, would have a trap-lik action.

Capacitation of the Sperm

Evidence is accumulating that the sperm must emain within the female tract for a period before it s capable of penetrating the egg. If sperms are ntroduced shortly after ovulation into the periovarian ac of the rat, they are soon found about the eggs in he Fallopian tube, but are not seen within any eggs until four or five hours after their introduction[24]. Similarly, in rats which are not permitted to mate until after ovulation, sperms are found at the site of fertilization one hour after mating, but no penetrated eggs are observed until 2–2½ hours after mating[31].

Failure of penetration, within several hours following the introduction of sperms into the Fallopian tube, has also been reported for the rabbit[25,32].

The main obstacle to penetration appears to be the zona pellucida, and the indications are that the sperm must undergo some form of physiological change or capacitation before it is able to traverse this membrane. Capacitation normally requires residence within the female tract; but recent studies with rabbit eggs suggest that capacitation may occur *in vitro* if sperms are incubated in the presence of tubal secretions[33].

Conclusions

The present trend of research on the processes eading up to fertilization in mammals permits a fuller appreciation of the significance of two phenomena: the distribution of sperms in the female tract and the lapse of time between the onset of sexual receptivity and ovulation.

The weight of evidence now available indicates hat the number of sperms which gather at the site of fertilization may be regarded as no more than a compromise between two simple requirements. On one hand, the larger the number of sperms at the site of fertilization the better will be the chances for he meeting of egg and sperm. On the other hand, he danger of polyspermy, from which there is imperfect direct protection, will be reduced in the presence of small numbers of sperms. The problem eems to be resolved by the presence under normal onditions of a small excess of sperms above the minimum necessary to provide good chances for the penetration of all the eggs. The actual number of sperms involved will vary in different species, since the chances of meeting will be influenced by the volumetric capacity of the genital tract and especially the site of fertilization. This control of sperm number s held to be an important and overt function of the emale genital tract, and particularly of the uterotubal junction.

The passage of the sperm through the cumulus oophorus is made possible by an enzyme which it carries, and a similar mechanism may enable the sperm to pass through the zona pellucida. An nportant difference, however, exists between these wo processes; for, although the freshly ejaculated sperm is capable of traversing the cumulus, it pparently cannot penetrate the zona until it has ndergone some form of physiological change or capacitation.

Time is required for the passage of the sperm to he site of fertilization and for the accumulation there f adequate numbers to provide good chances for the meeting of sperm and egg. The lapse of time between the onset of sexual receptivity and ovulation appears in many species to be well in excess of these requirements. The interval, however, is not unduly long when it is considered that time is needed also for the capacitation of the sperm, which may take much longer than the transit of the sperm, and that some latitude is clearly advantageous as the opportunity for mating may not exist at the beginning of receptivity. It seems probable that the low fertility which has been observed in some species when mating or artificial insemination is performed about the time of ovulation may be imputed to a failure of completion of the capacitation process before the egg nears the end of its fertile life. [May 13.

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SITE OF ACTION OF MUTAGENIC REAGENTS

Nitrogen Mustards

NITROGEN mustards are of interest for the treatment of some types of cancer. We have endeavoured to find the site of action in the cell of one of these compounds (ββ dichlorodiethyl methyl amine) by transfer of nuclei between treated and untreated amœbæ. We have used *Amœba discoides* and *A. proteus*. The figures quoted below are for *A. proteus*.

Amœbæ were given an exposure of fifteen minutes to various concentrations of nitrogen mustard. It is possible to treat either normal amœbæ or enucleated cytoplasm, but not isolated nuclei, with the drug. Transfers of nuclei may then be made between normal amœbæ and treated amœbæ (or cytoplasm). From examination of such transfers the following conclusions were derived.

(1) The L.D.50 for nuclei is 0·00015 per cent nitrogen mustard.

(2) The L.D.50 for cytoplasm is 0·0015 per cent nitrogen mustard.

(3) The cytoplasm is independently damaged, that is, by a direct action of the drug.

(4) The nuclei are probably damaged independently of the cytoplasm, that is, by a direct action of the drug.

(5) If the cytoplasm is lethally damaged, cell division never occurs.

(6) If the nuclei are lethally damaged, nuclear division usually occurs unless the nuclei are present in very badly damaged cytoplasm. Division of the nuclei is not necessarily followed by cytoplasmic division. If damaged nuclei are in normal cytoplasm, cytoplasmic division normally follows nuclear division; but if the cytoplasm is also damaged the probability of cytoplasmic division varies inversely as the amount of damage.

(7) Division of the amœbæ is delayed to an increasing degree with exposure to increasing concentrations of nitrogen mustard. The first division after treatment is little delayed unless lethal damage has occurred. The second division is much more sensitive than the first, and the delay increases more rapidly with increase in concentration.

(8) Other abnormalities observed included: unequal division; prolonged prophase with death of amœba before completing division; failure of nuclear reconstruction after mitosis; division into more than two cells (up to seven), some of which may be anucleate.

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X-Rays

In view of the results recorded in the previous communication it was decided to study the site of action of X-rays by a similar technique. Most experiments were made with a 400-kVp. machine, providing a dose-rate of 3,000 r. per minute. Some results were obtained using a 10-kV. machine giving a dose-rate of 27,300 r. per minute. Using the technique of nuclear transfer, the following conclusions were reached with *Amœba proteus*.

(1) The L.D.50 for nuclei is 120,000 r.

(2) The L.D.50 for cytoplasm is 290,000 r.

(3) The cytoplasm is independently damaged, that is, by a direct action of the radiation.

(4) Cytoplasmic damage is of two types: reversible damage already maximal at less than 100,000 r.; and lethal damage becoming prominent above 280,000 r.

(5) The nuclei are probably damaged independently of the cytoplasm.

(6) If the cytoplasm is lethally damaged, cell division never occurs.

(7) If the nuclei are lethally damaged, nuclear division seldom occurs. If division of a lethally damaged nucleus does occur, it is normally followed by cytoplasmic division.

(8) Division of the cytoplasm is delayed and is normally preceded by nuclear division. The delay reaches a maximum at 120,000 r. This delay is prominent for the first division, and small for th second division.

The main differences observed between the actio of X-rays and of nitrogen mustard were:

(*a*) The nuclei are ten times more sensitive t nitrogen mustard than is cytoplasm, compared wit a ratio of 2·5 for X-rays.

(*b*) The slopes of the dosage-mortality curves bot for nuclei and for cytoplasm are steep for X-irradia tion and relatively flat for nitrogen mustard Consequently, a dose of X-rays which is just letha for all nuclei will not cause any lethal damage t cytoplasms, whereas an exposure to nitroge mustard which is just lethal to all nuclei will als cause lethal damage to some cytoplasms.

(*c*) Whereas with X-rays delay in division i prominent for the first division and small for th second, with nitrogen mustard the delay is small fo the first division and prominent for the second.

(*d*) Lethal damage to nuclei by X-rays usuall prevents nuclear division immediately, whereas wit nitrogen mustard nuclear division is usually possibl after lethal damage.

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'AZIDINE' TRANSFORMATIONS

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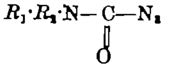
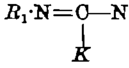
The carbamylazides, as a group, were classified by Bertho[1] as resistant to the Curtius rearrangement. However, other work[2] showed that while some members of this group (1, R_1 or R_2 = H, R_2 or R_1 = alkyl/aryl) failed to become rearranged, other (1, R_1 or R_2 = C_6H_5) did so.



$R_1{\cdot}R_2{\cdot}N{-}C(=O){-}N_3$

(1)

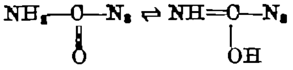


$R_1{\cdot}N{=}C(K){-}N_3$

(2)

Hurd[3] explained this anomaly by ascribing a hydroxyurea structure (2, K = OH) to the carbamylazides which resisted rearrangement. Hurd's formul contains the azidine system, a characteristic o which[4] is ready cyclization to substituted tetrazoles in the presence of bases. (By analogy with th nomenclature change of amide → amidine for th structural change $—CONH_2 \rightarrow —C(=NH)—NH_2$, i is suggested that, for the structural change $—CON_3 \rightarrow —C(=NH)N_3$, the nomenclature change should b from azide → azidine. This latter term does no appear to have been used previously in the literature. The expected cyclization product from carbamylazid (2, R_1 = H, K = OH) would be 5-hydroxytetrazol (3). Under a wide variety of reaction conditions, an with a large range of basic reagents, we have foun no trace of this cyclized material. Secondly, with ethereal diazomethane[5], two solids were isolated, analyses suggesting that one was a methylated carbamylazide (probably O-methylated since N-methylation with this reagent is rare), the other, of which only traces were found, a polymethylated urea. Because of the structural changes caused by bases, alkaline methylation of the carbamylazide affords different products.

From these observations, carbamylazide appears to display the following tautomerism:



$$NH_2\text{—}\underset{\underset{O}{\|}}{C}\text{—}N_3 \rightleftharpoons NH{=}\underset{\underset{OH}{|}}{C}\text{—}N_3$$

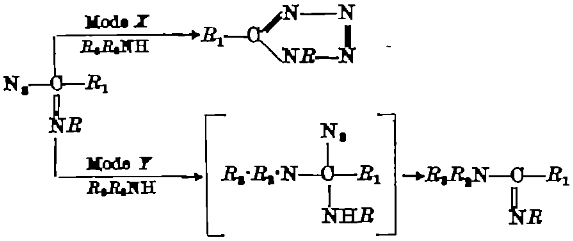
This equilibrium is displaced irrevocably to the right in the presence of diazomethane.

As the Curtius reaction is anionotropic[6], an interpretation, different from Hurd's, for the resistance of carbamylazide to such changes may be suggested. In general, with this type of transformation, the readiness of rearrangement depends upon the electrophilic powers of the migrating groups. Anionotropic migration must exceed the velocity of the other changes which may occur—and competitive reaction may be envisaged, migration-velocity (M_v) being necessarily greater than cyclization velocity (C_v) or replacement velocity (R_v)—for reactions of the Curtius type to take place.

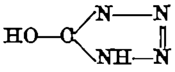
The electrophilic powers of the diphenylimino $(C_6H_5)_2N$—, phenylamino, C_6H_5NH— and the amino radicals are in reciprocal ratios to their basicities; thus, while the first readily undergoes anionotropic rearrangement (M_v being greater than C_v or R_v), the others, because of their greater basicities, have C_v/R_v greater than M_v and hence fail to undergo the intramolecular migration.

Replacement of the azide group alone is not sufficient proof of the absence of the azidine structure (*vide infra*). However, the observation that no cyclization occurs in the presence of basic reagents too weak to cause replacement was taken as an indication of the absence of azidine nature.

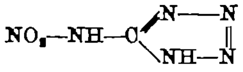
With the azidines the two main courses of reaction which may occur in place of the Curtius type are as follows:



Guanylazide[7] with hydrazine hydrate reacts exclusively by mode Y and with substituted hydrazines[8] by mode X, while nitroguanylazide[9,10] reacts preferentially by mode X in the presence of amines—due to the enhanced acidic powers of 5-nitroaminotetrazoles (4)—but in the presence of hydrazines by mode Y. Usually products derived from simultaneous reactions by both modes X and Y result. A third and rarer course of reaction may occur[11], namely, mode Z, $RC({=}K)N_3 \rightarrow RC({=}K)N<$ (followed by various modes of decomposition of this free radical, for example, attack of the solvent, to give $RC({=}K)N$—hydrocarbon); but only when the Curtius, or the alternatives X or Y, reactions do not take place.



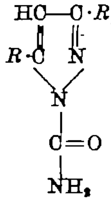
(3)



(4)

NH_2—CO·NH·NH·CO·NH_2

(5)



(6)

With carbamylazide, reaction in the presence of bases is exclusively that formulated in mode Y, and offers a new route for the preparation of ureas (and semicarbazides). From the results of Lieber *et al.*[12], the acid strength of 5-hydroxytetrazole, the possible cyclization product of carbamylazide by mode X, should at least be comparable to that of 5-aminotetrazole and hence should not offer any *a priori* obstacle to the base-produced cyclization. The nature of the azide, then, is apparently the sole determining factor in its stability towards the Curtius transformation.

With amines, reaction is rapid and results in high yields of the monosubstituted compounds. Towards diphenylamine, however, and towards amides and imides, the reagent is inert. With hydrazines, reaction is rapid to yield the monosubstituted semicarbazides; only with hydrazine itself does a disubstituted product, hydrazodicarbonamide (6), result. Towards 2,4-dinitrophenylhydrazine the reagent is inert. With amino-acids, under a wide variety of conditions, no hydantoins or hydantoic acids result, except in the case of isoleucine.

The ammonolysis of 1-carbamylpyrazoles (6) at present under investigation provides another route to these substituted ureas.

With thiocarbamylazide[13] another mode of reaction takes place, desulphurization occurring as a preliminary to reaction. The further steps, in this case, while not cyanamide formation, as earlier workers believed, are still under investigation. [May 17.

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LETTERS TO THE EDITORS

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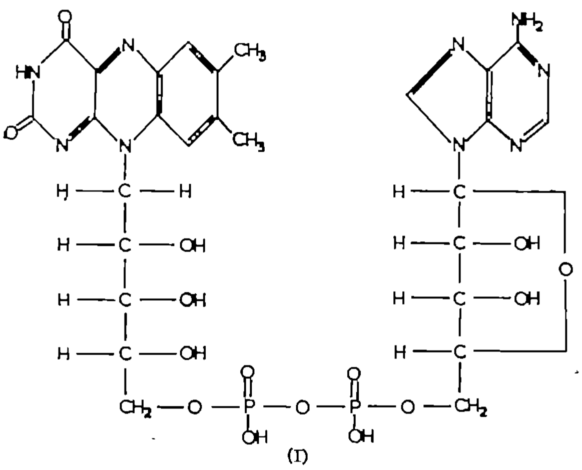
Total Synthesis of Flavin-adenine-dinucleotide

FLAVIN-ADENINE-DINUCLEOTIDE (FAD) is the coenzyme of a number of flavoprotein enzymes functioning as oxidation-reduction catalysts in biological systems. Isolated in 1938 by Warburg and Christian[1], it was assigned a probable structure (I) on the basis of available degradative evidence, although its preparation in a pure state has probably been rarely accomplished since its original isolation. Flavin-adenine-dinucleotide is structurally related to several other equally complex coenzymes (for example, coenzymes I and II, uridine-diphosphate-glucose and coenzyme *A*) in that all of them appear to be diesters of pyrophosphoric acid, in which one ester group embraces a pyrimidine or purine nucleoside residue, and indeed the members of the group are usually described loosely as nucleotide coenzymes. No chemical synthesis of any of these coenzymes has hitherto been achieved, although both flavin-adenine-dinucleotide and coenzyme-I have been prepared by enzymic reactions[2].

Over a period of years an extended series of investigations has been undertaken in this laboratory, having as its object the clarification of structural problems in the general field of nucleotide chemistry using the methods of synthetic organic chemistry. These researches have led to the structural elucidation and total synthesis of the ribonucleosides, and the development of a range of flexible methods for phosphorylation and polyphosphorylation of nucleosides[3]. Following the demonstration of the validity of our approach by the synthesis of adenosine triphosphate (ATP)[4], we have devoted increasing attention to the problem of synthesizing unsymmetrical diesters of pyrophosphoric acid of the nucleotide coenzyme type by unambiguous and generally applicable methods. As one of our initial objectives, flavin-adenine-dinucleotide was selected, since not only had riboflavin and adenosine been synthesized, but also we had devised convenient methods for the preparation of riboflavin - 5′ phosphate[5] and adenosine - 5′ phosphate[6], both of which could be regarded as possible intermediates.

Many attempts were made to apply methods involving disproportionation of polyphosphates and other mixed anhydrides to this problem (notably by Drs. H. S. Forrest and H. S. Mason[7]); but these failed, partly owing to the adverse physical properties of riboflavin and its derivatives, and partly owing to the tendency of the basic catalysts employed to disrupt any flavin-adenine-dinucleotide which might have formed. Arising from this work, however, came an understanding of the behaviour of mixed anhydrides of the oxy-acids of phosphorus, and this provided a novel method for preparing mixed diesters of phosphorous acid which could be applied to the nucleosides. Using it, we were able to synthesize 2′ : 3′-isopropylideneadenosine-5′ benzyl phosphite[8], and from it in turn 2′ : 3′-isopropylideneadenosine-5′ benzyl chlorophosphonate[9]. Condensation of this chlorophosphonate with the monosilver salt of riboflavin-5′ phosphate under carefully controlled conditions yielded the monobenzyl ester of the 2′ : 3′-isopropylidene derivative of (I). Debenzylation, followed by removal of the isopropylidene residue by treatment with acid under conditions which minimized fission of the pyrophosphate linkage, furnished P_1-riboflavin-5′ P_2-adenosine-5′ di-hydrogen pyrophosphate (I), identical with flavin-adenine-dinucleotide from natural sources in chromatographic behaviour (two solvent systems), chemical properties and ultra-violet absorption spectrum. When combined with the flavin-adenine-dinucleotide-free apoenzyme of D-amino-acid oxidase, the synthetic material gave a fully active reconstituted enzyme[10]; in the test solution used the value of 91 per cent was obtained for content of flavin-adenine-dinucleotide as expressed in terms of intensity of light absorption at 450 mμ[1]. We are indebted to Prof. D. Keilin and Dr. E. F. Hartree for carrying out these enzyme experiments.



(I)

This synthesis of flavin-adenine-dinucleotide not only establishes the correctness of structure (I), but it also opens the way to the synthesis of several other nucleotide coenzymes, and experiments in this direction are in progress. Full details of the synthesis here reported will be published elsewhere.

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Cambridge. Nov. 6.

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Evolution of Animal Fats

USING the theory of evolution as a general background, Hilditch and Lovern[1] have directed attention to the gradual simplification in the fatty-acid composition of animal fats as one proceeds from the lower forms of life to those that are more highly organized. In particular, they have noted the striking difference between the complexity of the fats of aquatic animals, which contain, in addition to C_{14}, C_{16} and C_{18} saturated acids, a wide range of unsaturated acids of the C_{14}, C_{16}, C_{18}, C_{20} and C_{22} series, as compared with the fats of the more highly evolved land mammals, which generally contain as major components only three acids, palmitic, stearic and oleic.

From consideration of the results[2] of the Fats Research Laboratory, New Zealand, together with those of other workers, however, it is suggested that the observed increasing simplicity of animal fats, as one proceeds from the lower to the more highly organized forms of animal life, is largely due to the fortuitous influence of the diet and only in part to the animals themselves. Thus, for example, aquatic mammals or birds deposit fats which are of the complex aquatic type, whereas land mammals or birds, which feed on fats of relatively simpler composition, deposit simpler types of fats[3]. On the other hand, it is now suggested that the major trend of evolutionary development on fats is discernible with respect to the fat metabolism of animals as follows:

(*a*) In the early stages of evolutionary development of fats in animals, the organism, as exemplified by fishes, is able to assimilate the dietary fat and so deposit it in its tissues more or less in the form present in the diet, subject, of course, to minor modifications induced by hydrogenation, dehydrogenation and in some instances to lengthening or shortening of the carbon chains. At this stage of development, the organism is apparently unable to make fat[4] (here termed 'synthetic' fat) from the non-fatty (protein and carbohydrate) constituents of the diet.

(*b*) In the next stage, as exemplified by amphibians, reptiles and most mammals, there is acquired, in addition to the ability to deposit the dietary fat mainly in its original form in the depot fat, an ability to make 'synthetic' fat. Such 'synthetic' fat is more or less of a uniformly simple composition and contains, as its main components, palmitic, stearic and oleic acids. The final composition of the depot fats of these animals will largely depend on the relative proportions of the dietary and of the 'synthetic' fats.

(*c*) In the final stage, the organism, as exemplified by certain ruminants, largely loses the power to deposit the fat from the diet[5], the constituents of which are broken down by the bacteria of the rumen before assimilation by the animal. The dietary fat no longer has any appreciable influence on the composition of the depot fat, which now consists almost entirely of 'synthetic' fat, with palmitic, stearic and oleic acids as the major constituents.

From the above conception of the factors which determine the fatty-acid composition of the depot fats of animals, it follows that the complexity of the fats of the less highly organized animals, such as fishes, is largely due to the fatty-acid composition of the diet, as, indeed, is indicated by the fact that fish, when fed unusual diets, will deposit in their depots fats which are different from the usual aquatic type. For example, grass-fed carp deposit in their fatty depots the diene and triene acids, characteristic of the grass lipids, but not characteristic of the fats of other aquatic species[6]. Eels, when fed fats of fatty-acid composition different from that originally present in their depots, have been shown to modify their depot fat to resemble more closely the dietary fat[6]. Further, it follows that if the dietary fat was similar in fatty-acid composition to that of 'synthetic' fat, all groups of animals would tend to lay down fats of somewhat similar fatty-acid composition; but if fed a dietary fat of different fatty-acid composition as, for example, linseed oil, then differences in fatty-acid composition of the depot fats would be observed as follows. Animals which had reached the first stage of development in regard to fat metabolism (*a*) would have fat in their depots of which the fatty-acid composition resembled that of linseed oil. Animals in the second stage of development (*b*) would lay down fats consisting of a mixture of 'synthetic' fat and linseed oil, the proportions of the latter in the depot fats depending on the proportions in the diet and on the rate of growth (cf. Callow[7]), whereas animals in the third stage of development (*c*) would show in their depots no appreciable evidence of linseed oil, but their fat would consist almost entirely of the 'synthetic' type.

From the work of Anderson[8], it is apparent that bacilli are able to synthesize lipids from non-fatty sources. The fatty material in this instance, however, is non-glyceridic in nature and, moreover, contains, for the most part, branched-chain fatty acids in contrast to the straight-chain even-numbered carbon-atom acids characteristic of the rest of animal and plant life.

Consideration of the nature of the bacillary lipids in relation to those already described above suggests that the evolution of fatty substances has commenced and ended with forms that are capable of making fats from non-fatty sources but incapable of depositing the dietary fat in their depots. The complexity of the fatty materials synthesized by bacilli from non-fatty sources, however, contrasts strikingly with the relative simplicity of the fats synthesized in the depots of ruminants. The evolution of fats thus appears to illustrate the loss and recovery of function, albeit in a somewhat changed form, during the development of the organism from less-specialized into more-specialized forms, and the discovery of branched-chain fatty acids in fats of ruminants[9] may be evidence of a vestigial characteristic carried through during development from bacteria to the more specialized forms of life.

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July 19.

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DR. F. B. SHORLAND'S letter on this subject may serve to direct attention to the large number and variety of animal fats the component acids of which are now known with adequate quantitative accuracy. This number is nevertheless still small in comparison with the large number of species of which the fats await similar study.

Dr. Shorland's conclusions in regard to the progressive changes in the capacity of animals to produce comparatively simple 'synthetic' fats consisting mainly of combined palmitic, stearic and oleic acids as well as, or instead of, merely assimilating dietary fat are constructive and broadly accord with the general trend of the facts so far elicited. At the same time, as one would expect in so complex a field, many animal fats do not appear at first sight to fall smoothly into place in his classification. A few instances may be mentioned here which suggest that Shorland's outline is, as he would doubtless agree, in the nature of a preliminary statement which will require in due course further elaboration or modification.

(*a*) The variation of fatty-acid composition within the complex types of marine animal fats is probably as great as that which characterizes fats of his second and third classes (amphibians, reptiles and mammals). This is seen in an extreme degree in the diverse fats of such species as the balænic whales, the sperm whales and the dolphin and porpoise family; but it also obtains to a lesser extent in those of many species of fish. This leads one on one hand to feel that Shorland may attach less importance than is necessary to the effect of species and too much to the "fortuitous influence of the diet", and on the other hand to inquire whether it is adequately established that marine animals derive all their fat from preformed dietary sources. Profound modification of dietary fat would appear essential to produce, for example, the characteristic wax-esters of the Physeteridæ or the isovaleric glycerides of the Delphinidæ.

(*b*) Shorland's intermediate stage (*b*), at which animals may acquire the ability to make 'synthetic' fat, more or less of a uniformly simple composition with palmitic, stearic and oleic acids as its main components, would seem to include a variety of species, but at the same time to exclude others which are at an equivalent or parallel stage of development. Thus fats of the type indicated, and usually rich in stearic acid, are deposited not only by ruminants but also by a wide range of other animals, including the feline tribe[1–3], the kangaroo[4], hippopotamus[4] and elephant[5]. In contrast, other equally developed animals, such as bears[2], apes[3] and human beings[6], produce fats with much higher proportions of oleic (and sometimes hexadecenoic) acid than the former group, but containing comparatively small amounts of stearic acid and sometimes less palmitic acid than the 'normal' animal fat figure[7] of 30 ± 3 per cent (mol.) of the total acids.

(*c*) It is clear that whereas ruminants produce to a major degree the simpler type of 'synthetic' fat rich in palmitic, stearic and oleic acids, the pig also normally synthesizes[8] similar kinds of 'synthetic' fat (poorer in stearic and richer in oleic acid) but is equally capable of assimilating in addition fats present in its food[9]. It has recently been shown[10] that the body fats of a pig fed freely on whale oil consisted substantially of mixtures of almost unchanged whale oil glycerides with typical 'synthetic' pig-fat glycerides.

The horse presents another instance which seems not to fit in Shorland's generalization, for as he[11] and others[12] have shown, the fat of pasture-fed horses contains notable amounts of linolenic acid apparently absorbed from the grass glycerides. It is indeed a striking example of species influence that fats of entirely different composition are produced by a horse, an ox, and a sheep feeding on the same field of pasture.

(*d*) Lastly, it should not be overlooked that the very small amounts of branched-chain acids recently shown to be present in certain animal fats may well arise, not from the true fat, but from sweat gland waxes or similar sources which have accidentally passed into the fat during its preparation from the animal tissue.

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Anti-mutagens

While studying the mutagenic action of various purine derivatives on bacteria, we came across a new phenomenon: we found that certain nucleosides can act as anti-mutagens.

Following the discovery[1] that caffeine—a purine derivative—increases the mutation-rate in fungi and in bacteria, we began a quantitative study of the mutagenic action of purine derivatives. Such a study has been made possible by the use of a constant flow device, called the 'Chemostat'[2–4], which maintains a stationary bacterial population growing at a fixed rate that can be set at will. The concentration of the bacterial population maintained in the growth tube of the 'Chemostat' is determined by the input concentration of one of the required nutrients, called the controlling growth factor, and the growth-rate is fixed by the rate at which fresh nutrient flows into the growth tube.

A variety of different mutations will occur at different rates in such an otherwise stationary population, and if one plots the concentration of one

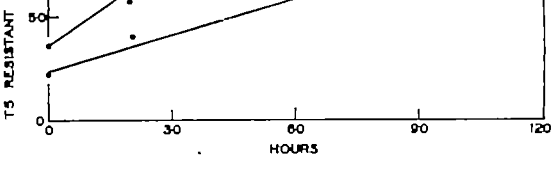

Fig. 1

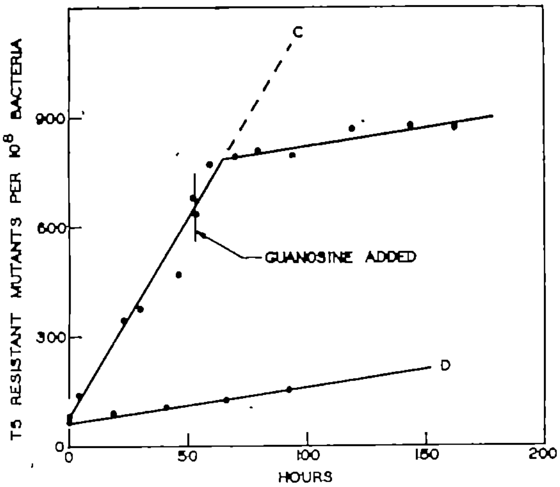

Fig. 2

particular type of mutant against time, one should obtain a straight line which rises with a slope that is determined by the mutation-rate. This holds for each type of mutant which grows at the same rate as the parent strain, that is, if there is no selection for or against the mutant. If there is selection against a mutant, the concentration of that mutant will remain stationary after an initial rise.

In the experiments to be reported here, we used a strain of *E. coli* (*B*/1*t*) requiring tryptophane, and used tryptophane as the controlling growth-factor. This organism is sensitive to the bacteriophage *T5*. Mutants resistant to *T5* present at any given time in the population growing in the 'Chemostat' can be scored by colony count simply by adding a small quantity of the virus *T5* to an aliquot at the time of plating; in the presence of the virus, only the resistant mutants will grow out into colonies.

As we reported earlier[3], mutation to *T5* resistance occurs at a constant rate independent of the rate at which the bacteria grow, that is, independent of the generation-time of the bacteria. By plotting against time the number of *T5*-resistant mutants present in the growth tube of the 'Chemostat', one obtains curve *A* of Fig. 1. The slope of this straight line gives a mutation-rate $\mu = 1 \cdot 4 \times 10^{-8}$/bacterium/hr.

When the nutrient medium contains theophylline (a dimethylxanthine) in a concentration of 150 mgm./l., the number of mutants rises very quickly, corresponding to the straight line *C* in Fig. 2, giving a mutation-rate of $10 \cdot 7 \times 10^{-8}$/bacterium/hr. This represents a seven-fold increase in the mutation-rate, which we attribute to the mutagenic action of theophylline. However, if the nutrient contains, in addition to 150 mgm./l. of theophylline, 50 mgm./l. of the nucleoside guanosine, the number of mutants rises much more slowly, as shown by line *D* in Fig. 2. The slope of this line corresponds to a mutation-rate of about 1×10^{-8}/bacterium/hr., indicating that guanosine, in the concentration used, completely counteracts the mutagenic action of the theophylline.

In the experiment mentioned earlier, which is described in the upper curve in Fig. 2, the bacterial population is first grown (at a generation-time of 3·2 hr.) in the presence of 150 mgm./l. of theophylline with no guanosine present. After 53 hr., guanosine is added to give a concentration of 150 mgm./l. For the first 53 hr. and for a short time thereafter, the number of mutants follows the straight line *C*, which gives a mutation-rate of $10 \cdot 7 \times 10^{-8}$/bacterium/hr.; but afterwards the number of mutants follows another straight line which gives a mutation-rate of less than $1 \cdot 5 \times 10^{-8}$/bacterium/hr. The two straight lines intersect, not at the time when the guanosine is added, but about 12 hr. later.

In order to explain this 12-hr. delay in the fall of the mutation-rate after adding guanosine, we do not have to assume that it takes that time for the guanosine to counteract the mutagenic effect of theophylline, but may attribute the delay to the fact that mutations are not immediately expressed in the phenotype of the bacteria. When the guanosine is added, the mutations induced by theophylline may very well cease to occur; but the mutations induced prior to the addition of guanosine continue to be expressed phenotypically for a period of about 12 hr.

The results shown in Fig. 2 have to be interpreted as an actual reduction of the mutation-rate by guanosine; that is, they cannot be attributed to a selection against the bulk of *T5*-resistant mutants resulting from the presence of guanosine. It is easy to show that if such a selection were responsible for the low mutation-rate shown by line *D* in Fig. 2, then in the upper curve in Fig. 2 the number of mutants resistant to *T5* should fall steeply after adding guanosine at the 53rd hour.

The concentration of guanosine needed to counteract the mutagenic effect of 150 mgm./l. of theophylline is quite low. For a concentration of about 2 mgm./l. of guanosine, the rate of mutation induced by theophylline falls to one-half.

The other normally occurring purine ribosides were examined for anti-mutagenic action at concentrations of 5 mgm./l. At this concentration adenosine and inosine are strongly anti-mutagenic against theophylline, whereas xanthosine has no such activity. In contrast to inosine itself, its components, that is, the free purine hypoxanthine and the free sugar ribose, are not anti-mutagenic even at concentrations of several hundred milligrams per litre.

A concentration of 500 mgm./l. of guanosine gives practically complete suppression of the mutagenic action of the following purine derivatives (at concentrations of 150 mgm./l.): theophylline, caffeine, theobromine, paraxanthine, and 8-azaguanine. But tetramethyluric acid and benzimidazole retain more than half their mutagenic effect.

One may ask what effect guanosine has on the spontaneously occurring mutations. As can be seen from line *B* in Fig. 1, 50 mgm./l. of guanosine gives a mutation-rate of $0 \cdot 6 \times 10^{-8}$/bacterium/hr., that is, one-half to one-third as much as the spontaneous mutation-rate derived from curve *A*. This shows that guanosine in the concentration used reduces the mutation-rate to *T5* resistance appreciably below the spontaneous mutation-rate.

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Agglutination Reactions in Human Red Cells Fragmented by Heat

Murray and Clark[1] have shown that, if red cells are heated to 50° C., substances can be obtained from the surrounding fluid which, even if derived from *Rh*-negative red cells, can give rise to anti-*D* agglutinins when injected into guinea pigs. Temperatures in the neighbourhood of 50°–56° produce extensive modifications of the human red-cell surface, namely, fragmentation, development of myelin forms, and, at the higher temperatures, hæmolysis[2]. It is therefore likely that the substances found by Murray and Clark in the fluid surrounding the heated cells are the products of the fragmentation phenomena and the changes in the red-cell surface which accompany them.

Thrice-washed human red cells (group *O*, *CDE* positive) are heated for 10 min. at 50°, 52°, 54° and 56° C., and then tested for their reactivity with anti-*D* serum at 37° C. As the temperature is increased, the fragmentation and hæmolytic phenomena become more and more pronounced, as already described[2], and as can be seen by examining the suspensions by phase contrast. At the same time, the serological reactivity of the red cell surface becomes modified. Agglutination by 'complete' (saline agglutinin) antibody becomes progressively weaker as the temperature to which the cells are heated is increased, and is almost lost after heating to 56° C. However, cells which have been heated even to 56° C. will react with 'incomplete' (blocking) antibody, as shown by a positive indirect Coombs reaction. The cell surface is not modified to such an extent, however, as to give a positive direct Coombs reaction.

Similar experiments show that heating progressively decreases the trypsinizability of red cells, and progressively decreases the reactivity of red cells which have been trypsinized before the heating.

The material obtained by ultracentrifuging the heated preparations, that is, the material which Murray and Clark find to be antigenic in the guinea pig, consists of tiny fragments and myelin forms. The reactivity of their surfaces, however, is so reduced that no agglutination-like phenomena can be produced by the addition of anti-*D* sera.

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Pseudo-Cholinesterase of Brain

Shortly after the distinction had been made between the true cholinesterase and the pseudo-cholinesterase[1,2], it was claimed that the brains of vertebrates contain true cholinesterase only[3]. This latter statement has proved to be incorrect; when large amounts of tissue are used for cholinesterase determinations, the presence of a small amount of pseudo-cholinesterase in brain can be demonstrated[4,5]. Experiments with selective inhibitors of pseudo-cholinesterase have rendered it highly improbable that this enzyme would have any important role in the hydrolysis of acetylcholine released at nerve endings[6–8]. However, the pseudo-cholinesterase in brain appears to be associated particularly with the myelinated fibre tracts of the central nervous system, and it has been suggested that the activity of this esterase may be connected with processes occurring in the myelin sheaths or neuroglial elements of the nervous system[5].

This suggestion is especially interesting in view of the fact that tri-ortho-cresyl phosphate (TOCP), which is known to be a selective inhibitor of pseudo-cholinesterase[7], causes paralysis in many species with demyelination of the peripheral nerves, degenerative changes in the anterior horn cells, and fatty degeneration in the white matter of the spinal cord[9]. Studies on the inhibition of the cholinesterases by tri-ortho-cresyl phosphate *in vitro* have been carried out recently by Earl and Thompson[10], who suggested that inhibition of the pseudo-cholinesterase by this substance might play a part in the demyelination and consequent paralysis. We have also investigated the significance of the pseudo-cholinesterase in brain along two lines in our laboratory.

First, a very detailed study on the cholinesterase activity of ox brain failed to reveal the presence of any pseudo-cholinesterase, thus confirming a previous report[11] on the absence of pseudo-cholinesterase in various other tissues of this species and of the sheep. The absence of pseudo-cholinesterase from the tissues of ruminants shows that the paralysis due to tri-ortho-cresyl phosphate, which can also be produced in ruminants[9,12,13], is not likely to be due to inhibition of pseudo-cholinesterase.

Nevertheless, we thought it necessary to substantiate this conclusion by inhibiting the pseudo-cholinesterase in a species the brain of which does contain this enzyme. Three groups of young male rats of a crossed Wistar-piebald strain, weighing between 75 and 85 gm., were used in this experiment. One group served as controls, the second group was injected subcutaneously with 0·5 ml. tri-ortho-cresyl phosphate, while the third group was injected intramuscularly with 0·05 ml. and after six weeks with 0·1 ml. of this substance. The injections were repeated every four days for three weeks, and from then on once a week for a total period of fourteen weeks. Animals were sacrificed at various times to determine the cholinesterase activities of the tissues by the methods described by Mendel *et al.*[2] and Thompson *et al.*[5,10]. The cholinesterase activities of the tissue homogenates were determined manometrically with 0·03 *M* acetyl-β-methylcholine[2] as specific substrate for the true cholinesterase, and 0·006 *M* benzoylcholine[2] and 0·03 *M* butyrylcholine[5,10] as specific substrates for the pseudo-cholinesterase. Esterase activities are expressed as μl. carbon dioxide produced per hr. per 100 mgm. tissue or per ml. serum (see table). The rats of group II were injected subcutaneously with 0·5 ml. tri-ortho-cresyl phosphate and those of group III intramuscularly with 0·1 ml. In both groups of rats treated with tri-ortho-cresyl phosphate, the pseudo-cholinesterase of brain was almost completely inhibited from the seventh day until the end of the experiment.

During this period of fourteen weeks, each of the seven remaining rats of the second group gained about 160 gm. on the average, those of the third group 300 gm. and the control animals 320 gm. Despite the complete and prolonged inhibition of the pseudo-cholinesterase in brain, none of the animals showed any signs of paralysis. The rats of the third group were indistinguishable in appearance from the controls; histological examination of the brain, spinal cord and sciatic nerves of these animals did not reveal any demyelination or other abnormalities.

INHIBITION OF THE CHOLINESTERASES OF RAT BRAIN AND OTHER TISSUES AFTER INJECTIONS OF TRI-ORTHO-CRESYL PHOSPHATE FOR 14 WEEKS

Tissue	Group No.	True cholinesterase activity	Pseudo-cholinesterase activity Benzoylcholine	Butyrylcholine
Cerebellum	control	96	8	38
	II	28	—	0
	III	52	—	0
Cerebrum	control	476	7	52
	II	133	—	0
	III	218	—	0
Thalamus, pons and medulla	control	286	26	146
	II	86	0	0
	III	185	0	2
Heart	control	29	155	830
	II	11	0	10
	III	16	10	54
Liver	control	—	37	210
	II	—	0	5
	III	—	2	18
Small intestine	control	—	184	960
	II	—	0	18
	III	—	26	148
Serum	control	160	78	416
	II	102	6	38
	III	150	16	82

Two conclusions can be drawn from these experiments. First, the integrity of medullated nerve fibres does not seem to depend on the activity of the pseudo-cholinesterase in the myelin sheaths; secondly, the pseudo-cholinesterase is not required for the hydrolysis of acetylcholine released by nervous activity in the brain.

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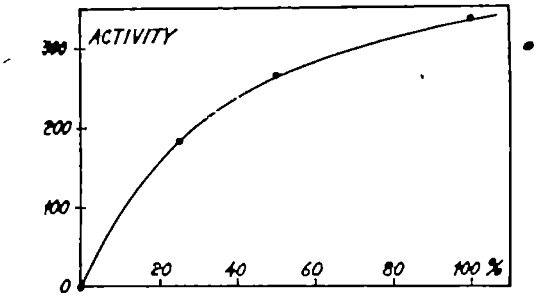
Isolation of a Soluble Fibrinolytic Activator from Animal Tissue

ANIMAL tissue contains a fibrinolytic activator (fibrinokinase) which cannot be brought into aqueous solution by the usual procedures for extracting biologically active substances[1]. This observation was confirmed by Tagnon[2] and by Lewis and Ferguson[3], who found that the microsome fraction of the disintegrated tissue was particularly active.

When bovine lung tissue was treated as described for the preparation of fibrinokinase, no fibrinolytic activator was obtained, but the tissue acted as a powerful inhibitor of trypsin and plasmin[4]. Recently[5], we succeeded in isolating from this tissue a soluble protease inhibitor by extraction with potassium thiocyanate, performed as described by Snellman, Jensen and Sylvén[6] for the isolation of heparin from animal tissue.

We have now found that a similar treatment of the insoluble fibrinokinase preparation yields the fibrinolytic activator in a water-soluble form. Thus a fibrinokinase preparation made in the usual manner from pig hearts was treated for one hour with *M* potassium thiocyanate. The tissue was removed by pressing through gauze and the solution was dialysed against diethylbarbiturate buffer (pH 7·8, $\mu = 0{\cdot}05$). The resulting solution showed a high activating power on plasminogen. The substance was obtained as a dry powder by precipitation with acetone and drying with acetone and ether, yield about 100 mgm. per gm. of crude material.



Activity (ordinate) of increasing concentrations (abscissa) of a stock solution (7 mgm./ml.) of the soluble fibrinolytic activator, recorded as the product of two perpendicular diameters of the lysed zones. Substrate: bovine fibrin containing plasminogen

The product obtained was not completely soluble in the buffer, but its solution showed a high fibrinolytic activity when tested by the usual fibrin plate method, where plasminogen is present in the substrate (see graph). On fibrin plates containing no plasminogen (prepared as described elsewhere[7]) no activity was found.

In view of this successful isolation of a soluble fibrinolytic activator from animal tissue, it might be interesting to investigate the possibility of using a solution of potassium thiocyanate in the extraction of other enzymatic substances which are found to occur preferably in the so-called mitochondria and microsome fractions of disintegrated tissue[8].

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Rapid Restitution of the Rat Pancreas following Acinar Cell Necrosis Subsequent to Ethionine

ONLY rarely has the suggestion been made that the pancreas, human[1] or animal[2], possesses the faculty of complete regeneration. Ethionine, a metabolic analogue of methionine, produces acinar cell necrosis of the pancreas[3]. Rats show within one to two weeks after pancreatic acinar cell necrosis a relatively complete restitution of the organ.

Thirty-eight fasted Wistar white rats, both sexes, 160–190 gm., having access to 'Purina' chow and water were used. Fourteen were each given 50 mgm. of D-L ethionine daily in distilled water intraperitoneally for 14 days. Sixteen each received 100 mgm. of ethionine intraperitoneally daily for 10 days. Six rats were used for controls. Animals were sacrificed at 2, 4, 6, 7, 8, 10, 14, 21 and 28 days and nine months after the initial injection.

Animals sacrificed during ethionine administration showed the characteristic effect[3]. On the lower dosage, complete acinar cell necrosis was seen by the tenth day. Ducts and islets were not involved. Regeneration, indicated by cells in mitosis, or cells with deeply basophilic cytoplasm and large nuclei, was noted on the seventh day. At the fourteenth day regenerating cells were frequent and lobule formation beginning. Seven days after cessation of ethionine, normal architecture was demonstrated by discreet lobules, well-formed acini, and zymogen granules in the apical cytoplasm. Seven days later, a few cytoplasmic vacuoles in the acinar cells were the only abnormality. Weakness, and severe loss of weight, progressing from the fifth day, were followed by clinical recovery within a day or two after cessation of the drug.

With the higher dosage, effects were similar but more pronounced. By the eighth day, acinar cells had disappeared and only intact duct and islet cells, inflammatory cells and small groups of regenerating, spindle mononuclear cells were present. Four days after cessation of ethionine, many mitotic figures, incipient lobule formation and acinar cells with basal basophilia were noted. At eleven days after treatment there was restitution of normal architecture, with zymogen granules present in the acinar cell cytoplasm and frequent mitotic figures. One animal sacrificed 18 days after drug cessation showed only minimal restoration. All other animals killed one to two weeks after the cessation of the drug showed restitution of the gland. Two animals, each of which received a second course of ethionine after recovery from the initial dosage, revealed no pancreatic abnormalities nine months later. Control animals had normal organs.

The high protein and enzyme content of the pancreas, and the significance of these substances in problems of growth, differentiation and neoplasia, suggest a possible experimental use of the pancreatic recovery from the effect of ethionine in these fields. Morphological destruction and restitution of a specific cell-type following the use of an analogue provides a means of exploring facets of methionine anti-metabolites.

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Acquired Resistance to Colchicine in a Strain of *Trichomonas vaginalis*

Trichomonas vaginalis Donné, 1837 can be made resistant to a variety of chemical compounds and is a suitable organism for the study of resistance, particularly as it can be maintained indefinitely in bacteria-free cultures. Moreover, it possesses a cytostome and ingests relatively large granules (for example, rice starch), and probably acquired resistance in the case of this flagellate does not depend on non-transit of a particular compound through the surface membrane as is apparently the case in resistant trypanosomes. Thus a strain of *T. vaginalis* was made resistant to 4.4′-diamidino stilbene. Initially the strain tolerated not more than 1 in 70,000; but by culturing repeatedly on gradually increasing concentrations, a strain was obtained which grew in a concentration of 1 in 5,000. 4.4′-Diamidino stilbene fluoresces in ultra-violet light, and it was easy to demonstrate its presence in the cytoplasm of resistant flagellates grown on a concentration of 1 in 5,000[1]. On the other hand, we failed to make an Indian strain of *Leishmania donovani* and a Sudan strain of *L. infantum* resistant to this drug by the usual method of subculturing in gradually increasing concentrations.

In view of the well-known effect of colchicine on mitosis, it was considered interesting to attempt to make *T. vaginalis* resistant to colchicine. Initially our strain grew in a concentration of 1 in 16,000 colchicine incorporated in the medium, but there were only a few survivors in flagellates inoculated into medium containing 1 in 11,000. After culturing on gradually increasing concentrations for a period of almost twenty-six months (September 9, 1949–November 22, 1951) a strain was obtained which has grown on a concentration of 1 in 600 during the last four months (in thirty-two passages).

During this work a number of strains, after having been established on particular concentrations, were maintained on colchicine-free medium for various periods and were then tested to determine whether they still maintained their resistance. The results were as follows:

Four strains were made resistant respectively to 1 in 3,000 (first grown on December 27, 1950, and maintained on this concentration for forty-five passages until May 17, 1951), to 1 in 2,000 (first grown on February 18, 1951, and maintained on this concentration for twenty-four passages until May 17, 1951), to 1 in 1,600 (first grown on May 11, 1951, and maintained on this concentration for only two passages until May 17, 1951), to 1 in 1,300 (first grown on June 6, 1951, and maintained on this concentration for twenty-seven passages until September 24, 1951), and were all kept on colchicine-free medium after the second of the above indicated dates.

On February 7, 1952, after the first three of the above strains had been grown for almost nine months (seventy passages) and the fourth for four and a half months (thirty-six passages) on normal medium, they were tested on their respective concentrations of colchicine and all gave rich normal cultures.

In the early passages, after transition from a lower to a higher concentration, cultures contained, apart from normal flagellates, large round multinuclear forms about 30 μ in diameter (these forms occur rarely in normal cultures); but in further passages the flagellates appeared normal in every respect. The temporary appearance of large round multinuclear forms in considerable numbers during the process of selecting resistant strains by subjecting *T. vaginalis* to progressively increasing concentrations is not peculiar to colchicine, for it also occurs in similar circumstances in the case of 4.4′-diamidino stilbene.

The above observations show that a strain of *T. vaginalis* was made resistant to concentrations of colchicine far beyond the maximum tolerated original dose, and that the resistance persisted after a considerable period of growth on colchicine-free medium.

We have to thank Dr. Anna Weizmann, of the Weizmann Institute, Rehovot, for preparations of pure colchicine from *Colchicum hierosolymitanum* Feinbr.

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Mode of Action of Chloramphenicol

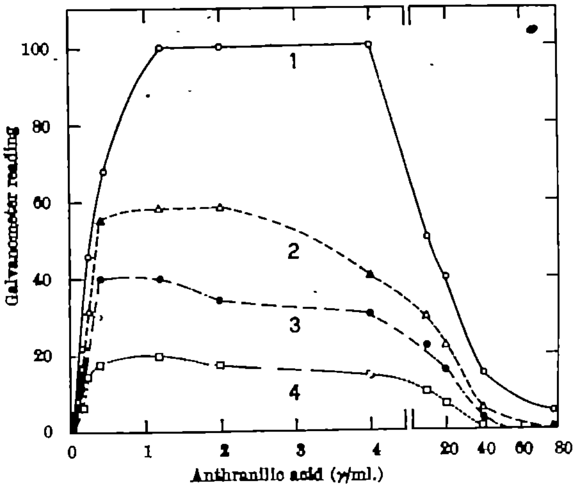
According to Woolley[1], chloramphenicol inhibits the utilization of phenylalanine in *E. coli*, due to its structural resemblance to that amino-acid. Truhaut, Lambin and Boyer[2], on the other hand, have concluded from experiments with *E. typhi* that the antibiotic interferes in the early stages of the synthesis of tryptophane, which Fildes[3] has formulated as follows:

anthranilic acid → indole
indole + serine → tryptophane.

In an attempt to elucidate the mode of action of chloramphenicol, its effect on *E. coli*, wild type, and on a number of its mutants, has been investigated. The inhibition caused in *E. coli*, wild type, can be fully reversed by indole and DL-tryptophane, less easily by DL-phenylalanine and L-tyrosine; it is not reversed by anthranilic acid. This result tends to show that chloramphenicol interferes with the synthesis of indole from anthranilic acid. The study of the mutants of *E. coli* clarifies the point still further.

In the anthranilic acid mutant (121–35), small quantities of anthranilic acid reverse the inhibition caused by chloramphenicol (up to 60 per cent of full growth), whereas larger doses inhibit growth (see graph). In the indole mutant (19–2), the inhibition is reversed by indole. In the tryptophane (19–2), phenylalanine (*M*83–5) and tyrosine (83–9) mutants, the inhibition is only reversed by the respective amino-acids if it is caused by low concentrations of chloramphenicol (1·2 γ/ml.).

The completeness of the reversal effects decreases from the indole mutant to the tyrosine mutant; this, incidentally, appears to point to a scheme for the interrelationship of the three aromatic amino-acids in which phenylalanine and—still more—tyrosine are further removed from the point of the attack of the antibiotic than tryptophane, that is:



Reversal of chloramphenicol inhibition by anthranilic acid in *E. coli* mutant requiring anthranilic acid. Incubated: 18 hr. at 37°. Curve 1: no chloramphenicol; curves 2, 3, 4. 1·2, 1·6 and 2·0 γ/ml. of chloramphenicol, respectively

precursor → tryptophane → phenylalanine → tyrosine[4].

The question of the mechanism by which indole is synthetized from anthranilic acid does not seem to have been investigated. The hypothesis that N-formylanthranilic acid is the intermediate product has been tested in view of previous experience with 4-formamido-imidazole-5-carboxamide[5] and of the observations of Knox and Mehler[6] on the transformation of tryptophane into kynurenine via formylkynurenine; however, N-formylanthranilic acid was inactive. In *E. coli*, wild type, the inhibition by chloramphenicol is overcome by the combination of anthranilic acid with methionine and vitamin B_{12} (see table). Folic acid was inactive, and *p*-amino-benzoic acid showed a negligible activity, when used in conjunction with anthranilic acid and methionine. All other—normal—'methyl donors' were completely ineffective, only histidine showing a very slight activity.

Analogously, the inhibition caused by chloramphenicol in the anthranilic acid mutant could be reversed by the addition of vitamin B_{12} or methionine, or the system vitamin B_{12} plus homocystein; the latter alone proved completely ineffective.

The methyl group of methionine has also been found to be the sole source of a 'lone' carbon atom in the biosynthesis of purines[7] and in the biosynthesis of nicotine in the tobacco plant[8].

The observation that larger quantities of anthranilic acid inhibit the growth of the mutant requiring anthranilic acid suggests that this amino-acid is not the immediate precursor of indole. The

Reversal of Chloramphenicol Inhibition in *E. coli*, Wild Type
(*Materials added*: Anthranilic acid, 4 γ/ml.; vitamin B_{12}, 0·0004 γ/ml.; DL-methionine, 12 γ/ml.)

Chloramphenicol (γ/ml.)	Per cent of full growth	Anthranilic acid	Vitamin B_{12}	DL-Methionine	Vitamin B_{12} + anthranilic acid	Vitamin B_{12} + DL-methionine	DL-Methionine + anthranilic acid	Vitamin B_{12} + DL-methionine + anthranilic acid
2·8	15	17	18	21	17	22	20	27
2·4	33	34	42	47	41	56	52	60
2·0	45	45	52	65	50	70	73	75
1·6	50	51	55	63	54	68	68	74
1·2	70	69	71	71	75	73	72	75

possibilities that N-methyl-anthranilic acid, an N-glycosido-anthranilic acid, or a peptide of anthranilic acid are intermediates in the conversion of anthranilic acid to indole, are now being investigated. The ability of the cell to synthetize peptides of anthranilic acid is demonstrated by the structure of certain alkaloids, for example, of the antimalarial alkaloid in *Hydrangea*[9] and of delsemin in *Delphinium oreophilum*[10].

The mutants used in this investigation were kindly supplied by Dr. B. D. Davis.

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May 17.

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Hypotensive Alkaloids of *Veratrum album*

INVESTIGATIONS on alkaloids of *Veratrum viride* necessitated the preparation of a pure specimen of protoveratrine and prompted an examination of the alkaloids which could be isolated from commercial samples of *Veratrum album*. As a result of these studies, we now report the isolation of two new hypotensive ester alkaloids which have been named 'germitetrine' and 'veratetrine'.

Extraction of commercial *Veratrum album* and crystallization of the crude product from ether according to the method described by W. A. Jacobs and L. C. Craig[1] yielded a crystalline fraction which was subjected, without further purification, to a 24-plate Craig counter-current distribution, using benzene and 2 *M* acetate buffer at *p*H 5·5 as the immiscible phases.

From tubes 17–24 of the above Craig distribution, protoveratrine was isolated (m.p. 270–271° with decomp. (cor.); $[\alpha]^{25}_{D}$, – 35·9° (con. 1·0 in pyridine); $[\alpha]^{25}_{D}$, – 10·9° (con. 1·0 in chloroform); calculated for $C_{44}H_{61}O_{13}N$; C, 62·28; H, 8·18; found: C, 61·70; H, 7·78 per cent). The material was further identified as protoveratrine by degradation studies. Hydrolysis at room temperature in presence of methanolic sodium hydroxide yielded the alkamine isoprotoverine (isolated and characterized by melting point, analysis and ultra-violet absorption spectrum) and an acidic fraction. The acidic fraction was treated with *p*-phenyl phenacyl bromide, and the resulting mixture separated chromatographically into the *p*-phenyl phenacyl esters of acetic acid, α-methyl butyric acid and methyl ethyl glycollic acid, using methods similar to those described by J. Fried, H. L. White and D. Wintersteiner[2].

The material recovered from tubes 10–15 was crystallized from benzene and yielded germitetrine (m.p. 229–230°; $[\alpha]^{25}_{D}$, – 74° (con. 1·0 in pyridine); $[\alpha]^{25}_{D}$, – 12° (con. 1·0 in chloroform)). Analytical data indicate the empirical formula $C_{41}H_{63}O_{14}N$; (calculated, C, 62·00; H, 7·92; N, 1·80; found: C, 62·01, 61·88; H, 7·89, 7·77; N, 1·37, 1·37 per cent); calculated equivalent weight, 794; found, 780. Germitetrine has a characteristic infra-red spectrum which differs from the spectra of protoveratrine and veratetrine. Alkaline hydrolysis of germitetrine and examination of the hydrolysis products by the methods indicated above has yielded the alkamine germine, together with the *p*-phenyl phenacyl esters of acetic acid, α-methyl butyric acid and a third unidentified acid. The *p*-phenyl phenacyl ester of the unidentified acid crystallized from ethanol in white needles (m.p. 163–164° (cor.)). Volatile acid determinations gave 2·8–3·02 equivalent of volatile acid and would indicate that the unidentified acid is non-volatile, since other evidence suggests that germitetrine is a tetra-ester containing two moles of acetic acid, one mole of α-methyl butyric acid and one mole of unidentified acid in combination with one mole of the alkamine germine.

From tubes 0–9 of the Craig distribution, veratetrine was isolated (m.p. 269–270° (dec.); $[\alpha]^{25}_{D}$, – 32° (con. 1·0 in pyridine); $[\alpha]^{25}_{D}$, – 6·8° (con. 2·0 in chloroform). The analytical data indicate the empirical formula $C_{43}H_{64}O_{16}N$; (calculated, C, 60·7; H, 7·58; N, 1·6; equiv. weight, 850·5; found, C, 60·1; H, 7·50; N, 1·4 per cent; equiv. weight, 839). Alkaline hydrolysis of veratetrine and examination of the hydrolysis products by the usual methods has afforded isoprotoverine and the *p*-phenyl phenacyl esters of α-methyl butyric acid, acetic acid and an unidentified acid.

This work will be described in greater detail in a forthcoming publication.

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Transport of Substances through the Tentacles of Leaves of *Drosera capensis* L.

IT was found by Darwin[1] that the tentacles of *Drosera* secrete a viscous liquid with their glands, that they curve after stimulation and that they absorb substances from the animals caught. The processes of uptake and transport have been extensively studied in my laboratory[2,3,4]. The marginal tentacles of a cut leaf are put between strips of agar which contain the substance to be absorbed. The tentacles translocate it in their pedicels to the leaf. The curving of the tentacles which would move them out of the agar can be prevented by adding an osmotic substance (sugar or salt) to the agar. This reduces the turgor of the tentacles so that they cannot curve.

The uptake of different substances was determined with simple methods: phosphate colorimetrically and nitrogen by micro-Kjeldahl method. The uptake of all substances depends more or less on the presence of oxygen. The results given here relate only to a class of actively absorbed substances, by which we understand that in the absence of oxygen no absorption takes place at all (this is only valid in sufficiently low concentrations).

Two groups of actively absorbed substances have been investigated: (1) inorganic phosphates; (2) amino-acids (asparagine and glutamine). The substances are only absorbed at low concentrations. A maximum level of uptake is attained at a rather low concentration. Experiments with simultaneous uptake of two substances show that, if substances of the same group are combined, summation results until the maximum level of uptake for that group is attained. If substances belonging to different groups are combined, the summation goes on until the maximum level is attained for each substance. This indicates that in the uptake of the two groups of substances different metabolic processes are involved.

These results have been confirmed by new observations with enzyme inhibitors. The inhibiting substances were applied in the agar which contained the transport substance. Substances inhibiting respiration (cyanide, azide, iodoacetate and arsenite) diminish the uptake of substances of both groups. Likewise, 2-4 dinitrophenol has an unspecific inhibitory function (Table 1). Some inhibitors were found to be more specific. For example, phloridzin inhibits the transport of phosphate but not that of asparagine, whereas penicillin inhibits the transport of asparagine but not that of phosphate (Table 2). The specific action is in good agreement with the assumption that the absorption of phosphates depends on different metabolic processes from that of amino-acids, but both depend on respiration.

EFFECT OF INHIBITORS ON THE UPTAKE OF ASPARAGINE AND PHOSPHATE BY THE TENTACLES OF *Drosera* LEAVES, IN PARTS PER 1,000 PARTS OF FRESH WEIGHT OF THE LEAVES

1. Non-specific inhibitor (2-4 dinitrophenol)		
	24-hr. uptake of 1/100 *M* asparagine (nitrogen)	24-hr. uptake of 1/80 *M* pot. dihydrogen phosphate (phosphate)
Without inhibitor	1·00	0·50
2-4 Dinitrophenol 10^{-7} *M*	0·74	0·40
2-4 Dinitrophenol 10^{-6} *M*	0·19	0·07
2-4 Dinitrophenol 10^{-5} *M*	−0·01	−0·07
(2) Specific inhibitor (penicillin)		
	24-hr. uptake of 1/100 *M* asparagine (nitrogen)	48-hr. uptake of 1/200 *M* pot. dihydrogen phosphate (phosphate)
Without inhibitor	1·35	0·75
Penicillin, 1 O.U./ml.	1·16	0·75
Penicillin, 2 O.U./ml.	0·74	0·77
Penicillin, 4 O.U./ml.	0·58	0·76

The specific action of penicillin on amino-acid uptake by *Drosera* tentacles reminds us of the inhibition investigated by Gale of the uptake of glutamic acid in growing cells of *Staphylococcus aureus*[3].

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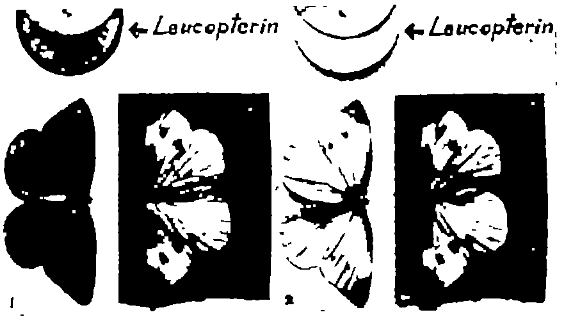
Sex in *Pieris rapae* L. and the Pteridin Content of their Wings

WHEN *Pieris rapae* L. was photographed under the illumination of ultra-violet light passing through the filter *UV-D*1 obtained from the Matsuda Lamp Co., the wings of female butterflies, in accordance with the description of Frank Lutz[1], showed a white image, for they reflected the light, whereas those of male butterflies gave a black shadow because they absorbed the ultra-violet light strongly, as seen in the accompanying photograph (Fig. 1); this is in striking contrast to photographs taken in daylight (Fig. 2). Experiments carried out to elucidate the mechanism of this phenomenon showed that it is due to the difference of pterin content between the male and the female wings.

Under ultra-violet light passing through the filter *UV-D*1, the male insects showed an intense dark vermilion fluorescence, whereas the female wings gave only a very faint pale fluorescence.



When an aqueous suspension of a small quantity of powdered leucopterin was filtered through a small filter paper and the residue with the filter paper was photographed under the illumination of ultra-violet light, it showed the same black shadow as that of the male wings (see Fig. 1). The leucopterin had under ultra-violet light the same vermilion fluorescence as the male wings.

A chemical analysis of the wings of *Pieris rapae* L. was then carried out. Equal numbers of the wings of female and male insects, after washing with ether, alcohol and then with water, were extracted with dilute ammonia. The extracts were then evaporated to a small volume, when two kinds of white deposits settled out from the extract of male wings, while a very small amount of precipitate was found in the case of the female wings only after concentration to a very small volume. The first precipitate from the extract of male wings was identified as a mixture of leucopterin with a small quantity of uric acid by comparison with the synthetic samples on paper chromatography[2], and by ultra-violet absorption spectra, while the second (a small quantity) consisted of uric acid and xanthopterin *a*[3]. The precipitate extracted from the female wings consisted of xanthopterin *b*, which was identified by its R_F and a deep purple fluorescence under ultra-violet light on paper chromatography[4].

The filtrates of the above precipitates showed on paper chromatography in the case of male wings spots of leucopterin, xanthopterin *a* and a trace of xanthopterin, and in the case of female wings spots of xanthopterin *b* and a trace of xanthopterin.

Generally speaking, the pterin content of female wings is very small in contrast with that of male wings.

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[1] Cf. Yagi, *Shizen* (Japanese), 7, No. 1, 60 (1952).

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Diurnal Variations in the Blood Picture of Cattle

CATTLE bloods were examined at intervals during the course of the day at Kabete, Kenya, altitude 6,300 ft., the maximum temperature at the season of the experiment being greater than 75° F., the minimum less than 52° F. The cattle were Zebu/European cross. Water was given them at one point while the experiments were in progress but did not affect the results. Blood was drawn from the jugular vein into oxalated tubes, prepared according to Wintrobe[1]. The neck was constricted with a rope while the vein was entered, but released while the blood sample was being drawn. Blood was drawn at hourly intervals between 9·0 a.m. and 3.0 p.m.

Hæmoglobin figures (estimated by Sahli) varied little and may be regarded as usually constant. The normal variation did not exceed 1 gm. per 100 c.c.

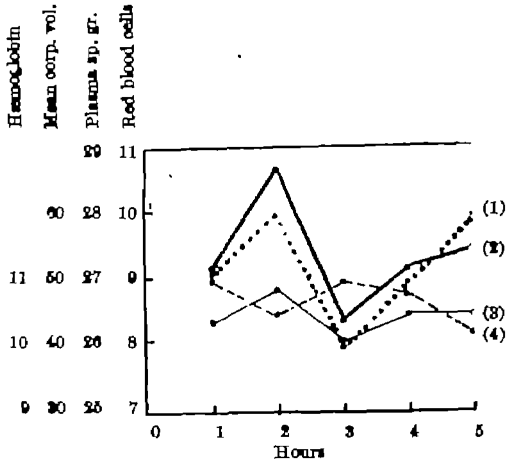

Fig. 1. No. 3237. (1) Specific gravity of plasma; (2) red blood cells (millions/c.mm.); (3) hæmoglobin (gm./100 c.c.); (4) mean corpuscular volume (c.μ)

The red-cell count varied over two million on initial counts of seven million to ten million. Maximum variations of the packed cell volume occurred of 6 per cent (that is, per cent red cells of whole blood) on initial figures of 37–48 per cent; mean corpuscular volume showed variations in most cases, the greatest change being from 47 to 59 c.μ. Mean corpuscular hæmoglobin showed variations of as much as 3 γγ on initial readings of 12 γγ and mean corpuscular hæmoglobin concentration of 3 per cent on initial figures of 21–27 per cent. Plasma specific gravity varied within wide limits, a fall from 1·028 to 1·025 being recorded. Blood specific gravity figures had no significance, owing to the changes of specific gravity of plasma; the difference between the specific gravity of the blood and plasma, however, showed wide variation.

Estimations of dry weight of plasma samples have shown that plasmas of high specific gravity contain a greater percentage of dry matter. The fall of specific gravity is therefore due to dilution of the plasma with fluid.

The following correlations were found: (1) between the red cell count and the specific gravity of the plasma; (2) inversely both between red blood cells and mean corpuscular hæmoglobin, and between packed cell volume and mean corpuscular hæmoglobin concentration; (3) between packed cell volume and the specific gravity of the plasma; (4) inversely between mean corpuscular volume and the specific gravity of the plasma; (5) the difference between blood and the specific gravity of the plasma is inversely related to the red cell count.

Some of these changes in the case of one animal studied are shown in the accompanying charts.

The key to these changes must lie with the variation of the specific gravity of the plasma. The hæmoglobin content of the blood is maintained at a constant level; but fluid added or abstracted alters the ratio of cells to plasma. In many cases, the fall of plasma specific gravity is greater than that of red cells, showing that in spite of a reduction of the red cell count there are more red cells in the circulating blood. Changes in the size of the red cells are presumed to be due to alterations of osmotic pressure. Some change of mean corpuscular hæmoglobin concentration would be expected, due to changes of size of red cells. Changes of mean corpuscular hæmoglobin, however, reveal a mechanism in which the quantity of hæmoglobin in the individual cell may be varied. The mean corpuscular hæmoglobin is in inverse proportion to the red cell count, but related to the difference between the specific gravity of the blood and plasma. It follows that the weight of the red cells is proportional to their hæmoglobin content.

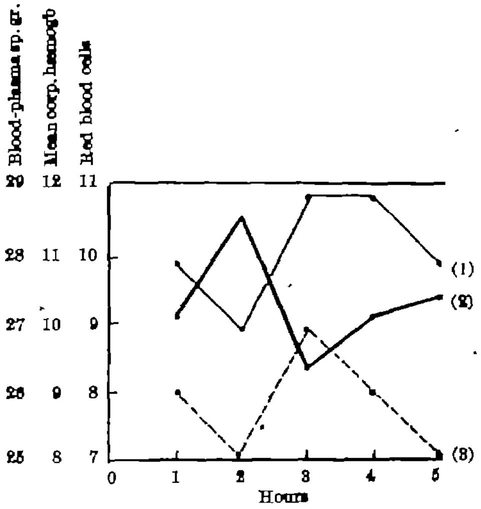

Fig. 2. No. 3237. (1) Mean corpuscular hæmoglobin (γγ); (2) red blood cells (millions/c.mm.); (3) difference between specific gravity of blood and plasma

The object of this work was achieved when the diurnal variations were demonstrated, and it will probably not be further pursued. It is evident that workers should not attach too much weight to variations in the blood picture of cattle under African conditions. Other implications are involved, namely, the variation of the fluid content of the circulating blood. This may be due to the action of the liver on water metabolism, and reference may be made to Lichtman's work[2], who describes this effect.

It is possible that a study of the control of water metabolism, suggested by this work, may be of importance to an understanding of the physiology of cattle in hot climates or in times of drought.

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July 15.

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Vapour-Liquid Equilibrium Relationships in Extractive Distillation

THE advantages of using binary data to calculate the effect of a high-boiling solvent on the volatility of a pair of liquids have frequently been emphasized. Recently, a thermodynamic method of calculating the average value of the logarithm of the volatility ratio of the low-boiling pair (components 1 and 2) at a constant mole fraction of the high-boiling solvent (component 3) under isothermal conditions from binary data has been advanced[1]. A treatment of this type has now been developed for single liquid-phase systems under a pressure of one atmosphere and the following approximate expression obtained:

$$[\log \bar{\alpha}_{12x_3}]_{x_3',\text{ isobaric}} \approx 4\cdot559\ [\Delta T_{21} + (\Delta T_{23} - \Delta T_{13})/x_3']/T \qquad (1)$$

These terms have the following significance: $[\log \bar{\alpha}_{12x_3}]_{x_3',\text{ isobaric}}$ is the average value of the logarithm of the volatility ratio of component 1 with respect to component 2 at a constant mole fraction, x_3', of the high-boiling solvent taken from the composition $x_1 \rightarrow 0$ to $x_2 \rightarrow 0$ under isobaric conditions. Thus this quantity is defined by equation (2), where the integral on the right-hand side is to be taken for a pressure of one atmosphere and for a constant mole fraction, x_3', of component 3.

$$[\log \bar{\alpha}_{12x_3}]_{x_3',\text{ isobaric}} = \left[\int_0^{1-x_3'} \log \alpha_{12x_3} dx_1\right]/(1-x_3') \qquad (2)$$

ΔT_{21} is the normal boiling point of pure component 2 minus the normal boiling point of pure component 1, in degrees Celsius; ΔT_{23} is the normal boiling point of the mixture of components 2 and 3 containing a mole fraction x_3' of the extractive solvent 3, minus the normal boiling point of pure component 2, in degrees Celsius; ΔT_{13} is the normal boiling point of the mixture of components 1 and 3 containing a mole fraction x_3' of the extractive solvent 3, minus the normal boiling point of pure component 1, in degrees Celsius; T is the mean of the normal boiling points in degrees absolute of the mixtures (1,3) and (2,3) containing a mole fraction x_3' of component 3.

For many systems the value of $[\log \bar{\alpha}_{12x_3}]_{x_3',\text{ isobaric}}$ will be found to be nearly equal to that of the logarithm of the volatility ratio of component 1 with respect to component 2 in the mixture containing equal mole fractions of components 1 and 2 and a mole fraction x_3' of component 3.

Previously, it was shown[1] that for isothermal data the most satisfactory third component will, in general, be that material which yields the largest numerical value of the function $[\log \bar{\alpha}_{12x_3}' - \log \bar{\alpha}_{12}]$, where the pure substance 1 is the component with the highest vapour pressure and where $\log \bar{\alpha}_{12}$ is the average value of $\log \alpha_{12}$ for the binary (1,2). From expression (1) it follows that, subject to the approximations used, the most satisfactory third component at a given mole fraction x_3' is that material which gives the largest numerical value for the expression $(\Delta T_{23} - \Delta T_{13})/T$.

The derivation of expression (1) is based on a rigorous thermodynamic treatment, but it involves many additional assumptions, of which the following are some of the more important. The vapours have been assumed to behave as ideal gases and the molar volume of the liquids has been assumed to be negligible compared with that of the vapour. The vapour pressure of the extractive solvent has been assumed to be negligible at the normal boiling temperatures of the mixtures (1,3) and (2,3) containing a mole fraction x_3' of component 3. The activity coefficients in the binary (1,3) have been assumed to obey the relationships $\log \gamma_1 = C_1(x_3')^2$; $\log \gamma_3 = C_1(1 - x_3')^2$, where C_1 is a constant. Equations of a similar type involving a constant C_2 have been assumed to be applicable to $\log \gamma_2$ and $\log \gamma_3$ in the mixture (2,3). A term on the right-hand side equal to $\left[\int_{T_{23}}^{T_{13}} (\Delta H/T^2)\mathrm{d}T\right]/2\cdot303R(1 - x_3')$ has been neglected in the derivation of expression (1), where ΔH is the molar heat of mixing of the mixture containing x_1, x_2 and x_3' mole fractions of components 1, 2 and 3, and T_{13}, T_{23} are the normal boiling points on the absolute scale of mixtures (1,3) and (2,3) containing a mole fraction x_3' of component 3. The latent heats of vaporization of the pure components 1 and 2 and of these materials from the binary mixtures (1,3) and (2,3) have been assumed to satisfy Trouton's rule.

Application of expression (1) to the experimental results for seven systems and a total of nineteen concentrations of third component where the experimental values of $[\log \bar{\alpha}_{12x_3}]_{x_3',\text{ isobaric}}$ varied from 0·05 to 0·44 showed a standard deviation of 0·043 units between the calculated and observed figures. This value is equivalent to a deviation of approximately 10 per cent in the anti-logarithm of $[\log \bar{\alpha}_{12x_3}]_{x_3',\text{ isobaric}}$.

Although a considerable number of assumptions is made in the derivation of expression (1), and although this expression is only approximate, nevertheless it is thought that this relationship is sufficiently accurate for use in the preliminary selection of the most suitable solvent for the separation of a given binary (1,2). The small amount of experimental measurement required for use in expression (1) is an attractive feature of this treatment.

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April 25.

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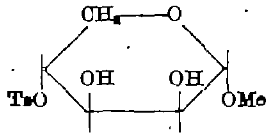
[1] Herington, *Research*, 3, 41 (1950).

4-Deoxy-L-Ribose

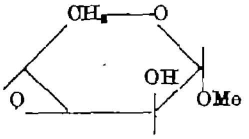
Recent investigations[1] of the behaviour of the Dische reagent[2] towards various deoxysugars and their glycosides have revealed that a coloration is obtained with a number of such compounds, and that the reagent cannot be regarded as specific for 2-deoxyribose. Colorimetric evidence based on the Dische test thus does not preclude the occurrence of deoxysugars other than 2-deoxy ribose[3] in the deoxypentose nucleic acid structure. As an extension to the investigations on the known 2-deoxyribose[4] and 3-deoxyribose[5] (otherwise known as 3-deoxyxylose), we have synthesized 4-deoxy-L-ribose, with a view to its characterization and the study of its behaviour towards colorimetric reagents.

3 : 4-Anhydro-α-methyl-D-lyxoside (II) was formed by treatment of 4-tosyl-α-methyl-D-lyxoside (I) with sodium methoxide. Scission of the ethylene oxide ring with hydrogen bromide in acetone was expected to yield two derivatives[6], 4-bromo-α-methyl-D-lyxoside (III) and 3-bromo-β-methyl-L-xyloside (IV), although, in fact, only the 4-bromo compound was isolated. Hydrogenation of the latter (III) in the presence of Raney nickel led to the glycoside of the required compound.

α-Methyl-lyxoside was shaken for 12 hr. with acetone containing concentrated sulphuric acid. After neutralization and removal of the solvent, 2 : 3-acetone-α-methyl-D-lyxoside was distilled as a viscous syrup (b.p. 65°/0·02 mm.; n^{21}_{D}, 1·4575). This compound reacted readily with *p*-toluenesulphonyl-chloride in pyridine to give crystalline 4-tosyl-2 : 3-acetone-α-methyl-D-lyxoside (m.p. 96–97°; $[\alpha]^{22}_{D}$, − 10·2° in ethanol (con., 1·85)). When warmed with dilute acetic acid the isopropylidene group was removed and 4-tosyl-α-methyl-D-lyxoside ($[\alpha]^{21}_{D}$, + 30·0° in chloroform (con., 1·4); n^{21}_{D}, 1·5140) resulted. Mild alkaline hydrolysis of this 4-tosyl derivative yielded 3 : 4-anhydro-α-methyl-D-lyxoside (b.p. 115° (bath temp.)/0·02 mm.; $[\alpha]^{22}_{D}$, + 98·6 in acetone (con., 1·4)). The anhydro ring was cleaved when this compound was boiled with hydrogen bromide in acetone for 4 hr., and crystalline 4-bromo-α-methyl-D-lyxoside (III) (m.p. 134–135°) was obtained. Evidence for the structure of this compound was obtained from its ready oxidation by lead tetra-acetate in glacial acetic acid[7]. Reduction of (III) with hydrogen in the presence of Raney nickel and calcium hydroxide at room temperature and atmospheric pressure gave 4-deoxy-β-methyl-L-riboside ($[\alpha]^{21}_{D}$, + 89° in water (con., 0·22)), which was hydrolysed by dilute aqueous acid to 4-deoxy-L-ribose (V) ($[\alpha]^{21}_{D}$, + 23 in water (con., 0·2); n^{22}_{D}, 1·4920) which gave a crystalline α-benzylphenyl hydrazone (m.p. 102–103°).



(I)



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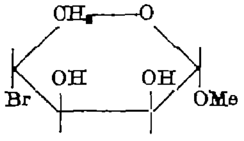

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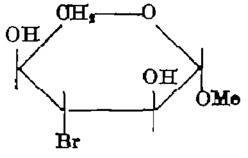

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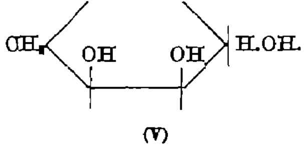

(V)

Comparative Dische tests[2] performed simultaneously on 2-, 3- and 4-deoxyribose revealed that no coloration was given by the 4-deoxy compound or by ribose itself.

The chromatographic R_G values[8] of the three deoxyriboses were determined in butanol (40 per cent), ethanol (10 per cent), water (50 per cent) on Whatman No. 1 paper giving the following figures: 2-deoxyribose, 0·50; 3-deoxyribose, 0·60; 4-deoxyribose, 0·53.

The structure of this 4-deoxy compound involves certain problems of nomenclature, since the penultimate carbon atom is, in this case, symmetrical. We propose, therefore, that the configuration of this type of compound be decided by reference to the ultimate *asymmetrical* carbon atom, and in this instance the compound is therefore named '4-deoxy-L-ribose'.

We wish to thank Sir Rudolph Peters for his interest in these investigations.

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May 25.

[1] Allerton, R., Overend, W. G., and Stacey, M., *J. Chem. Soc.*, 255 (1952).

[2] Deriaz, R. E., *et al.*, *J. Chem. Soc.*, 1222 (1949).

[3] Levene, P. A., and Jacobs, W. A., *J. Biol. Chem.*, 12, 411 (1912). Levene, P. A., *J. Biol. Chem.*, 48, 119 (1921). Kent, P. W., *Nature*, 166, 442 (1950).

[4] Meisenheimer, J., and Jung, H., *Ber.*, 60, 1462 (1927). Deriaz, R. E., *et al.*, *J. Chem. Soc.*, 1879 (1949).

[5] Kent, P. W., Stacey, M., and Wiggins, L. F., *J. Chem. Soc.*, 1232 (1949).

[6] Peat, S., "Adv. Carbohyd. Chem.", 2, 49 (Acad. Press, N.Y., 1946).

[7] Hockett, R., and McClenahan, W. S., *J. Amer. Chem. Soc.*, 61, 1667 (1939).

[8] Jones, J. K. N., *et al.*, *J. Chem. Soc.*, 930 (1949)

Modified Newtonian Systems

To the usual assumptions for Newtonian mechanics, we add the following, in order to account for the behaviour of light:

(1) The speed of light is the same in all directions, relative to the emitting source.

(2) If a source moves with constant velocity, relative to a Newtonian origin, the speed of light emitted along the line of motion is the same relative to the origin or the source.

From these two additional assumptions, it is possible to develop transformation equations for two Newtonian frames S and S'. We take V as the velocity of S' relative to S and c the speed of light relative to an emitting source considered fixed in S'. If accented co-ordinates are referred to S' and unaccented to S, we have the following equations

$$\alpha x' = x - Vt, \quad y = y', \quad z = z', \quad \alpha t' = t - Vx/c^2,$$

where

$$\alpha(V)\,\alpha(-V) = 1 - V^2/c^2.$$

The simplest values of α are $(1 + V/c)$, $(1 - V/c)$ and $(1 - V^2/c^2)^{1/2}$. The Lorentz–Einstein relative velocity formula is independent of α, and so experiments which are interpreted on this formula cannot be used to choose a suitable value of α. As a preliminary, however, phenomena requiring simple kinematics have been treated. A direct explanation of the Doppler effect gives $\alpha = 1 \pm V/c$ rather than $(1 - V^2/c^2)^{1/2}$.

With this value for α the formula for stellar aberration is derived. Instead of the usual $\sin \delta\theta = \frac{V}{c} \sin \theta$, it is found that

$$\sin \delta\theta = \frac{V}{c} \sin \theta \; (1 + \cos \theta).$$

There is a large discrepancy in these formulæ when θ is near $\pi/3$, and it is suggested that an experimental check should be made.

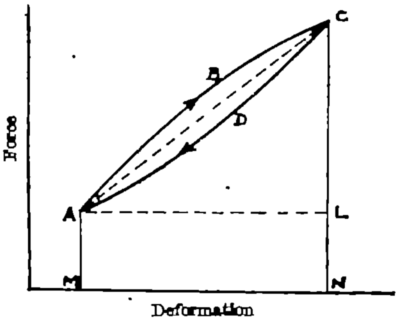
The transformation equations can be generalized without much difficulty and give at once the general Doppler formula.

R. Capildeo

University College,
London, W.C.1.
May 26.

Hysteresis in Rubber

In the discussion following a recent series of lectures given in the University of Nottingham on the dynamic properties of rubber, it became evident that the methods of specifying and measuring the amount of hysteresis in rubber are subjects of controversy. Two terms in current use for specifying hysteresis are 'percentage damping' and 'resilience', as defined in the accompanying diagram.



$$\text{Percentage damping} = \frac{\text{area } ABCD}{\text{area } ABCL} \times 100$$

$$\text{Resilience} = \frac{\text{area } ADCNM}{\text{area } ABCNM} \times 100$$

Resilience is thus the ratio of energy output to energy input during one complete cycle, but the physical significance of the term percentage damping is more obscure. The two terms are complementary only if the loop starts from zero strain. Resilience is generally measured by means of a rebound pendulum in which the cycle starts from zero strain, and as a result resilience and percentage damping are almost universally considered to be complementary. It should be stressed, therefore, that when a cycle is superimposed on a static strain, the terms are no longer complementary. Such cycles can be recorded on a Roelig machine[1] and also on the machine in use at this University, details of which are in course of publication. Investigations carried out with this machine show that the hysteresis loop changes in slope and area as the static strain is varied. This means that resilience at zero static strain cannot be converted to resilience at some finite static strain simply by including an additional area such as $ALNM$. Resilience or percentage damping must therefore be measured under the conditions in which the rubber is to be used.

It has also been found that resilience is very much a function of both frequency and amplitude. The latter result means that the use of a rebound pendulum to measure resilience is fundamentally unsound, though the figure obtained from such an instrument may not be much in error.

As to the relative merits of the two terms resilience and percentage damping, the former gives a figure of considerable practical importance, and is therefore likely to appeal to the rubber user. One unfortunate feature, however, is that the rubber technologist has given the term resilience a meaning different from that given by engineers. The latter consider resilience as the energy stored in a material in the strained state.

For comparing the mechanical behaviour of two rubbers, or of one rubber under different conditions, the term percentage damping is better, since it will reveal small differences which would be masked by using resilience. That is, a small change in the area of the hysteresis loop results in a much smaller percentage change in resilience than in the term percentage damping. It should be stressed, however, that the term percentage damping as defined by Roelig[2] is the ratio of the area of the loop to the area $ABCL$ and not to the area of the triangle ACL. Roelig, in his earlier paper[1], used the area of the triangle, and many investigators since have followed this practice. The use of the triangle has several drawbacks and can lead to much ambiguity when the ends of the loops are very rounded or when the major axis of the loop is curved.

D. M. Davies

Engineering Department,
University of Nottingham.
May 12.

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[1] Roelig, H., Proc. Rubber Tech. Conf., 821 (1938).

[2] Roelig, H., *Rubber Chem. and Tech.*, 18, 62 (1945).

'Detectivity': the Reciprocal of Noise Equivalent Input of Radiation

There is a perfectly sound and well-known way of stating the ability of a radiation detector to detect weak signals. One simply states the amount of input radiation that produces a steady electrical output equal to the root-mean-square noise voltage, under conditions of measurement that are stated adequately. But unfortunately the noise equivalent input suffers from a crippling psychological defect: it is upside down—the better detector has a lower noise equivalent input.

Because of this psychological defect, one frequently hears the relative performance of detectors described by a statement such as: 'Detector A has a better signal-to-noise ratio than detector B'. This use of the signal-to-noise concept involves, of course, a logical confusion. The signal-to-noise ratio is a combined property of a detector and a signal, whereas the intent of the above sentence was to describe a property pertaining only to the detector.

To this difficulty there is one solution, and I believe only one solution, which is sound both psychologically and logically. The solution is to introduce as an independent concept the reciprocal of the noise-equivalent radiation input, and to give this concept a name. For some time now I have been using the name 'detectivity' for the reciprocal of the noise equivalent input, and I now propose this term for general use. With this concept the sentence discussed above becomes simply, 'Detector *A* has more detectivity than detector *B*'.

The need for this concept was set forth in an unpublished report dated March 18, 1950; in the report I suggested the terms 'detectity' or 'recinepity' for the concept and asked for better suggestions. In a reply dated July 20, 1950, Dr. Peter B. Fellgett suggested the term 'detectivity', which I now prefer.

'Detectivity' is a very appropriate name for this concept. It is self-descriptive, and it matches the companion terms 'sensitivity' and 'responsivity'; it is translated easily into other languages. The primary disadvantage is that it uses as basis the word 'detective', which is usually employed with another significance.

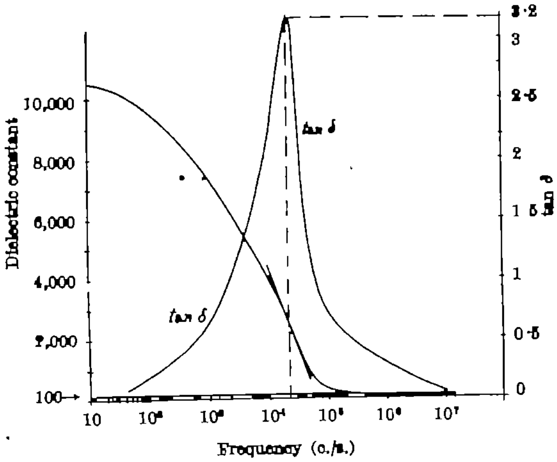
In summary, a need exists for a simple method of describing that property of a radiation detector which is greater for the detector that achieves a greater signal-to-noise ratio on a given radiation signal. Both the concept and a name for the concept have been lacking heretofore. 'Detectivity' is suggested as the name for the concept, and the detectivity is defined as the reciprocal of the noise equivalent input of a detector.

R. CLARK JONES

Polaroid Corporation,
730 Main Street,
Cambridge 39, Mass.
May 6.

A New Dielectric Material

I HAVE prepared a ceramic material which, although apparently being pure rutile, has quite different dielectric properties. It was obtained by heating pure titanium oxide (TiO_2) to a temperature of 1,400° C., as described elsewhere[1]. X-ray analysis leads to the same Debye–Scherrer pattern as rutile (axis ratio 1 : 0·911). The frequency dependence of the dielectric constant and of tan θ (θ = loss angle) of this substance is shown in the accompanying graph, measured at the Centre d'études des Télécommunications, Paris, by courtesy of the director, M. Caye. This substance thus exhibits a Debye type of loss connected with a very high static dielectric constant.



L. NICOLINI

Department of Engineering,
Institute of Industrial and Applied Chemistry,
University of Bologna.
Aug. 29.

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[1] Italian Patent 7592, Aug. 9, 1951.

Zoological Nomenclature

As from March 1, 1953, the International Commission on Zoological Nomenclature will start to vote on the following cases involving the possible use of its plenary powers for the purposes specified in brackets against each entry. Full particulars of these cases were published on August 29, 1952, in the *Bulletin of Zoological Nomenclature*, those relating to cases (1) to (4) in Part 10 and those relating to cases (5) to (14) in Part 11 of Vol. 6.

(1) *Sphinx* Linnæus, 1758 (Cl. Insecta, Ord. Lepidoptera) (designation of type species); (2) Houttuyn (M.H.), 1787, *Animalium Musei Houttuinensi Index* (suppression); (3) *Phalæna* Linnæus, 1758 (Cl. Insecta, Ord. Lepidoptera) (suppression, and validation as of generic status of eight terms used by Linnæus for groups thereof: *Bombyx*, *Noctua*, *Geometra*, *Tortrix*, *Pyralis*, *Tinea*, *Alucita*, as from 1758, *Attacus*, as from 1767; and names of families based thereon; alternatively, for *Bombyx* and *Pyralis* (as from Fabricius, 1775) (designation of type species); (4) *Episema* Ochsenheimer, 1816 (Cl. Insecta, Ord. Lepidoptera) (designation of type species, thereby also preserving *Diloba* Boisduval, 1840); (5) *cydippe* Linnæus, 1761, *Papilio*, and *adippe* Linnæus, 1767, *Papilio* (Cl. Insecta, Ord. Lepidoptera) (suppression, and validation of *adippe* Denis and Schiffermuller, 1775, *Papilio*); (6) *hispidus* Olivier, 1811, *Palæmon* (Cl. Crustacea, Ord. Decapoda) (validation); (7) *Sicyonia* Milne Edwards, 1830 (Cl. Crustacea, Ord. Decapoda) (validation); (8) *Hymenocera* Latreille, 1819 (Cl. Crustacea, Order Decapoda) (designation of type species); (9) *Pyramidella* Lamarck, 1799 (Cl. Gastropoda, Sub-Cl. Prosobranchia) (validation, by suppression of *Plotia* Roeding, 1798); (10) *Dasypeltis* Wagler, 1830 (Cl. Reptilia) (validation); (11) *Trichopsylla* Kolenati, 1863 (Cl. Insecta, Ord. Siphonaptera) (suppression); (12) *pungens* Walcknaer, 1802, *Pulex*, and *vespertilionis* Dugès, 1832, *Pulex* (Cl. Insecta, Ord. Siphonaptera) (suppression); (13) *sinus* Linnæus, 1767, *Coluber* (Cl. Reptilia) (determination of application); (14) *Mellita* Agassiz, 1841 (Cl. Echinoidea) (validation).

Comments on the above cases should be sent to me as soon as possible.

FRANCIS HEMMING
(Secretary to the International Commission on Zoological Nomenclature).

28 Park Village East,
Regent's Park,
London, N.W.1.
Aug. 29.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 1

Royal Society (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Anniversary Meeting.

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. G. de Q. Robin and Mr. J. J. Holtzscherer: "Depth of Polar Ice Caps".

Society of Engineers (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. B. R. Byrne: "The Fatigue of Metals—Facts and Theories Reviewed".

Society of Chemical Industry, London Section (joint meeting with the Fine Chemicals Group and the London and South-Eastern Counties Section of the Royal Institute of Chemistry, at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Mr. G. E. Smith: "Essential Oils".

Tuesday, December 2

School of Pharmacy, University of London (in the Meyerstein Lecture Theatre, Westminster Hospital Medical School, Horseferry Road, London, S.W.1), at 5.30 p.m.—Sir Eric Rideal, F.R.S.: "Adsorption and Reaction in Monolayers and some Biological Implications".*

Wednesday, December 3

Royal Sanitary Institute (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Investigations into Swimming Bath Water Treatment" (to be opened by Dr. S. G. Burgess, Mr. D. Burns and Mr. C. W. Tidy).

Physical Society, Colour Group (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 3.30 p.m.—Mr. Oliver Cox: "The Architectural Use of Colour in Schools".

Royal Society of Medicine, Surgery Section (at 1 Wimpole Street, London, W.1), at 5 p.m.—Discussion on "The Use of Radio-Isotopes in Surgery".

Institution of Electrical Engineers, Radio Section (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. A. Wright: "A Survey of Present Knowledge of Thermionic Emitters".

University of London (in the Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Prof. M. Born, F.R.S.: "Research in Theoretical Physics by the Department of Mathematical Physics, Edinburgh".* (Further Lectures on December 5 and 10.)

Society of Public Analysts and Other Analytical Chemists, Polarographic Discussion Panel of the Physical Methods Group (at Sir John Cass College, Jewry Street, London, E.C.3), at 6.30 p.m.—Annual General Meeting; Mr. P. R. D. Pomeroy and Mr. R. A. White: "Modification of the Cambridge Polarograph for Derivative Polarography"; Dr. W. Stross: "The Polarographic Determination of Cadmium in Aluminium and some other Alloys".

Society of Public Analysts and Other Analytical Chemists (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Dr. H. H. Green: "Industrial Fluorosis".

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Scientific Films: "The Chameleon" (English), "Marvels in Miniature" (Australian), "L'Hippocampe" (French), "Cardiac Output in Man" (introduced by Prof. J. McMichael).

Wednesday, December 3—Friday, December 5

European Association of Exploration Geophysicists (at the Stadthalle, Corvinusplatz 2, Hanover, Germany).—Third Meeting.

Thursday, December 4

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. H. E. M. Barlow: "Guided Electric Waves".*

Physical Society, Low Temperature Group (in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Annual General Meeting; at 5.30 p.m.—Prof. F. E. Simon, F.R.S.: "Has Low Temperature Physics any Practical Applications?"

British Institution of Radio Engineers, Scottish Section (in the Department of Natural Philosophy, The University, Edinburgh), at 7 p.m.—Mr. J. H. H. Merriman: "The London to Kirk o' Shotts Television Cable/Radio Link System".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Royal Society of Medicine, Neurology Section (at 1 Wimpole Street, London, W.1), at 8.15 p.m.—Dr. F. M. R. Walshe: "Thoughts on the Equation of Mind with Brain" (Hughlings Jackson Lecture).

University of London (in the Swanley Hall, Wye College, Wye, Kent), at 8.15 p.m.—Sir David Brunt, F.R.S.: "The Basis of Micro-climatology".*

Friday, December 5

Institution of Post Office Electrical Engineers (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 5 p.m.—Mr. W. J. Bray, Mr. R. L. Cooke and Mr. R. W. White: "The London-Wenvoe Experimental Radio Link for Television".

Society of Dyers and Colourists, London Section (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. P. R. Peacock: "Food Dyes".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Dr. F. J. Siddle: "New Fibres and the Problem of Colouring Them".

Society of Cosmetic Chemists of Great Britain (at the British Colour Council, 13 Portman Square, London, W.1).—Mr. Taylor: "Detergents".

Saturday, December 6

Hospital Physicists' Association (in the Reid-Knox Hall, British Institute of Radiology, 32 Welbeck Street, London, W.1), at 10 a.m.—Discussion on "Ionization Chambers and various Aspects of their Use in the Measurement of X-Rays and Gamma-Rays".

British Mycological Society (at the Linnean Society of London, Burlington House, Piccadilly, London, W.1), at 12 noon.—Annual General Meeting; at 2.30 p.m.—Discussion on "Micro-Structure in relation to the Identification of Higher Fungi".

London County Council (at the Horniman Museum, London Road, Forest Hill, London, S.E.23), at 3.30 p.m.—Mr. J. W. Brailsford: "The Mildenhall Treasure".*

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Biochemist in the Department of Pathology—The Area Pathologist, Royal Devon and Exeter Hospital, Exeter (December 6).

Educational Psychologist at the Guildford Child Guidance Clinic—The County Medical Officer, County Hall, Kingston-upon-Thames (December 6).

Physicist (Senior Experimental Officer) to organize and supervise operations involving processing of active materials and to be responsible for accounting and movement control of active materials used by research and development group, and Physicists (Assistant Experimental Officers) to carry out radiation measurements with special reference to health hazards, at a Ministry of Supply establishment at Aldermaston—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.292/52A (December 6).

Radio-Biologist for the Radiotherapy Department, for research in radio-biology in connexion with radiation in general—The Secretary and House Governor, Mount Vernon Hospital, Northwood, Middx. (December 6).

Engineers at a Ministry of Supply establishment at Bickley, Kent.—Ref. C. 646/52A, for technical inspection of optical and survey instruments and allied equipment; Ref. C. 678/52A, for control of group engaged on above duties—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No. (December 13).

Experimental Officer at the National Physical Laboratory, Teddington, to assist in installation and running of large servo-connected differential analyser and design of other analogue computing equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.448/52A (December 13).

Scientists, Grade II, or Scientists, Grade III, or Scientific Technical Officers, Grade I (with degrees, or equivalent, in physics, chemistry, mathematics or mining engineering) on the staff of the Director of Scientific Control, to carry out environmental studies at collieries in connexion with a long-term field research into the occurrence and causes of pneumoconiosis—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting T1/568 (December 20).

Director of the Division of Industrial Hygiene, New South Wales Department of Public Health—The Agent General for New South Wales, 56 Strand, London, W.C.2 (January 12).

Chair of Geology and Mineralogy—The Secretary of the University Council, Trinity College, Dublin (January 15).

Reader in the Department of Soil Science and Chemistry, Imperial College of Tropical Agriculture, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 40 Norfolk Street, London, W.C.2 (January 15).

Chair of Child Health in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31).

Lecturer in Aircraft Structures and Design—The Secretary of University Court, The University, Glasgow (January 31).

Agricultural Officer and a Biochemist in the Department of Agriculture, Fiji—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSO.63/49/01–2.

Assistant (Grade A) in Physics—The Principal, Technical College, Queen Street South, Huddersfield.

Assistant Physicist (with honours degree in physics) in the Radiotherapy Centre—The Group Secretary, War Memorial Hospital, Scunthorpe, Lincs.

Assistant Research Chemist (organic) in the Hop Research Department—The Registrar, Wye College, Wye, Ashford, Kent.

Combustion Research Chemist, to conduct both research and investigation of practical problems in the combustion of gas turbine and jet engine fuels and to assume some responsibility in the guidance and supervision of this work—The Chief, Personnel Branch, National Research Council, Ottawa, Ont., Canada; or The Chief Scientific Liaison Officer, National Research Council, Africa House, Kingsway, London, W.C.2.

Educational Psychologist (female, with an honours degree in psychology) to the Child Guidance Clinic—The Town Clerk, Town Hall, Bradford.

Geologists (with a first- or good second-class honours degree in geology) in the combined Survey Department for Sarawak and North Borneo (C.S.D.60/92/01), and Geologists (with a first- or good second-class honours degree in geology) in the British Solomon Islands Protectorate (C.S.D.60/46/01)—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting the appropriate Ref. No.

INSPECTORS OF MINES (with a degree or diploma of a recognized School of Metalliferous Mining, and two years postgraduate experience) in Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.99/14/01.

LECTURER (with honours degree in physiology) IN PHYSIOLOGY AND PHARMACOLOGY—The Registrar, Municipal College, Portsmouth.

LECTURER OR ASSISTANT LECTURER IN AERODYNAMICS—The Head of Aeronautics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7.

MINING GEOLOGIST (with a B.Sc. degree with honours in mining geology) in Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting No. 27079/40.

PHYSICIST OR ELECTRICAL ENGINEER at outstation of the Royal Aircraft Establishment, Woodbridge, Suffolk, to lead section engaged on application of radar to ballistics and other trials, including responsibility for conduct of trials, maintenance of ground radar equipment, plotting tables, etc., and development of techniques—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.291/52A.

PRINCIPAL SCIENTIFIC OFFICER at Sellafield, for work on health physics and other research problems associated with handling radioactive materials—The Ministry of Supply, Risley, Warrington, Lancs, quoting 393.

RESEARCH PLANNING OFFICERS at Salwick and Sellafield—The Ministry of Supply, Division of Atomic Energy (Production), Warrington, Lancs, quoting 385.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics, or equivalent, and an interest in properties of semi-conductors) at the Ministry of Supply Telecommunications Research Establishment, Malvern, for research into methods of sensitization of photo-conductive cells, particularly lead selenide—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.298/52A.

SCIENTIST, Grade II or III (graduate chemist), in the Cannock Chase area—The Divisional Establishment Officer, National Coal Board, West Midlands Division, Himley Hall, Dudley, Worcs.

SENIOR SCIENTIFIC OFFICER OR SCIENTIFIC OFFICER AT THE ROAD RESEARCH LABORATORY, West Drayton, for research on properties and performance of bituminous road materials and related machinery—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W 1, quoting E.506/52.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Electrical Research Association. Technical Report L/T.255: Excitation Temperatures of Hydrogen Arcs. By H. Edels and J. D. Craggs. Pp. 18+8 plates. 12s. Technical Report W/T.24: Electrical Soil Warming for Salad Crops in Frames. By A. E. Canham. Pp. 9+1 plate. 9s. (Leatherhead: Electrical Research Association, 1951–1952.) [208

Department of Scientific and Industrial Research. Report of the Water Pollution Board with the Report of the Director of Water Pollution Research for the Year 1951. Pp. iv+56+4 plates. (London: H.M. Stationery Office, 1952.) 2s. 6d. net. [208

Friends of the Lake District. Report and News Letter. Pp. 20. (Ulverston: Friends of the Lake District, 1952.) [208

Reports on the Progress of Applied Chemistry. Vol. 36, 1951. Pp. 878. (London: Society of Chemical Industry, 1952.) [208

Agricultural Research Council. Foot-and-Mouth Disease Research: Interim Report. Pp. iv+12. (London: H.M. Stationery Office, 1952.) 6d. net. [258

Department of Scientific and Industrial Research: Forest Products Research. Bulletin No. 1: Dry Rot in Wood. Fifth edition. By K. St. G. Cartwright and Dr. W. P. K. Findlay. Pp. iv+36+8 plates. (London: H.M. Stationery Office, 1952.) 2s. net. [258

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 894, Vol. 245: The Imaging Properties of Electron Beams in Arbitrary Static Electromagnetic Fields. By P. A. Sturrock. Pp. 155–187. (London: Cambridge University Press, 1952.) 7s. 6d. [258

Problems of Power Transmission at Voltages above 225 kV. By François Cahen. Pp. 64. (London: British Electrical and Allied Manufacturers' Association, 1952.) 5s. [258

Department of Scientific and Industrial Research. Report of the Pest Infestation Board with the Report of the Director of Pest Infestation Research for the Year 1951. Pp. iv+36+4 plates. (London: H.M. Stationery Office, 1952.) 2s. net. [278

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 63, Part 4, No. 21: The Statistical Theory of Stiff Chains. By Dr. H. E. Daniels. Pp. 290–311. 3s. 6d. Vol. 63, Part 4, No. 22: Artificial Holograms and Astigmatism. By Dr. G. L. Rogers. Pp. 313–325+1 plate. 2s. 9d. Vol. 63, Part 4, No. 23: Studies in Practical Mathematics, 7, On the Theory of Methods of Factorizing Polynomials by Iterated Division. By Dr. A. C. Aitken. Pp. 326–335. 1s. 9d. Vol. 63, Part 4, No. 24: The Solution of a Functional Equation. By A. H. Read. Pp. 336–345. 1s. 9d. (Edinburgh and London: Oliver and Boyd, Ltd., 1952.) [278

Rapid Testing by Fluorescence. Pp. 12. (Slough: Hanovia, Ltd., 1952.) 1s. 6d. [288

Air Ministry: Meteorological Office. Geophysical Memoirs No. 88: Humidity of the Upper Troposphere and Lower Stratosphere over Southern England. By J. K. Bannon, Dr. R. Frith and H. C. Shellard. (M. O. 530c.) Pp. 36. (London: H.M. Stationery Office, 1952.) 2s. 6d. net. [288

University Grants Committee. Returns from Universities and University Colleges in receipt of Treasury Grant, Academic Year 1950–1951. (Cmd. 8638.) Pp. 44. (London: H.M. Stationery Office, 1952.) 2s. net. [19

Memorandum on Non-Destructive Methods for the Examination of Welds. (T 29.) Pp. 64. (London: British Welding Research Association, 1952.) 5s. [19

Department of Scientific and Industrial Research. Forest Products Research, Bulletin No. 25: Identification of Hardwoods; a Lens Key. Pp. vi+122+8 plates. (London: H.M. Stationery Office, 1952.) 5s. net. [19

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SELECTION AND TRAINING FOR RESEARCH

SINCE in its report on "University Development from 1935 to 1947" the University Grants Committee commented on "the tendency to over-emphasize in the name of research the value of certain forms of postgraduate activity which have little real importance from the point of view of advancing the frontiers of learning", the research activities of the universities of Great Britain have been frequently discussed, perhaps more especially in relation to higher technological education. In an interim report for the years 1947–51 issued early this year, the University Grants Committee reiterated the opinion that the universities must always remain the main agency for fundamental research, and from this view there is little, if any, dissent. The question at issue is rather the extent to which the ordinary science graduate should receive some training in research, and whether such training fits him or otherwise for an industrial career, which may or may not be in research.

It has been argued, though more particularly in respect of fundamental research, that only the exceptional man, who has given evidence of possessing the appropriate qualities of mind, should be encouraged to pursue postgraduate research in the university, and that such training is quite unnecessary for the ordinary student. If he has acquired a clear understanding of the scientific method and of the technique and fundamental principles of his chosen discipline, he should be able to adapt himself to whatever work may be required of him when he enters industry or on any other career. Moreover, the shortage of trained scientific men has made it essential that the methods of training, whether before or after entering industry or the selected occupation, should be as efficient as possible from the point of view of avoiding misfits and waste of trained man-power and of securing easy and smooth adaptation.

Such considerations make the proceedings of the second annual conference on industrial research held at Columbia University, in June 1951* of wide interest in Great Britain as well as in the United States of America. The conference, which was sponsored by the Department of Industrial Engineering of that University, was concerned specifically with the selection, training and use of personnel in industrial research. To some extent it strayed into side-issues, as, for example, the discussion on operational research provoked by Mr. R. L. Ackoff's paper on methodology and mathematical statistics and their application in research, and by the papers of Dr. P. N. Powers on industrial research workers and defence, and R. M. Hogan on research and national man-power policy. The latter papers, however, demonstrated that the question of efficiency and avoidance of waste in training is as important in the United States as it is in Britain, and Mr. Ackoff's contribution emphasized the importance of the issue between generalized and specialized training in regard to the assimilation of the graduate in industry.

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* Selection, Training and Use of Personnel in Industrial Research. Proceedings of the Second Annual Conference on Industrial Research, June 1951. Sponsored by the Department of Industrial Engineering, Columbia University. David B. Hertz (editor), Albert H. Rubenstein (assistant editor). Pp. x+274. (New York: King's Crown Press; London. Oxford University Press, 1952.) 30s. net.

The two most critical issues raised in these discussions turn, first, on the specific qualities required in the industrial research worker, and second, on the recognition of these qualities and selection of the workers who possess them. The decision between general and specific training must depend, at least in part, on our ability to define fairly precisely the qualities for which we are looking, and to consider the methods which most effectively encourage the development of these qualities. Until that stage is achieved, there seems to be little point in fostering postgraduate research when the utility of the latter may be called in question from the point of view of subsequent adaptation of the graduate concerned.

In two of the papers, those of E. W. Engstrom, vice-president in charge of research in the Radio Corporation of America, and of Prof. D. B. Hertz, of Columbia University, much stress was laid upon the desirability of originality and creativeness. These are precisely the qualities that mark the outstandingly successful research worker, whether in industry or elsewhere, and at the same time they are those which are the most difficult to distinguish. Even as to the conditions in which they flourish and are best fostered we know relatively little, though those conditions are also the conditions in which research work in general is most fruitfully pursued, though not necessarily those in which high inventiveness is likewise encouraged.

Nothing in the discussion of these two papers suggested that, despite agreement as to the importance of creativeness, there is any recognized means of detecting it at an early stage; as Dr. Engstrom remarked, only experience can show whether a man possesses such powers. Apart from this, the main emphasis was laid on the soundness of the scientific training which a candidate for a research post in industry has received, and on his ability to work with others as a group. Whether he has already been engaged in research appears to be immaterial so long as he possesses these qualifications. It might be said that, as Dr. H. A. Leedy pointed out in a subsequent paper on training young research workers, the capacity to learn is more important than the knowledge the candidate has actually acquired, subject to a certain basic minimum.

It is comparatively easy to specify desirable qualifications for a research worker, as not only Dr. Leedy but also other conference speakers recognized, notably, besides Dr. Engstrom, Dr. H. K. Work in his paper on the university's role in training research workers. Besides fundamental professional knowledge already noted, and the ability to use it, much stress was laid by these three speakers on the personal qualities and character of the applicant, including not merely the ability to work with others, but also such qualities as the capacity to express himself clearly and concisely, his scientific inquisitiveness, practical outlook, initiative and energy. The difficulty is not to specify the desirable qualities but to determine which applicants possess them, and Dr. Leedy frankly admitted that the best we can hope for is that some few of the men chosen will live up to expectations.

Although it may be conceded that the quality of creativeness and imagination which lifts the research worker to the highest level is almost impossible to diagnose by any selection technique, Dr. Leedy's view as to the futility of selection techniques seems to be too pessimistic and scarcely warranted by the general trend of the discussions at this conference. At least if we know what we are looking for we should be able to eliminate a fair proportion of misfits, and even to do this involves avoiding waste of trained man-power on a scale sufficiently serious at present to justify an effort to improve existing techniques of selection. On this the Conference at Columbia University reflected opinion freely expressed at the Conference on Industry and the Universities organized by the Federation of British Industries in Great Britain in November 1949. Moreover, it brought out, as did the latter, that what industry looks for in its research workers is, in the first place, not so much training in the technique of research, or even the possession of creative ability and imagination. Industry is prepared to take a chance that the second will develop as training in the necessary research technique is given within industry itself. The prime necessity is the possession of a sound knowledge and understanding of some scientific discipline, and the ability to think clearly and to express ideas clearly in speech or writing. If a recruit possesses these qualities, together with those other personal qualities such as reliability and the capacity to co-operate, industry will be able to make effective use of him, even if he does not prove to be in the first rank as an original investigator. These qualities, moreover, are those which should be to a large extent the natural result of a university education, not only in the faculty of science but also in any other faculty. To the extent to which the university graduate seeking to enter industry is deficient in them, we should seek to inquire into the character of the education he received at his university and to remedy such deficiency at its source.

The corollary of an efficient selection technique for industrial research personnel is an appropriate standard in university and in technological education, and this is a point to be remembered in the current discussion on the expansion of higher technological education in Britain. There is, however, a further reason why industry can afford to take some chance in respect of creative ability on the part of its recruits for industrial research. Prof. S. B. Littauer, in his paper "What Makes a Good Research Man", pointed out, much as other speakers had done, that a research worker must possess a background of knowledge as well as some imagination and inventiveness, and that the extent to which these are desirable is not easy to define. In technical research, however, logical procedures are dominant factors: such research demands the astute organization of reproducible knowledge pertinent to the problem under study, the focusing and weighing of evidence, the determination of the relevance of data and the unbiased testing of hypotheses. These and other requirements, such as making inferences from observations about the general principles which govern these observations and predicting from accepted principles what may be expected to result from selected operational procedures, amount to a methodology, the adequacy of which largely determines the effectiveness of the investigation.

Prof. Littauer argues that the research recruit should not be expected to possess such a scientific methodology, but that its acquisition should be encouraged by the research organization and the research director. What ultimately makes a good research man is a research organization and a research director that provide such encouragement, and with it the atmosphere, opportunity and stimulation to expand and utilize efficiently his substantive knowledge in an organized attack on the research problems confronting him. Not only will an organization which provides such conditions get the most effective results from its existing staff, but also it will not need to worry about selecting the creative and outstanding research worker. Such men will be attracted to work in the conditions which are most favourable to creative thought and work.

Thus we come back to the conclusions of the Barlow report on scientific staff. Selection techniques have their part to play in avoiding misfits, and especially if they have been used still earlier to avoid wasting time and money on those unfitted to profit by a university training; but they are of secondary importance compared with the provision of conditions in which creative work is most fruitfully pursued. If we do not offer these conditions, we shall not attract men of the quality we desire; and the warning is one that should be kept specially in mind at such a time of stringent economy, not least in government research establishments. But it is also relevant to the question of the form which new technological institutions in Britain are to take. Whether the technological research on an increased scale which is so desirable in Great Britain is developed within the walls of university departments of technology or of the higher colleges of technology or of a new technological institution, or in co-operation with industry or research associations in industry itself, matters relatively little, provided the conditions of academic freedom and status are provided which will ensure that the institution attracts to its staff men of the right ability and standing. If such conditions are satisfied and the right atmosphere exists, even sponsored research itself may present little difficulty and may indeed encourage the development, not merely of ability and technique in research, but also of the inventiveness and scientific curiosity which are so desirable.

AN ESSAY ON MORPHOGENESIS

Morphogenesis

An Essay on Development. By John Tyler Bonner. Pp. vii+296. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1952.) 32*s*. 6*d*. net.

THE subject of morphogenesis can be approached from many different points of view. In this very readable 'essay' Dr. Bonner has drawn widely on both the plant and animal kingdoms, especially the lower groups, to illustrate particular points. In general, his subject-matter will be familiar to those whose special interest lies in the study of morphogenesis; but he has dealt with many aspects in a new and refreshing manner. Thus he has contributed chapters on size and pattern, physics and chemistry of development, patterns of growth, patterns of morphogenetic movements, polarity and symmetry, patterns of differentiation, and an analysis of development. Botanists in particular will be interested to note to what good use he has put the developmental data of green algæ (Volvocales and Chlorococcales), myxomycetes and oomycetous fungi, in discussing morphogenetic movements which are so familiar to the zoologist. The author regards morphogenesis, or the emergence of an organismal pattern, as being referable essentially to the progressive, constructive processes of growth, morphogenetic movement and differentiation; and to the limiting of these processes in various ways by intrinsic and extrinsic factors which check, guide and canalize them. He also recognizes that the physical bases of many morphogenetic processes may or may not be the same for all organisms. Polarity, for example, has a different physical basis in different organisms.

In that even the simplest morphological or structural feature is the result of the action of a whole nexus of factors, and these of different kinds, it may well be doubted if any morphogenetic development will ever be adequately explained. Dr. Bonner, of course, makes no claim to having solved any of the problems of morphogenesis; but in a lucid and interesting manner he has discussed many of the major aspects and has shown, by reference to a wide range of examples of individual developments, that some phenomena are of very general occurrence and hence that it is reasonable to seek for common underlying causes.

The data of morphogenesis, already multitudinous, are increasing daily from diverse sources. There may, therefore, be several views as to how the subject is to be tackled in the hope of advancing knowledge. Few will disagree with the author that "the only way of finding a solution to the riddle of development will be to discover new and penetrating facts". As to how these facts are to be discovered it is, of course, hard to be explicit; but the thesis is advanced that a sustaining aim should be to search for a micro-theory which would explain in a satisfying manner the general phenomena of development; for such a theory is more likely to afford an insight into the inner mechanism of the relevant phenomena than any other kind of theory. The same general idea has also been advanced by other investigators, for example, Woodger. This matter is argued closely by the author, and, as he points out, such a micro-theory does not necessarily imply that all the phenomena of biology are to be brought down to physics and chemistry: some kind of intermediate micro-theory may prove quite satisfactory—for example, the action of genes as envisaged in contemporary genic theory. No micro-theory can yet be offered ; but the kind that would be satisfying would be one in which, as in crystal structure, the organism could be envisaged as being constructed of small repetitive units.

It is difficult, in a short review, to give an adequate idea of the contents of this volume, or essay, for it is essentially an extended discussion. The reader, however, may be assured that it not only touches on many of the main features of morphogenesis, as presently understood, but also that it is the product of much thought and bears the impress of a philosophic mind. C. W. WARDLAW

GENERAL DISCUSSIONS ON CHEMISTRY

Heterogeneous Catalysis

(Discussions of the Faraday Society, No. 8.) Pp. 366. (Aberdeen : Aberdeen University Press, Ltd., 1950.) 30*s*. net.

Colloques Internationaux du Centre National de la Recherche Scientifique

10 : Réactions dans l'état solide, Paris, Octobre 1948. Pp. iv+222. 1100 francs ; 25*s*. 30 : Réarrangements moléculaires et inversion de Walden, Montpellier, 24–29 avril 1950. Pp. 152. 2000 francs ; 44*s*. (Paris : Centre National de la Recherche Scientifique ; London : H. K. Lewis and Co., Ltd., 1949–51.)

Institut International de Chimie Solvay

Huitième Conseil de Chimie tenu à l'Université de Bruxelles du 10 au 15 Septembre 1950. Le mécanisme de l'oxydation ; Rapports et discussions. Pp. iii+503. (Bruxelles : R. Stoops, 1950.) 550 francs.

ALTHOUGH general discussions and symposia on selected topics are recognized features of scientific life, it is somewhat doubtful whether the publication of the proceedings contributes very much to the edification of the general reader. The papers presented are not often novel and generally consist of material already published, presented in such an abbreviated form that they are unintelligible except to specialists, and the discussion is usually chaotic and composed of fragments which are mutually self-destructive. The Faraday Society seems to have felt this situation, since its discussions are prefaced by summaries or surveys which try to make some sort of coherent picture of what occurred. It is no doubt true that the proceedings are stimulating to the participants ; but the average scientific reader, in search of concrete information, may sometimes feel that, having fulfilled this purpose, they might well have ended there. A report prepared by an independent author is usually much more intelligible and informative.

The Faraday Society discussion on heterogeneous catalysis comes off rather well in these respects, since it includes some important new material in the experimental field, and although the subsequent discussions of the papers are on the familiar lines, they do not occupy too much valuable space. The introductory paper, by Prof. H. S. Taylor, is readable and informative. Some of the outstanding difficulties and contradictions in the field are dealt with in other papers. The section on techniques brings together some valuable information on modern methods. The whole volume is well above the usual standard of such discussions and cannot fail to be useful both to specialists and those whose interests are more general.

The two "Colloques Internationaux" are less praiseworthy. The articles are too numerous and too brief to be wholly intelligible, and the volumes leave a feeling of surfeit and mental dyspepsia which they are bound to produce in such a form. The topics are of great interest and importance ; but the treatment as a whole does not present a coherent picture of the state of the subjects. All the same, the volumes will be found useful in a limited field. Readers who know little of the subjects will not know very much more after reading the fragments. It is suggested that a smaller number of contributions, more adequately treated and with some regard to the needs of non-specialists, would be more suitable. No doubt the participants gained much from the proceedings ; but they might well have been satisfied with this and let the matter rest. May we hope that future publications will be more attractive to the general scientific reader ?

The report of the eighth Solvay Congress contains some papers of reasonable length, carefully prepared and clearly presented. They are all intelligible and valuable, and a reader will gain real information from them. The field covered is wide, and includes the important biological aspects. The authors do not assume that the reader already knows what is in the papers, and in general lay the foundations well. The mathematical treatment is limited to what is really essential, and is adequately related to the experimental material. The discussions are often confused and unnecessary. The bibliographies are extensive and good. The subject of the mechanism of oxidation, in its present stage of development, is difficult and most important, and this volume may be said to clarify and unify a good deal of scattered material in a very satisfactory way. Some important newer reagents such as periodic acid have found extensive applications but are still not adequately treated in the detailed text-books. They are well represented here. The whole volume is sure of a welcome from many kinds of readers. J. R. PARTINGTON

BRITISH AMATEUR ORNITHOLOGIST'S VADE-MECUM

The Pocket Guide to British Birds

By R. S. R. Fitter. Pp. xvi+240+112 plates. (London and Glasgow : Wm. Collins, Sons and Co., Ltd., 1952.) 21*s*. net.

THIS text-book aims at presenting British birds accurately to the beginner by coupling Mr. R. A. Richardson's fine illustrations with the use, not of measurements and technical descriptions, but of a simple classification into eight groups : very short, short, medium short, medium, medium long, long, very long, and huge. There are also wing, neck, leg and bill ratios in similar categories. It seems a pity that the length of each bird is not given in inches, so that if the student finds himself very close to, or able to handle, a wild bird, he can check by measurement. To some extent the artist has overcome this difficulty by providing a silhouette of a sparrow upon each page of illustrations.

The beginner who may be at first confused by the novel classification in this book should take heart from Mr. Fitter's observation that even the expert cannot be confident about the identity of some of the "small brown birds", unless they call or sing, when the novice possessed of a good ear may as quickly recognize the species; and he may turn to the key at the end of the book for alternative methods of identification—colour, structural features, behaviour, voice and habitat. There are a calendar of migration and breeding periods, lists of geographical races and rare visitors, and an index. About half a page is devoted to each common (or not very rare) British bird, and this section forms the bulk of the highly condensed but accurate text. The first to be described is the smallest, the goldcrest, classified under "Land Birds: Very Short". The last is the mute swan—under "Water Birds: Huge". Sensibly included are some introduced semi-feral species. Chinese goose, mandarin duck, 'London' pigeon and budgerigar, for example, are described; and they are likely to confuse the amateur in search of indigenous species, unless he is warned about these 'foreigners'.

This guide depends upon the success of Mr. Richardson's six hundred colour and four hundred black-and-white illustrations, of which Mr. Peter Scott, himself responsible for some free-flying non-indigenous wildfowl in Britain, says in the foreword that "nothing of the kind has been so well done in Britain before" and "a new bird painter of great skill has entered the field". I am inclined to agree that the combined efforts of artist and colour processor have been successful in overcoming the difficulties of presenting the fine differences of shade and tint between related species, to a degree not so uniformly attained before. The warblers have not been, and may never be, portrayed in colour to the satisfaction of the expert, so delicate and changeable are their tints, according to the strength of the natural light. It was a good plan to show alike-coloured, even though otherwise unrelated, species on the same page. The black-and-white illustrations are mainly of birds in flight, usefully showing wing-pattern and form. The whole seems to justify the claim on the jacket, of a pocket-guide which is also "the complete identification book".

R. M. LOCKLEY

HISTORY OF THE NORTH AMERICAN BUFFALO

The North American Buffalo

A Critical Study of the Species in its Wild State
By Frank Gilbert Roe. Pp. viii+957. (Toronto: University of Toronto Press; London: Oxford University Press, 1951.) 90s. net.

IT is unfortunate that our thirst for knowledge of the larger forms of wild-life often postdates their partial or complete elimination. Inevitably, perhaps, the pioneers of a spreading civilization have little interest in preserving, much less documenting, the natural features of the new worlds they open up. As a consequence, we are compelled to search diligently among the ruins for scraps of knowledge in order to build up even an inadequate story of what has been lost for ever. The story of the North American buffalo is but one of many, and in this book the author, after years of research, has written a thousand pages closely documenting the history of the buffalo, from its first discovery in 1530 to its virtual extermination in the 1880's.

Dr. F. G. Roe's text reads like a legal judgment, an objective recital of all the available evidence, with little sign of the possible verdict until, towards the end and preceding the four hundred pages of appendixes, bibliography and general index, he gives a few pages of concluding summary. The twenty-four chapters deal with the general characteristics of the buffalo, and with its habitat, but more especially with its former numbers, the regularity or otherwise of its behaviour, and its influence upon the Red Indians who occupied the same territory. Throughout, his approach is avowedly iconoclastic, and it is perhaps in a subconscious attempt to counteract this that his effort to maintain an objectivity leads to a certain obscurity in the writing.

It is the common practice in referring to the North American buffalo always to speak of their countless millions that blackened the plains. Dr. Roe seems to think that, even as a mere figure of speech, this is widely misleading, and he takes his reader through an analysis of a large quantity of reports and statistics to prove it. Yet there is more support for this contention in the evidence he brings forward to prove his second point, that the erratic habits of the buffalo accounted for the peculiar nomadism of the Indians of the plains.

Our modern information tends to suggest an almost clock-like regularity in the habits of wild animals, so that the idea of anything—bird, beast or even porpoise—wandering or behaving fancy-free is regarded as somewhat old-fashioned. In strong contrast to this, a case is made out in this book for believing that the behaviour of buffalo, singly or in herds, was strongly individualistic. The author goes so far as to reject any notion of vast seasonal migrations. His views are unorthodox, also, in regard to the habits of wolves. Observations in recent years on the North American wolf have suggested a remarkable regularity in its habits, but the evidence put forward by Dr. Roe leads him to suppose that the wolves formerly preying on the buffalo were compelled to an erratic nomadism in order to follow their supply of food. Moreover, he believes the Indians of the plains owed their nomadic habits to that same need for keeping in touch with their main source of subsistence, and he postulates a definite link between the presence of this inexhaustible supply of food and the Indian mentality and general outlook on life. Incidentally, he exonerates the Indians from the criticisms of wastefulness in their slaughter of the buffalo and fixes the blame very certainly on the improvident white settler.

Another conclusion given by Dr. Roe in his summary, especially interesting since he is an engineer by profession and not a biologist, is the more remarkable in that it is reached by way of a severely objective study of documentary evidence. To the many zoologists to-day who deny intelligence in any but the human species, with perhaps a dawning intelligence in the higher apes, Dr. Roe points out that, if the theory of evolution means anything, it must mean that "the dawning of the capacity for individual impulse *must begin somewhere*" (his italics), and he conceives "of no sound reasons why this should not apply to the buffalo species". Finally, "In relation to buffalo in particular, the most philosophic and generally reliable historian of the species at . . . large explicitly credits them with a degree of individual variation in conduct which can scarcely be ascribed to anything else than some form of personal intelligence, define it how we may".

MAURICE BURTON

THE ROYAL SOCIETY

ANNIVERSARY ADDRESS BY DR. E. D. ADRIAN, O.M., F.R.S.

AWARD OF MEDALS, 1952

Copley Medal

THE COPLEY MEDAL is awarded to Prof. Paul Adrien Maurice Dirac for his remarkable contributions to the quantum theory of elementary particles and electromagnetic fields. All his work has a very distinctive quality, in that he has known how to make evident the relationship of the remote abstractions of the pure mathematician to the extremely practical problems facing the atomic physicist. This appeared even in his earliest work, for in 1926 he took up the non-commutative algebra of Heisenberg, and solved the problem of a non-commutative planetary orbit. Not long afterwards, he showed how the 'matrix mechanics' of Heisenberg could be identified with the 'wave mechanics' of Schrödinger. It is this paper, with its development of the idea of 'representations of physical states', that more than any other has given the colour of his work.

The advances made in 1927 had not provided a relativistically invariant mechanics for the electron, nor had they explained the phenomenon of 'electron spin'. In 1928 he remedied both of these defects at the same time. Perhaps the deepest quality of this work was that it replaced the second-order equations, previously universal in wave-theory, by equations of the first order. These equations had some astonishing consequences, such as possible states of negative kinetic energy; and Dirac attempted a physical interpretation of these states by the concept of a background of electrons occupying nearly all such states. An unoccupied state appeared in the physical world to be a particle of electronic mass and positive charge, equal in magnitude to that of the electron. The 'positive electron' or 'positron' was actually only discovered several years later, and it fitted into Dirac's scheme.

During the same period he was responsible for another discovery of the very first importance, the Fermi–Dirac statistic which was independently formulated by both these authors. Dirac began with the conception that electrons are all identical, and made the point that unless electrons obeyed this statistic it would be possible to recognize their individuality; this is a typical example of the manner in which he has known how to devise the most practical conclusions from the most abstract principles. It was this statistic which served to explain the nature of the conduction of electricity in metals, one of the most formidable difficulties of the older physics.

Some of Dirac's most brilliant work was done at Cambridge while he was a Senior Student of the 1851 Exhibition. He was elected a Fellow of the Royal Society in 1930, the year in which appeared the first edition of his book, "Principles of Quantum Mechanics". This book has the highly individual character of all its author's work; considering the novelty and difficulty of the subject, its clarity of style and directness of approach are models of what a scientific text-book should be. Dirac was appointed to the Lucasian chair at Cambridge at the early age of thirty and was awarded a Nobel Prize in Physics, jointly with Schrodinger, in 1933.

Rumford Medal

The RUMFORD MEDAL is awarded to Prof. Fritz Zernike. In the year 1934 Prof. Zernike described a simple method of indicating the absolute errors in the surfaces of concave spherical mirrors. Realizing that minute defects in the regularity of the surface would give rise to diffraction images out of phase with the central image, he proposed the use of a phase plate to neutralize this difference. Interference then takes place, and on looking through the phase plate the position and magnitude of any irregularities are clearly indicated and may be retouched as necessary. A year later Zernike applied a similar method to the microscope, with results of far-reaching importance.

During the long period of the evolution of the microscope, there have been periods of quiescence and of great activity—the latter always stimulated by some outstanding individual. Of these periods it is only necessary to refer to the close of the past century when Abbe made what then appeared to be an exhaustive study of the light distribution in the back focal plane of the objective. He showed that objects with a highly organized structure gave rise to a series of diffraction spectra of the zero, first and higher orders.

It was then assumed that a transparent phase object must of necessity give rise to an image of low contrast unless suitable staining techniques could be employed to differentiate clearly between the various structures forming the object. The phase object was thereby converted into an amplitude object by means of elaborate techniques which gave rise to changes in the object and in some cases to artefacts. These methods could not, of course, be applied to living material.

By slightly modifying a standard microscope, Zernike showed that it was possible to neutralize the phase difference existing between the spectra of zero and first orders, and thus by interference to transmute the invisible changes of phase produced by the object into changes of amplitude in the resulting image. Living transparent cellular structures are by this means imaged in contrast in such a manner that for small phase changes the depth of tone at any image point is proportional to the phase change brought about at the corresponding object point.

To summarize, Zernike was the discoverer of a new and most valuable microscope technique, an advance comparable with that contributed by Ernst Abbe towards the close of last century. Phase-contrast microscopes are now in daily use in laboratories throughout the world. Science is also indebted to Zernike for many valuable contributions to the underlying mathematical theory. Zernike's work has also acted as a great stimulus to the study of diffraction phenomena and has led indirectly to other important advances in the field of interferometry.

Royal Medals

A ROYAL MEDAL is awarded to Prof. Christopher Kelk Ingold, professor of chemistry in the University of London and director of the Chemical Laboratories at University College, for his extensive investigations of the mechanism of, and the factors influencing, organic reactions.

Over many years it has been Ingold's purpose to treat the mechanism of organic reactions in a quantitative fashion and to understand the factors influencing such reactions in terms of fundamental physical chemical concepts. Thus, for example, in the very early days he made the first successful attempt to understand the interaction between two ions, and between an ion and a permanent dipole, in terms of quantitative electrostatic factors, and applied this work to the velocity of esterification and hydrolysis.

Ingold and his co-workers, for the first time, gave a complete elucidation of the reaction between an ion and a polar molecule. They have studied the influence of substituents on the velocity of organic reactions and have made the most detailed and beautiful analysis of the structure of benzene. All this work is characterized by detailed experimental investigation in which quantitative data on the mechanism of reaction have been obtained. On this quantitative work it was possible for Ingold to base a detailed theoretical framework, and it would be fair to say that no man has contributed with such detailed exactness and with such breadth of theoretical vision to our knowledge of the mechanism of organic reactions as has Ingold. Moreover, his work and ideas are not only applicable to the particular reactions which he has studied. His ideas are at the very basis of quantum chemical theory: in some cases he has anticipated quantum mechanical ideas —in others he has been quick to see the application of such ideas to his own work.

A ROYAL MEDAL is awarded to Sir Frederic Bartlett for his work on experimental psychology. The School which he founded at Cambridge on the beginnings made by Rivers and Myers became, under his leadership, the dominant school in Britain and one of the most famous and respected in the world. There were good reasons for this. Bartlett, at the beginning of his career, saw in mental process a field for experimental observation complete in itself, independent both of philosophical theories and physiologists' stimulus-response investigations. He very early recognized the many factors that enter into these responses and saw that they could be explored in manual and bodily action, in hand skills and skills at games, as well as in verbalizations. An interesting point was his discovery of the important part played by memory of previous performance in maintaining or increasing an individual's skill. His work has always shown great originality of method, unusual power of penetrating a problem and fertility in discovering analogous subjects for experiment. While realizing their validity in certain respects, he has shown a refreshingly critical judgment of the limitations of statistical methods in biology, and he has done much to prevent modern experimental psychology from degenerating into the composition of graphs and arithmetical tables.

His book on "Remembering" (1932) is a classic of psychological research, emphasizing the effects of social conventions and different ways of living on performance and response. During the Second World War, Bartlett and his pupils in the Cambridge laboratories did a great deal of research for the Services, especially on the effects of fatigue in diminishing quality of performance in pilots and the complex factors that facilitated it. Since then his advice has been eagerly sought in industrial personnel problems.

Bartlett's output has been considerable, but it is the clarity and conciseness of his thought which has made his experimental results so fruitful.

Davy Medal

The DAVY MEDAL is awarded to Prof. Alexander Robertson, professor of organic chemistry in the University of Liverpool. He achieved a world-wide reputation as an authority on the organic chemistry of those natural products belonging to the class of compounds containing heterocyclic oxygen atoms. Arising from his early studies with Sir Robert Robinson on anthocyanidins and anthocyanins, Robertson developed an interest in the natural glycosides, and his first major studies were in this field. He developed new methods of synthesis for biosides of phenols, and by a combination of analytical and synthetic procedures he established the structures of a large number of these substances, including indican, the natural glycoside of the indigo plant, and ruberythric acid, the glycoside of madder.

Following on these investigations, he commenced his long series of studies of hydroxy-carbonyl compounds, and on heterocyclic oxygen compounds of natural occurrence. Compounds of these types include many of the familiar non-nitrogenous bitter principles of plants, as well as a variety of fish poisons and insecticides. Over the past twenty years Robertson's output of research in this field has been prodigious, and his work throughout has been marked by brilliance, alike in perception and execution. Among his many triumphs may be mentioned his clarification of the chemistry of the rotenone group of insecticidal compounds from derris root, of usnic acid from lichens, and of the complex natural colouring matters, rottlerin from kamala, dracorubin from dragons blood resin, and the pigments of the insoluble red woods. It is worthy of particular mention that in all these cases Robertson was dealing with problems which had baffled many investigators and were regarded as chemical puzzles; such they would have remained but for his brilliant synthetic studies on oxygen-ring compounds in general. Further development from this point led to his clarification of the structure of the natural furano-coumarins and furano-chromones and of the mould colouring matters, citromycetin and citrinin. In another colouring matter isolated from a micro-organism, violacein, Robertson encountered the remarkable oxidation of hydroxy-indole derivatives, which is bound up with the problem of melanin formation in animals, and he has since then made, and continues to make, notable contributions to our knowledge of the mechanism of melanin formation.

In short, Robertson is a brilliant organic chemist, who has not only solved a long series of structural problems which had baffled earlier workers, but in so doing has opened up new fields of study.

Darwin Medal

The DARWIN MEDAL is awarded to Prof. John Burdon Sanderson Haldane, Weldon professor of biometry in University College, London, for his work on the analysis of the causes of variation and of the mechanism of selection. The conclusions derived from his researches have permeated practically every field of evolutionary discussion, and his ideas have fundamentally altered our knowledge of evolutionary change.

For many years he has insisted that a proper study of evolution involves the development of methods for investigation of the genetics of populations. His mathematical treatment of the question was the first of its kind, and has played a large part in the great development of understanding of evolution during the past twenty-five years.

He has been a pioneer in applying biochemical knowledge, especially of enzymes, to problems of genetics. His contributions to strictly genetical problems are fundamental. They included some of the earliest demonstrations of linkage in birds and mammals and of partial sex-linkage in man. He made the first investigations of human mutation-rates (simultaneously with L. S. Penrose), has studied interspecific hybrids and discovered the rule by which their sex is determined. He was one of the first to develop a theoretical treatment of polyploidy and to show its evolutionary significance.

He has thus made first-rate contributions by his detailed researches, his mathematical treatments and his general analysis of evolutionary problems, to the field of Darwin's work.

Buchanan Medal

The BUCHANAN MEDAL is awarded to Sir Rickard Christophers. Many of the early papers by Christophers appeared in the reports to the Malaria Commission of the Royal Society from 1900 onwards. He was one of the two principal authors of these reports, which make a fundamental contribution to our understanding and prevention of malaria, the greatest cause of sickness in the tropics.

Fifty years ago, Christophers originated the fundamental idea that malaria is not transmitted by *Anopheles* mosquitoes in general but by certain species of *Anopheles*, not by others: much turned on the insect's choice of host, and both in Asia and Africa it was shown that different species of *Anopheles* breed in different types of water: the control of the dangerous species is still based on this, and 'species sanitation' constitutes a fundamental advance in public health.

Turning to the disease itself, Christophers distinguished several main types in the epidemiology: he developed new quantitative methods. He observed that, in such a region as the Punjab, people are not soaked in malaria; they possess, therefore, little immunity, with the consequence that immense fulminant epidemics may occur at intervals of a few years. This he contrasted with the hyper-endemic type of malaria which occurs in places where people are exposed to malaria at all seasons and in every year; in such places the disease may indeed be grave, especially to children, but it does not occur in great outbreaks.

It is not too much to say that nearly all our basic knowledge of the conditions leading to the spread of malaria arises from investigations carried out, mostly in India, by Christophers and those immediately associated with him.

Sylvester Medal

The SYLVESTER MEDAL is awarded to Prof. Abram Samoilovitch Besicovitch, Rouse Ball professor of mathematics in the University of Cambridge. Besicovitch left Russia in 1925 and came to Great Britain after working for a short time with Harald Bohr in Copenhagen; he is one of the foremost authorities in the world on the theory of plane sets of points and the area of surfaces. His first notable work lay in the generalization of the theory of almost periodic functions of Harald Bohr. By dropping the condition of continuity of the functions, he obtained a theorem of the Riesz–Fischer type, thus rounding off the theory in an essential point. Later, and in collaboration with Bohr, he showed how to develop the whole theory from the point of view of function spaces. His book, published in 1932, is still the standard work on the analytical side of the theory.

During the 'thirties he published a large number of papers on various topics of analysis; but probably the most significant of his papers in this period are those devoted to the study of the structure of sets of points in the plane, which are among the deepest and most original contributions to modern analysis.

In recent years he has made a number of fundamental contributions to the theory of the area of surfaces in space. He has also solved a number of isoperimetric problems and made a very important contribution to the additive theory of numbers.

Hughes Medal

The HUGHES MEDAL is awarded to Prof. Philip Ivor Dee, who is distinguished for his application of the cloud-chamber technique to the study of nuclear transmutations. After early work with Prof. C. T. R. Wilson, he studied the interaction of neutrons with electrons immediately after the discovery of the neutron by Chadwick, and showed that the neutron–electron interaction was extremely small. He then applied the cloud chamber to the study of the transmutations of lithium and boron by high-speed protons which had been discovered by Cockcroft and Walton. His very elegant photographs showed directly and proved conclusively the disintegration of boron into three alpha-particles. He then turned to the study of the disintegrations produced by heavy hydrogen, which had been discovered by Rutherford and Oliphant. The cloud-chamber evidence proved that the disintegration of deuterium by deuterons could take place either into a proton and a triton or into a neutron and helium-3. This is one of the most important of the nuclear transmutations.

Dee was then largely responsible for the design and installation of the one-million volt proton/deuteron accelerator in the Cavendish Laboratory during 1936–39. This equipment was remarkably successful and has been copied by numerous laboratories. It enabled a new series of refined experiments on nuclear transmutations to be undertaken. Under his direction, the High Voltage Laboratory carried out a large number of investigations on the transmutation of the light elements which clarified many important aspects of such transmutations.

Dee left the Cavendish Laboratory with his group on the outbreak of war in 1939. He was responsible at the Telecommunications Research Establishment for the development of the technique of microwave radar—probably the most important technical development of the War.

At the end of the War he was appointed to the chair of natural philosophy in the University of Glasgow and has there built up an active school of nuclear physics. He has equipped a high-voltage laboratory, and installed a 30-million volt electron synchrotron and a 330-million volt electron synchrotron. He has recently published an important paper with Richards showing that alpha-particles produce chemical effects in liquids through the interaction of short-wave radiation.

The Council has already presented to the Fellows its report on the work of the Society during the past year—the 290th year of its existence. It was a year in which we had to sustain a grievous loss in the death of our Royal Patron, King George VI. The Queen has been graciously pleased to become Patron of the Society, and the Fellows will rejoice to know that our historic Charter Book is now adorned with Her Majesty's signature on the appropriate heraldic page, a reminder of the great privileges which the Society has always enjoyed since the days of its Royal Founder.

There are certain items in the Council's report to which I may refer. There is, for example, the encouraging fact that the delays in publication of papers in the *Proceedings* and *Transactions* show a steady reduction. The average time between the receipt of a paper and its publication has been 26 weeks for *Proceedings A*, and since June 12 papers have taken less than 20 weeks. But costs continue to rise and, apart from our own publications, there is the very serious problem of financing the publication of abstracts, particularly in the field of chemistry. We must not rely unduly on the help of industry and of Government funds for such important work; but I should like to take this opportunity of thanking those industrial concerns which have contributed so generously towards it. All of us, scientists, industrialists and Government alike, know the great value of our abstracting publications, and none of us can afford to relax our efforts to keep them flourishing.

These abstracting services show us how scientific knowledge is expanding; but before tendering advice about them we ought, no doubt, to set our own house in order. The Royal Society Library contains a wealth of scientific material and papers not yet adequately catalogued: we were most grateful to the Pilgrim Trust for the grant it gave three years ago to enable us to make a calendar of the Society's papers from 1800 onwards, and it has now earned our renewed gratitude by providing a further grant.

One other benefaction should be mentioned. As the Treasurer reported last year, the Society has received the sum of £70,000 on account of the John Joseph Jaffé bequest. During the year we have been able for the first time to award a "Mr. and Mrs. John Jaffé Donation" from this bequest. This first award was made to Sir Geoffrey Taylor, who retired from the Yarrow professorship in February 1952 but continues to direct an important research programme in Cambridge. When we receive the whole of the bequest, we look forward to making many further awards in a manner which will be in accordance with the wishes of the donor and will render great service to the advancement of science. We are very grateful to the late Mr. Jaffé for this bequest.

There is one item which concerns our staff. At the end of the year Mr. P. D. Rogers, deputy assistant secretary, is due to retire from the Society's service after being with us for more than forty years. He began as a junior when Sir Archibald Geikie held office and has served in all under ten presidents of the Society. He is now our Clerk of Council, and the Society will know that the smooth running of our business owes much to the care and efficiency of his work. During these past forty-one years he has seen the Society's responsibilities expanding over a wider and wider field. We are extremely sorry to see him go and we congratulate him on his long and successful career at Burlington House.

NEW TECHNIQUES IN THE STUDY OF THE NERVOUS SYSTEM

It is not usual at the anniversary meeting of the Society to give more than the names of those Fellows of the Society who have died during the year, but there is one of them who occupied a special place as much by reason of his personal qualities as of his great services to science over many years. Charles Scott Sherrington was president during 1920–25, he was a physiologist of world-wide renown, a man of letters as well as a scientist and one who inspired universal affection. Few scientists of our time have been so well qualified to judge the advance of human understanding of the natural world, for he lived long enough to have witnessed most of the great achievements of the present era and he had made an intimate study of the science of the Middle Ages, when the schoolmen and the alchemists were as satisfied with their theories as we are with ours.

But Sherrington was primarily a physiologist and so was interested in the development of ideas concerning the living organism—"Man on his Nature". In his own work he had seen the transformation of physiology from a science still largely anatomical and concerned with the description of bodily adjustments into one which is more concerned with the cell and makes full use of the most advanced techniques of physics and chemistry. His work reflected this change in that his earlier experiments dealt with reflex movements and his later with the control of the individual motor units; but its enduring quality comes from the fact that he was always alive to the whole range of biological inquiry. He thought of cell activities in their relation to the organized behaviour of the whole animal.

He studied the integrative action of the nervous system. That was the title of his classical series of lectures published in 1906. His method was to select a relatively simple movement which could be evoked under standardized conditions, like the withdrawal of the foot from a noxious stimulus, to study the whole apparatus of sense organs, nerve fibres and central cell stations concerned in such a reflex and by doing so to establish the general principles by which simple movements are compounded to give more elaborate activity.

His book was reprinted by the Physiological Society when the International Congress met in Oxford in 1947. It needed no alteration, and although a great deal had been found out about the nervous system since 1906, the general conclusions are still the only general conclusions which can be drawn. But this is not so much a confession of the failure of neurologists to solve their problems as an index of the fundamental difficulty, at all events the fundamental nature, of the main problem, which is to construct a physiological picture of intelligent behaviour.

So much has been written about this in recent times that there is no point in elaborating it now, but our picture of the nervous system is extending in several directions; changes of emphasis have followed new techniques and it may be worth considering where they may be expected to lead.

The most striking advance has come from the great development of techniques for studying what goes on in the very small units of which the nervous system is built up. The new methods of microscopy are scarcely old enough to have borne fruit, but the electronic amplifier has made it a relatively simple matter to study the electrical activity of single nerve cells, and there are corresponding advances in the technique of manipulating very small and delicate living structures.

An early result of the introduction of the amplifier was to establish the nature of the signals by which the nervous system carries out its business. They are all of them trains of nerve impulses, brief outbursts of activity revealed by their electrical effects, travelling rapidly along the nerve fibres and succeeding one another at intervals as short as 1/1,000 sec. Recording them has shown what kind of information can be carried by the nerve fibres and how the sense organs react to stimuli.

But although these electrophysiological methods have been in use for upwards of twenty-five years, our knowledge of the sense organs is still very far from complete. It has been biased, naturally enough, in favour of human sense organs, and it is only in recent years that we have begun to learn much about the sense organs of animals constructed on a different plan or for a different environment. For example, the most remarkable because the most unexpected recent addition to sensory physiology has been Lissman's discovery that certain fish can guide themselves by the aid of the currents which they produce from special electric organs in their bodies. The massive electric discharge of the torpedo was described in a communication to the Royal Society by Walsh in 1773. It is powerful enough for the torpedo to use it as a weapon of offence; but it appears that various freshwater fish have electric organs too small to have any paralysing effect, but large enough to set up pulses of current in the water for their own sense organs to detect. Regions of different conductivity near the fish will distort the pattern of current flow, and if the sense organs are adequately spaced they will reveal the distortion and therefore the presence and the position of the object. Those who attended the soirée last May will have listened to these guiding discharges made audible by connecting electrodes in the water to a loud-speaker system. Bats are known to guide themselves by the sounds they produce, and this is another example of an animal generating the stimulus to be used by its own sense organs. Mankind has learnt to produce such guiding stimuli artificially, as when we light a lamp to see our way in the dark, but the sense organs were evolved without consideration of all that man might do. Our semicircular canals are excellent devices for signalling the limited rotation of the head on the trunk; but they are worse than useless if we subject ourselves to continued rotation on a turntable. In the same way this electric signalling system in fish breaks down when faced with the results of human activity. Rushton has recently investigated the reactions of the eel, *Gymnotus*, an animal which has two kinds of electric organ, a larger one for stunning its prey and a smaller one for detecting it. The system enables the eel to detect and eat the small fish, which in natural surroundings are the only objects likely to have a high conductivity, but if metal electrodes are placed near it the eel detects and eats these too. Indeed, the stomachs in electric eels which have lived in civilized regions are said to contain an assortment of scrap metal erroneously swallowed because the electrical detecting system was not designed to exclude such man-made objects.

Animals which live on land could have little use for organs the sole function of which is to produce electric currents, but small electric currents are, in fact, produced whenever nerve fibres or nerve cells are in action. These action currents are due to ionic interchanges at the cell surface. They play an essential part in nervous transmission; but their study is important not only because they show how information is transmitted but because they give a clue to the molecular changes in the cells. The biophysical problems arising from the phenomena of animal electricity have been recognized since the days of Galvani, and it is in this field that the most rapid progress is now taking place.

It has come from three technical developments: the use of very large nerve fibres, of very small exploring electrodes and of radioactive tracers. All three contribute to the study of the living cell surface and the molecular changes which it controls. Most vertebrate nerve fibres have a diameter of less than 10 μ, and a single fibre is formidable material for the biophysicist; but the giant nerve fibres of squids are large structures, half a millimetre or more in diameter. They were introduced to physiology by Prof. J. Z. Young, and their use has made it possible to study the interior of the fibre as well as the exterior. Later it was found by Ling and Gerard that tubular electrodes of hard glass, with a diameter of 1 μ or less, would penetrate the cell membrane without appreciable damage, so that results obtained with giant fibres can now be extended to other types of cell structure.

The results have given us a new outlook on cell activity. This year, for example, Prof. A. L. Hodgkin and A. F. Huxley read a paper to the Society describing the sudden changes in permeability which occur in the cell membrane when it is subjected to a current which tends to depolarize it. It used to be thought that the result of depolarization was to make the membrane generally permeable to all ions, but the change is much more remarkable; in fact, during activity the relative permeability to different ions is the reverse of what it is during rest.

At rest there is a higher concentration of potassium and a lower concentration of sodium ions in the fibre than in the fluid outside it, and the surface membrane prevents the free diffusion which would equalize these differences. During each pulse of activity, started by depolarizing forces, there is a sudden movement of sodium into the fibre, succeeded almost at once by a movement of potassium out of it. The actual entry of sodium and loss of potassium ions has been measured quantitatively by Keynes and others using radioactive ions. The quantities involved in a single impulse are very small; Keynes and Lewis reckon it as 3–4 μμ mol. through 1 cm.^{2} of surface, but to maintain its state the fibre must restore the potassium it loses and get rid of the sodium which it gains at each impulse.

The biophysicist has therefore two sets of problems to study: those of the surface membrane, which starts and stops this ionic interchange; and those of the cell metabolism, which keeps up the differences in concentration of sodium and potassium in the resting state, pumping out the sodium and restoring the potassium. As Hodgkin points out, although the loss for each impulse in the giant nerve fibre of the squid is only a millionth of the total internal potassium, in the very fine dendrites of the central nervous system the internal store would fall much more rapidly if it were not replenished. Where continuous activity is the rule, as in the controlling regions of the central nervous system, there may well be considerable fluctuations in the internal levels of potassium and sodium ions which may have a profound effect on the working of the cells and about which we are still completely ignorant.

This attack at the biophysical level is beginning to reduce the problems of cell organization in the nervous system to the molecular level. It is likely to explain many of the characteristic properties of nervous tissue, and certainly a clear picture of the cell mechanism must be the basis for any picture of the nervous system as a whole. But the title of Sherrington's book reminds us that most of the picture is very far from clear. The cell units are there to give the integrative action of the whole animal, and we have to find out how they are organized into the nervous system as well as how each one stores and discharges ions.

The problem of organization is partly anatomical—deciding what each fibre tract and cell mass contributes to the total activity. Here there has been and will be a steady advance. But the special feature of the nervous system is the wide variety of action it controls and its power to make behaviour appropriate to future as well as to present needs. It is, in fact, the great diversity of its interests which makes it so difficult to proceed.

Since we are still searching for the physical changes which accompany learning, the changes—structural or molecular—which make the nervous system react differently after training, there is little as yet to bridge the gap between the biophysics of the nerve cell and the fully elaborated activity of the whole system. If we could find, for example, the cell changes which establish a conditioned reflex, we should still have only the general principles of nervous organization. We could not forecast in detail how any particular nervous system would react unless we knew every detail of its past history.

The sort of difficulty which confronts us in studying the organization of the brain is illustrated by recent work which aims at plotting by electrical methods the more remote consequences of the arrival of a sensory message in the brain. Lilly in the United States and Grey Walter in Britain have already made some very interesting observations by different techniques; but to describe their results adequately is already a considerable feat, involving the reduction of four-dimensional patterns to a two-dimensional page.

To understand the integrative action of the nervous system we have to relate the unit to the whole system and the system to the work it has to do. The study of the unit is advancing rapidly, though it is mostly concerned with the immediate response to stimulation and we know little about slower and more persistent effects. When we do know more, it may be that the general plan on which the units are organized will become much clearer. Perhaps a complete revision of outlook may be necessary. At all events there is no need to be pessimistic. There is a wealth of new material and new methods, and a branch of natural science is in a healthy state when it has advanced to the stage where its traditional conceptions begin to look inadequate.

BIOLOGY OF DESERTS

A SYMPOSIUM on "The Biology and Productivity of Hot and Cold Deserts", organized by the Institute of Biology, was held at the Royal Institution during September 25–27. It consisted of six sessions devoted to various aspects of desert biology: climate and physical environment; plant ecology; entomology and ecology; economic aspects; and mammalian physiology and ecology.

Dr. Edward Hindle, president of the Institute, in an opening speech in which he welcomed delegates from abroad, mentioned that the United Nations Educational, Scientific and Cultural Organization showed a special interest in the symposium and contributed towards the expenses of speakers from overseas. Brigadier R. A. Bagnold (the well-known desert explorer) then communicated an introductory paper on the geography of deserts by Prof. Frank Debenham (formerly professor of geography in the University of Cambridge), who was not able to attend in person, and read his own paper on the physical aspects of dry deserts. In the first of these papers, it was pointed out that the distribution of deserts in the world is due mainly to the circulation of the atmosphere, particularly in its lower layers, whereby certain areas are starved of moisture. In addition, many local factors affect the intensity of desert conditions, and excessive insolation by day tends to produce extreme instability in the rainfall. Brigadier Bagnold then said that this intermittent precipitation is variable not only in time but also in place, and only by nomadic wandering over large areas can its effect be exploited. If nomadism were prevented for political reasons, much of the desert would become totally unproductive. Prof. F. W. Shotton (University of Birmingham) emphasized the salinity of most underground desert waters, which are consequently unsuitable for irrigation. Although in semi-desert areas such as southern Palestine considerable development of underground waters can still be hoped for, the prospect for the greater part of the true deserts must always be poor. Dr. C. B. Williams (Rothamsted Experimental Station) then described three studies of microclimatic conditions made some years ago at Wadi Digla in the hilly desert near Cairo. Great variations in conditions occurred between localities only a few feet apart, particularly during the summer; but twelve metres within a cave the daily and seasonal range of temperature was only 2 deg. C. Thus by moving a very short distance, animals can escape extremes of heat and have a wide range of conditions at their disposal. In the discussion that followed, Prof. J. A. Prescott (Waite Agricultural Research Institute and University of Adelaide) pointed out that the variable and local nature of the rainfall in northern Australia has long been realized by pastoralists whose cattle, unhindered by fences, travel great distances to favourable areas. and Dr. H. Greene (Rothamsted Experimental Station) suggested that, although the violent spates of water in the wadis of the Sudan carry so much sediment that storage by dams is impracticable, the deposition of this as silt results in a natural rotation of the soil.

Dr. Hugo Boyko (chief ecologist to the Ministry of Agriculture, Israel) opened the second session with an account of the main lines of plant ecological research that are being carried out in his country. These include pasture problems and the effect of grazing, searching for food plants adapted to desert conditions and for plant raw materials, and the application to biology of other branches of science such as climatology, hydrology and hydro-engineering. A paper by Prof. Th. Monod (director of the Institut Français d'Afrique Noire) outlined the distribution of the basic contracted and diffuse types of vegetation in the Sahara, and Prof. R. D'O. Good (University College, Hull) gave an account of the desert flora of the arid Bahrain Islands in the Persian Gulf. These islands are of interest in that they illustrate with peculiar clarity, and within a circumscribed area, many of the characteristic features of deserts in general. Prof. M. Zohary (Hebrew University, Jerusalem) then presented an analysis of the many hydro-economic types of vegetation occurring in the Near East deserts, and a paper by Prof. I. Reichart (Jerusalem), crediting xerothermic climates with the suppression of many pathogenic bacteria and downy mildews, was followed by a general discussion.

In the third session an exposition of phyto-sociological research carried out in French North Africa to provide a rational basis for the evaluation of the soil was given by Prof. L. Emberger (Montpellier). At Montpellier and Zurich a cartographical method has been devised to demonstrate vegetational associations which directly indicate the nature of the underlying rock, and similar surveys are now being carried out in central Tunisia and western Algeria. The secretary-general of the International Union of Biological Sciences, Prof. P. E. L. Vayssière, then described how modern methods of rapid travel have, in a number of cases, transported pests of such economic plants as dates and cotton across natural barriers of arid desert, and introduced them into oases and other areas from which they had previously been absent. Dr. B. P. Uvarov (director of the Anti-Locust Research Centre, London) gave a warning that desert irrigation schemes may increase the danger of locust infestation in other areas by providing new permanent breeding-grounds. The desert locust requires adequate soil moisture before it can increase in numbers to the point of swarming, and, both at Abyan near Aden and at Tokr on the Sudan coast, irrigation schemes have already resulted in a semi-permanent population of desert locusts. Dr. A. S. Balachowsky (Institut Pasteur) gave an account of the problems of applied entomology in the Sahara, with particular reference to the biology of indigenous species that have become adapted to feed upon cultivated plants. This was followed by a description by Prof. F. Bernard (Algiers) of the economic importance of social insects, particularly termites and ants, in the desert. Methods were suggested for encouraging useful, and for reducing harmful, species.

The microbiological formation of sulphur in Cyrenaican lakes, particularly Ain-ez-Zaua, was the subject of a joint paper by K. R. Butlin and J. R. Postgate, who led an expedition from the Chemical Research Laboratory, Teddington, to the area in 1950, and methods of increasing the yield were discussed. Prof. E. P. Stebbing (formerly professor of forestry in the University of Edinburgh) emphasized that the man-made desert is a stern reality ; man has been the enemy of forests since earliest times, and large-scale clearing has resulted in erosion and the production of arid regions. Dr. S. M. Manton (King's College, London) then gave an outline of the large irrigation and development schemes being carried out in Central Asia, and of the biological research associated with the construction of the Turkmenian canal and the development of the Kara Kum desert. She was followed by Prof. J. F. V. Phillips (Achimota, Gold Coast), who discussed aspects of the ecology and productivity of the arid regions in southern and eastern Africa. The deserts themselves are of little potential productive importance, but their significance in regard to possible encroachment is profound. Mismanagement by most African and many European farmers, he said, is increasing the desiccation of the land at an alarming rate. Emphasis was laid on the role of the tsetse fly in controlling too rapid a development and on the agencies responsible for increased erosion. From experience gained while associated with the Groundnuts Scheme, Prof. Phillips gave warning of the far-reaching repercussions of insufficiently planned attempts to clear large areas of natural vegetation within a short time, and advocated ecological surveys and pilot schemes extending over at least five years. In the discussion that followed, the damaging effect of clearing forest by fire was contested by Dr. A. S. Thomas (London).

Sessions on the last day were devoted to problems of mammalian physiology and ecology. Prof. F. S. Bodenheimer (Hebrew University, Jerusalem) described research on the seasonal cycle of the gonads and endocrine glands in gazelles and camels, carried out in his laboratory at Jerusalem. This cycle is adapted to the seasonal rainfall, with the result that the young are born when vegetation is most abundant. Dr. Norman C. Wright (scientific adviser to the Ministry of Food) compared the morphology of domesticated animals inhabiting hot and cold deserts, in contrast to that of animals from non-desert areas. The majority of the former are slightly sweating species that employ polypnea as a temperature defence mechanism. Solar radiation is reduced by various protective devices which were discussed from the point of view of the histology of the skin, the hair characteristics and behaviour reactions. Suitable fodder may help to alleviate the gross heat burden. Water conservation in kangaroo-rats and pocket mice was discussed by Dr. Bodil Schmidt-Nielsen (Cincinnati), who has investigated the physiology of the desert rodents in Arizona. She found that these animals never drink, but obtain an amount of water equal to more than half the weight of the dry seeds which form their staple diet by oxidizing this food within their bodies. Evaporation from the respiratory tract is relatively small because of the low temperature of the respired air, the urine is very concentrated and the fæces contain less water than that of most mammals. The subject of heat regulation in these animals was mentioned by Dr. Knut Schmidt-Nielsen, who said that the loss of water by evaporation is avoided by living in burrows during the day and emerging only at night. If a kangaroo-rat is exposed to great heat, the fur of its throat becomes moistened with saliva, but even by this means it cannot survive for more than twenty minutes. Although the areas covered by bluebush in southern Australia have been greatly depleted during the past century, Prof. H. C. Trumble and Mr. K. Woodroffe (University of Adelaide) found that properly controlled grazing, pruning of older bushes and seedling establishment by reduction of competition for moisture from annual species could induce a general improvement. Problems of water conservation and of adaptive coloration formed the principal topics of the discussion which followed.

In the final session, Dr. J. S. Weiner (Oxford) discussed human adaptability to high temperatures and suggested that the function of the skin pigment in the Negro is primarily to protect the sweat glands from injury by excessive ultra-violet light. Dr. Frank Marsh (London) then described experiments on rabbits subjected to great environmental heat, which threw light on the treatment of human heat-stroke, and a paper was given by Dr. Edmond Sergent (director of the Institut Pasteur d'Algérie) on the problems of populating the Sahara: he postulated that white families could never become acclimatized there as the heat is too great for the women and children, black races would find the winters too cold, and the nomads, who are camel owners, shepherds and warriors, are useless at manual work; consequently, only the indigenous negroid race could usefully multiply, and only in proportion to the amount of water available. Dr. O. G. Edholm (London) described the physiological effects of cold environment on man. He said that although acclimatization to cold occurs, it is a relatively slow process, and suggested that, in fact, man has probably evolved as a tropical animal. Sir David Brunt (formerly of the Imperial College of Science and Technology) showed by means of graphs the conditions in which office work can be carried on in the afternoon in tropical climates. The limitation appears to fall within a well-defined range of temperature and humidity.

After the discussion, Dr. Frank Malina spoke on behalf of Unesco, and Prof. J. F. Danielli (King's College, London), honorary secretary of the Institute of Biology, summed up. The latter said that, from the papers presented at the symposium, it was apparent that individual deserts present a multitude of different problems. Scientific investigation must precede development; but in most cases the major difficulties are social, moral and political, and present problems of ethics rather than of science.

The proceedings of the symposium will be published by the Institute of Biology, Tavistock House South, W.C.1. Prof. R. D'O. Good has very kindly read through this article in manuscript.

J. L. CLOUDSLEY-THOMPSON

NEWS and VIEWS

Mechanical Engineering in Manchester: Prof. Jack Diamond

THE Council of the University of Manchester has announced the appointment of Mr. Jack Diamond to the first chair of mechanical engineering in the Faculty of Science. This is additional to the Beyer chair (founded in 1868 and first held by Osborne Reynolds) and the chair of electro-technics (1912). In addition there are also, in the Faculty of Technology, chairs in both mechanical and electrical engineering, established when that Faculty was established in the Manchester College of Technology in 1905.

Mr. Diamond's early training was followed by an apprenticeship at H.M. Dockyard School, Chatham, from which he proceeded to the City and Guilds College, London, as a Whitworth Scholar in 1932. In 1935 he was awarded first-class honours in mechanical engineering and was elected to a Senior Whitworth Scholarship. This he held for the next two years at St. John's College, Cambridge, where he undertook research in heat transfer; he was awarded the degree of M.Sc. in 1937. Mr. Diamond was then appointed a demonstrator in mechanical sciences in the University of Cambridge and a supervisor in St. John's College, resigning in 1939 on taking a temporary commission as an engineer officer in the Royal Navy. Three years later he was appointed assistant to the Engineer Manager of Rosyth Dockyard and, after becoming a temporary lieutenant-commander (E.), retired from the service in 1944 to become a senior scientific officer in the British Atomic Energy Team at Montreal. Since 1946, he has been a senior principal scientific officer at the Atomic Energy Research Establishment at Harwell, working on the design and development of nuclear reactors and on associated heat-transfer problems.

Seventieth Birthday Anniversaries: Profs. J. Franck and M. Born

ON August 26, 1952, Prof. James Franck, the director of the Fels Fund research in the University of Chicago, and formerly of Gottingen and the Johns Hopkins University, celebrated his seventieth birthday. A tribute in honour of his birthday appears in the July number of the *Reviews of Modern Physics* (24, 117; 1952). It is contributed by Prof. Peter Pringsheim, of the Argonne National Laboratory, Chicago, and consists of a short biographical article describing briefly Franck's numerous scientific achievements. Born in Hamburg, Franck studied chemistry in Hamburg and Berlin, and was appointed in 1920 to the chair of physics at Gottingen. During the thirteen years that followed, Gottingen became under Franck's direction one of the most important centres of research in atomic and molecular physics, a happy and brilliant period which was brought to an abrupt end when Hitler assumed power in Germany. Throughout his whole career, Prof. Franck's work has been characterized by a simplicity in experimental apparatus and principle: the well-known Franck–Condon principle is but an application of the law of conservation of momentum, and the Franck–Hertz experiment of 1914, for which Franck obtained the Nobel Prize a few years later, was a straightforward experimental confirmation of Bohr's atomic theory. The study of fluorescence has been Franck's main occupation, and from that he has been led more recently into the important field of research in photosynthesis. Finally, Prof. Pringsheim singles out for special mention Franck's two outstanding qualities, his obsession for science and his inexhaustible kindness. As a further tribute and one emanating from Gottingen itself, Profs. M. von Laue and R. W. Pohl, the editors of the *Zeitschrift für Physik*, have collected together in the number for September 15 (133, 1; 1952) a series of articles specially contributed by colleagues and friends of Prof. Franck and of Prof. Max Born, of the University of Edinburgh, who also celebrates his seventieth birthday this year, on December 11. Most of the articles are in German, but several are in English.

The Pharmaceutical Society: Hanbury Memorial Medal

THE Pharmaceutical Society has awarded the Hanbury Memorial Medal to Prof. Gösta Edman, professor of botany and pharmacognosy in the Royal Pharmaceutical Institute, Stockholm. This Medal is given periodically for "high excellence in the prosecution or promotion of original research in the Natural

History and Chemistry of Drugs". Prof. Edman's investigations have dealt with several aspects of drugs of vegetable origin. These include studies of the ash content and the presence of silica in drugs and the application of chemomicroscopical tests. His numerous microscopical studies of structure have been directed towards the discovery of adulteration, and to the identification and standardization by structural characters of crude vegetable drugs both in the unground condition and in the form of powder. The Medal will be presented at a meeting of the Society on February 9, when Prof. Edman will give an address entitled "Ash Pictures in the Identification and Assay of Vegetable Drugs".

American Academy of Arts and Sciences: Rumford Medals

RUMFORD MEDALS of the American Academy of Arts and Sciences have been awarded to the following: Prof. Enrico Fermi, of the University of Chicago, for his studies of radiation theory and nuclear energy; Prof. Willis Eugene Lamb, jun., of Stanford University, for his studies of the atomic hydrogen spectrum; and Prof. Lars Onsager, of Yale University, for his contribution to the thermodynamics of irreversible flow. The bicentenary of the birth of Benjamin Thompson, Count Rumford, will be celebrated by the Academy in Boston during March 26–28, 1953, when the Medals will be presented and conferences arranged on the fields of science represented by the recipients. Rumford was born at Woburn, Mass., now a suburb of Boston, on March 26, 1753, and in 1796 he gave a fund to the Academy to be used for the awarding of gold and silver medals to encourage scientific investigations in the field of heat and light. To date forty-eight Rumford Medals have been awarded.

American Section of the Society of Chemical Industry: Perkin Medal

THE American Section of the Society of Chemical Industry has awarded the Perkin Medal for 1953 to Dr. Charles Allen Thomas, president of Monsanto Chemical Co., St. Louis, and chairman of the board of directors of the American Chemical Society. The Perkin Medal, of which this is the forty-seventh award, is given for outstanding achievements in applied chemistry and was founded in 1906, being first awarded to Sir William Henry Perkin in commemoration of the fiftieth anniversary of his synthesis of mauve, the first synthetic dye. Dr. Thomas has made outstanding contributions to many phases of industrial chemical development—including the atomic energy programme; several phases of the pioneer development and general utilization of anti-knock, high compression fuels for internal combustion engines; important contributions to knowledge of the chemical reactions of hydrocarbons in the presence of catalysts, particularly aluminium chloride; synthesis of resins and other useful products from petroleum and its by-products; and fire-fighting devices and methods—as well as for his leadership in both the profession and industry of chemistry.

Sheep Biology Laboratory, Prospect, New South Wales

A NEW Sheep Biology Laboratory has recently been set up at Prospect, near Parramatta, New South Wales, by the Commonwealth Scientific and Industrial Research Organization, and Prof. C. W. Emmens has been appointed as officer-in-charge. Prof. Emmens has a distinguished record as an animal physiologist and was for many years engaged on research at the National Institute for Medical Research, London; concurrent with his new post, he will continue his present work as professor of veterinary physiology in the University of Sydney. The Prospect Laboratory will concentrate on problems of fertility and reproduction, the physiology of wool production, and sheep breeding and genetics, and it is hoped eventually to build it up as a leading world centre of information on all scientific data relating to sheep and wool husbandry, particularly the Merino and other types specially evolved in Australia. A balanced programme of both laboratory studies and field investigation is planned to develop the potentialities of healthy sheep in terms of quality and quantity of fleece, higher lambing percentages and the breeding of specialized types. Linked with the central Laboratory will be a series of sheep and wool field-stations in the major wool-producing regions, equipped to study all relevant aspects of soils, pastures, animal husbandry, disease control and plant and animal management. The Laboratory is being established on an area of 130 acres which has been carefully selected to provide good potential for pasture management and improvement and space for the cultivation of fodder crops. The full building programme will not be complete for some time, but sufficient laboratory accommodation and animal houses, feed stores, fleece and shearing sheds are now available in prefabricated buildings to enable research to be started.

Abstracting Board of the International Council of Scientific Unions

THE International Council of Scientific Unions has set up an Abstracting Board (Bureau des Résumés Analytiques du C.I.U.S.) with the purpose of facilitating the work of existing well-established journals publishing abstracts of original papers in the field of the natural sciences (see p. 960). A beginning has been made in the field of physics, and two member journals, *Physics Abstracts* and the *Bulletin Analytique*, are represented on the Board. In principle, any journal can seek membership to the Board, which is constituted, under a neutral chairman, of representatives of the interested International Unions and representatives of the member journals, together with the secretary-general of the Council as an *ex-officio* member. The present constitution of the Board is as follows: *Chairman*, Dr. Verner W. Clapp (assistant librarian, Library of Congress); *Secretary*, Prof. G. A. Boutry (Paris); *Members*, Dean Elmer Hutchisson (Case Institute of Technology), representing the International Union of Pure and Applied Physics, Dr. J. H. Ashery, representing *Science Abstracts*, Dr. G. Kersaint, representing *Bulletin Analytique*, Prof. A. V. Hill (secretary-general of the International Council of Scientific Unions). Dr. L. H. Lampitt sits as an observer for the International Union of Pure and Applied Chemistry. The offices of the secretariat are at the Institut d'Optique, 3 Boulevard Pasteur, Paris 15e, where work has already begun with the aid of a special subvention from Unesco. The secretary of the Board will gladly give any information desired about the facilities which can be extended to member journals.

Preservation of the Peak District

THE annual report for the year up to May 1952 of the Sheffield and Peak District Branch of the Council for the Preservation of Rural England (pp.

28; from the honorary secretary, Mrs. Gerald Haythornthwaite, Endcliffe Vale House, Sheffield 10; 1952), after expressing disappointment that the Government's nominees on the Joint Board for the Peak District National Park should include so few with knowledge and experience of rural preservation in the region, stresses the major threat to the Peak constituted by the unlimited demands of the limestone industries to encroach upon the National Park. The Joint Board has adopted the policy that, while quarrying in the Park cannot be excluded, demands should receive the closest scrutiny; but the Joint Committee for the Peak District National Park considers that, in view of proposals to demolish Eldon Hill and to extend the Tunstead Quarries eastward so as to destroy Meadow, Wormhill and ultimately the exquisite series of dales from Peak Forest to Millersdale, the time has come to make a stand for the very existence of the Park and of the Peak. Open-cast coal-mining still constitutes a threat at Wentworth Woodhouse and in the Cordwell valley, and East Derbyshire continues to lose farmlands and woods at a disastrous rate. Action has also been necessary in regard to Sheffield's Green Belt, on which housing proposals threatened encroachment, as does the Sheffield Development Plan, which fails to indicate Green Belt land as such. In conjunction with the Don Valley Amenities Society, steps have been taken to restore the lost beauty of this Valley, and the first hardwood trees of the Wharncliffe State Forest were planted during November 1951. In spite of protests, the Government has approved the use by the War Department as a training-area and mortar-range of 2,700 acres north of Upper Hulme and west of Staffordshire Roaches in one of the wildest parts of the National Park, and this is a serious loss to amenity.

Journal of the Mechanics and Physics of Solids

The first number of a new periodical entitled *Journal of the Mechanics and Physics of Solids* (1, No. 1, pp. 76; 90s. per vol. (4 Nos. per vol.); London: Pergamon Press, Ltd.) appeared in October under the joint editorship of Dr. R. Hill, of the University of Bristol, and Prof. W. M. Baldwin, jun., of the Case Institute of Technology, United States. The setting-up of this journal, under a distinguished advisory board, marks a further step in the emergence of studies of solid deformation from the general wide background of physics, mathematics, physical chemistry and metallurgy. The process has been detectable for some years, and notably so since 1945, during which time a vigorous development in solid-state physics, strongly led by physicists in Great Britain and in the United States, has transformed the whole approach to the mechanics of crystals. During these years, the same fundamental problem of elucidating the mechanisms of the deformation of materials and aggregates of various kinds, both metallic and non-metallic, has engaged the attention of research workers in every branch of pure and applied science, and the result of these researches is scattered throughout the literature. The more general that deformation phenomena and theories are discovered to be, the greater does the need become for some common channel of expression. There certainly exists, then, a strong reader-demand for a publication on these lines. As for the writer of research papers, it may be said that the subject with which this new journal is concerned had grown far too large for the journals that already existed. Further, and quite simply, the subject is worthy of a journal of its own. It is clearly not the concern of a publication devoted in the main to fundamental research (and this would appear to be the case to judge from the first issue) to seek any sort of justification for its activities on practical grounds; fundamental research is its own justification. Yet those concerned with the technological development of modern machines (the word is used in its widest sense) know well that the old materials have been exploited to the limit, and far beyond the limit, and that the primary barrier to advance is not the design of successful machines, but their fabrication, for present materials cannot contain them. The importance of the subject is thus in no doubt. Pure and applied science will surely welcome the appearance of this new journal as both timely and valuable.

Fiftieth Volume of the *Journal of the Bombay Natural History Society*

On September 15, 1883, five Scotsmen, one Englishman and two Indians met in Bombay and formed a society for the study of natural history, and this was the beginning of the Bombay Natural History Society. Three years later, though the membership was still small and confined to the residents in or near Bombay, the Society decided on the bold step of starting a journal. At this time there was only one periodical in India—the *Journal of the Asiatic Society of Bengal*—for the publication of papers on zoology and botany, and these, as a rule, of a strictly scientific character. The aim of the editors of the Bombay *Journal* has always been to publish not only scientific papers but also articles of a more popular character, and at the same time to encourage members to contribute short notes on any subjects of interest. How successful they have been is shown by the long series of volumes—the fiftieth of which has now been issued (50, No. 4; from the Society, 114 Apollo Street, Bombay). Many of the volumes run into more than a thousand pages and contain papers of great importance by specialists as well as popular articles such as "A Popular Treatise on the Common Indian Snakes", and the "Beautiful Flowering Trees of India", while the short notes from members have thrown much light on the distribution, etc., of both plants and animals. Though in the main the contributions to the *Journal* have dealt with the fauna and flora of India, Burma and Ceylon, there have also been a few on countries beyond these boundaries, such as "A Survey of the Fauna of Iraq" started during the First World War. At one time the membership of the Society numbered more than two thousand, and copies of the *Journal* were in practically every club and mess in India. Since 1947 the membership has decreased, but the standard of the *Journal* is as high as ever; and for this the editors are to be congratulated.

A Diffusion Reaction Theory of Morphogenesis

In a recent publication, "The Chemical Basis of Morphogenesis" (*Phil. Trans. Roy. Soc.*, B, 237, 37; 1952), Dr. A. M. Turing has advanced the theory that a system of chemical substances, described as morphogens, reacting together and diffusing through a tissue, may account adequately for some of the main phenomena of morphogenesis in plants and animals. The biochemical system in an embryonic tissue, envisaged as being initially quite homogeneous, that is, with a homogeneous distribution on the morphogens, may be 'triggered off' by some random disturbance ; the system then becomes unstable, the distribution of the morphogens becomes heterogeneous and later a pattern or structure may develop. Such diffusion reaction systems are considered in the hypothetical case of a ring of cells. Using the digital computer, Turing has shown that in such a system the onset of instability may take six different forms, of which the most interesting form, from the point of view of morphogenesis, consists in the development of stationary waves on the ring. This would be equivalent to the accumulation of one of the morphogens at evenly distributed points on the ring, and might account for such developments as the tentacle pattern in *Hydra* and for whorled phyllotaxis and similar phenomena in plants. A system of reactions and diffusion on a sphere, which is also considered, could account for gastrulation, while another reaction system in two dimensions yields patterns resembling dappling. There are also indications that stationary waves in two dimensions may account for phyllotaxis. Basically the theory does not involve any new hypotheses ; but, assuming a gene-controlled metabolic system, it suggests that certain well-known physical laws are sufficient to account for many of the facts of morphogenesis.

Plant Raw Materials

The new botanical journal, *Materiæ Vegetabiles* (editors, Drs. C. Regel and Fr. Tobler ; published by Dr. W. Junk, The Hague), of which the first number has just been issued, is essentially utilitarian in its aims. The journal, in fact, "will be dedicated to the whole domain of vegetable raw materials", and it will contain papers in which research, cultivation, extraction, amelioration, preparation and utilization are treated in their mutual relationships. The literature of plant products appears either in book-form or widely scattered in botanical, agricultural, technical, chemical and trade journals. The new journal will provide a means of bringing these important practical contributions together under one cover, and by so doing should make for a stimulation of research into the better production and wider utilization of plant products. The present number includes papers on such diverse topics as the value of Karoo veld in stock raising, flax as an oil and fibre plant in La Plata territory, the scientific basis of improved rosin production, cæsalpinias as sources of tannin, the effect of manuring on fibre content in *Yucca*, the significance of terpene accumulation in plants, and the utilization of fibre from the stems of edible bananas. The subscription for the volume of four numbers is 40 Dutch guilders.

Library of the National Institute for Research in Dairying, Shinfield

No. 4 in the Library Association series of pamphlets, "The Development and Administration of a Special Library", by C. H. Tomalin, is an account of the Library of the National Institute for Research in Dairying, Shinfield, Reading (pp. 36 ; 1951. 5*s*. or 3*s*. 6*d*. to members). It gives a brief account of the present stock of the Library and of the administrative methods in use, as well as of the development of the Library from the founding of the Institute until the new Library building was opened in October 1934. Primarily the Library exists to serve the scientific staff of the Institute; but it is also much used by scientific workers visiting the Institute. A card index is maintained which records all significant papers in dairy research published since 1920.

Symposium on Food Supplies

The Nutrition Panel of the Food Group of the Society of Chemical Industry is arranging an extended symposium on "Food and the Future", which will be discussed at a series of four meetings, to be held during the period December 1952–April 1953, when the topics will be, respectively : the problem of future world food supply ; present methods of attack on the problem ; new natural sources of foodstuffs ; and synthetic food potentialities. At the end of the series, Dr. Norman C. Wright, scientific adviser to the Ministry of Food, will sum up the discussions. The first of these meetings will be held in the rooms of the Chemical Society at Burlington House, Piccadilly, London, W.1, at 6.15 p.m., on December 10, when Mr. F. Le Gros Clark will deal with a general statement of the problem of future world food supply under the title "The Yardstick of Population", and Dr. E. W. Russell will consider "Limitations affecting the World Food Supply". Visitors will be welcome. The honorary secretary of the Panel is L. C. Dutton, Virol, Ltd., Hanger Lane, Ealing, London, W.5.

Announcements

H.R.H. The Duke of Edinburgh has accepted election to honorary membership of the Institution of Mining and Metallurgy and also of the Institution of Gas Engineers.

Dr. G. R. de Beer, director of the British Museum (Natural History), has been elected *correspondant* of the Section of Anatomy and Zoology of the Paris Academy of Sciences in succession to the late T. O. J. Mortensen.

The following appointments have recently been made in the University of Sheffield : Dr. J. White, senior lecturer in refractories, to be reader in ceramics ; Dr. A. S. Gladwin, to be lecturer in electrical engineering.

The following announcements have been made from the University of London : the title of reader in mechanical engineering applied to mining in the University has been conferred on Dr. William Davies, in respect of the post held by him at the Imperial College of Science and Technology ; the degree of D.Sc. has been conferred on Mr. Dan Lewis, an internal student at the John Innes Horticultural Institution.

The Textile Institute, under the terms of the Cotton Industry War Memorial Trust, awards scholarships to young craftsmen in the cotton industry, which are designed to cover the cost of a three-year full-time university degree-course in textiles. Two such awards have just been made, to N. Clark (Stalybridge, Cheshire) and R. M. Watson (Manchester), respectively, both of whom have elected to go to the Faculty of Technology of the University of Manchester. This scholarship scheme was started in 1930, and to date ten awards have been made.

The annual conference of the Geographical Association will be held at the London School of Economics, Houghton Street, London, W.C.2, during December 31, 1952–January 3, 1953. The programme will include business meetings, lectures, discussions, reports and special visits to places of interest. There will also be exhibitions by the various sections of the Association and displays of books, visual aids and other educational equipment. Further information can be obtained from the honorary conference organizer, Dr. W. G. V. Balchin, of King's College, Strand, London, W.C.2.

THE PLACE OF THE SCIENTIST IN CIVIL DEFENCE

ON the evening of October 16, the London and South-Eastern Counties Section of the Royal Institute of Chemistry, the London and Home Counties Branch of the Institute of Physics and the Institute of Biology met in the City of London School to discuss the place of the scientist in civil defence. Speaking from the chair, Dr. C. W. Herd, chairman of the local section of the Royal Institute of Chemistry, said the meeting had been arranged to enable members to state their views on the employment of scientists in civil defence, and, so that they might hear something from the official angle, he was glad to introduce the Director-General of Training and the Scientific Adviser to the Home Office and also the honorary scientific advisers from the London Civil Defence Region.

In outlining points which were causing anxiety, Dr. Herd said he would be expressing personal views; but these were based on many discussions with professional colleagues, so he thought they would be typical of the opinions of many members present. During the Second World War, there was a good deal of dissatisfaction over the status of gas identification officers in relation to other branches of civil defence. To-day he felt that official recognition of the professional standing of chemists, physicists and biologists recruited for technical reconnaissance was inadequate to enable the services of these officers to be utilized effectively. This resulted in a sense of frustration among the officers concerned and might even prevent some from offering their services. Senior technical reconnaissance officers should, in their special field, be recognized as competent advisers to civil defence controllers. At present, to be quite frank, he said, professional men ack confidence in the scientific side of civil defence at local-authority level, and this confidence must be built up if the scheme is to be a success.

After referring to other points which on present evidence seem unsatisfactory, Dr. Herd said he thought he duty of the technical reconnaissance officer should be first to the public, to inspire confidence and maintain morale; secondly, to the civil defence controller o advise on scientific and technical matters; thirdly, o direct technical reconnaissance; and, finally, to ollect scientific and technical information for transmission to regional advisers. He suggested that a enior technical reconnaissance officer should be free o gather around him all scientists in his district and o give them technical information and training, so hat there would be a pool of trained men available o deal with any emergency in addition to those fficially recruited to the headquarters establishment. Potential recruits should now be reassured regarding heir status in the corps and their method of recruitment, with full information of the nature of their uties and the amount of training they would have o undertake. Regarding training, they should not e expected to attend very elementary lectures on echnical subjects. Once in the corps, interest should e maintained through periodic meetings officially rganized to keep them up to date in their subjects. uch meetings should not be left to the initiative of he officers themselves as happened during 1939–45.

Prof. W. V. Mayneord, one of the London regional scientific advisers, said that scientists ought to remember they are all primarily citizens, so that many of their duties are the same as other members of the community, even though the highly technical nature of modern warfare throws a special responsibility upon them. The contribution a person could make to civil defence depends upon his general training, and a physicist's first approach to the problem should be in the direction of quantitative studies of the effects of weapons in different circumstances. Such work could help the scientists officially employed on this type of research. The first thing to remember about the atomic bomb is the fear of the unknown that such a weapon creates. The trained scientist should therefore make himself as well informed as possible on all aspects of the subject, so that he might win the confidence of the public and do valuable work by allaying unwarranted fears.

Prof. Mayneord then dealt with the technical aspects of an atomic explosion, pointing out that radiation effects, though of great scientific interest, are likely to be only of secondary importance in causing casualties. Existing knowledge could be used to assess the relative values of different materials in building structures as protection against the penetration of radiation. Similarly, knowledge of the dose required to produce specific effects could be used to determine the circumstances in which the civil defence services could work in complete safety or when, in emergency, a calculated risk might be deliberately accepted. The scientist could be of value in the training of non-technical people, especially in designing the form which such instruction should take, as this is most important. To sum up, the scientist in civil defence should make himself a competent adviser in whom his controller will have full confidence, and in reconnaissance work the aim should be accurate observation and reporting of significant facts followed by informed interpretation of this information, so that it could be quickly and effectively used in dealing with the tactical situation.

Prof. H. N. Rydon who, until his recent appointment to Manchester, was also one of the scientific advisers in the London Region, then discussed the nature and magnitude of the problems resulting from the use of biological and chemical warfare. By the end of the Second World War, a new group of chemical agents had been developed in Germany, namely, the nerve gases, the characteristics of which he then described, pointing out the high toxicity of some of these in both the liquid and vapour phases. A satisfactorily sensitive test for detection has been developed, and civil defence services will be provided with a vapour detector kit capable of identifying the vapour of either mustard gas or the nerve gases in the required concentrations. The technical reconnaissance officer will be responsible for gas detection in the field and for advice on any measures required to deal with the situation resulting from an attack with chemical agents. He must in addition always be on the look-out for unusual effects, for it cannot be assumed that new and even more toxic agents will not be discovered. Systematic study of the behaviour of war gases in cities would be of the greatest importance, for there is no practical experience of their use in such circumstances. The role of the trained chemist in collecting such data would be of great value to the scientists at regional and government headquarters, and would also be of value to the Armed Forces.

The effectiveness of biological warfare, Prof. Rydon said, is still unknown; but he thought the wild stories about a single bomb causing a widespread epidemic could be dismissed as fantastic. Comparatively little is yet known about the precise conditions required for initiating an epidemic; but it is known that to cause one deliberately at a selected time would be very difficult. Advances in the development of new drugs and antibiotics also reduce the possible choice of agents which might, even theoretically, be expected to achieve such an object. The standard of hygiene in modern organized communities is another factor which reduces the chances of epidemics being successfully initiated by attack from the air. Sabotage might perhaps remain a possibility; but this method would be localized in its effect and more amenable to control. If the epidemic idea be dismissed, biological warfare may be regarded as an exaggerated form of chemical warfare with agents having a toxicity greater than any of the war gases by a factor of tens; but against this the chances of people receiving an effective dose are probably reduced by a factor of a similar order. Biological warfare is a possibility with which civil defence must be prepared to deal; but there are still many problems connected with the choice of suitable agents and finding effective methods of using them, so that the chance of its success as a method of waging war may still be problematical. Whereas the potentialities of chemical warfare can be evaluated with fair accuracy, biological warfare is still an untried weapon.

In preparing to meet such threats, the services of trained chemists would be invaluable, and Prof. Rydon hoped that as a result of the meeting there would be a good response from chemists. The chemist could adequately perform many of the tasks connected with atomic and biological warfare as well as those in the chemical field, for his training puts him in a category intermediate between the physicist and the biologist. He hoped no one would withhold his services under the impression that civil defence is a purely passive function. The application of scientific advice could go a long way towards defeating an enemy's objective by minimizing the effects of his weapons, and this could at times be as important as the active operations of offensive warfare.

Sir John Hodsoll, director-general of training in the Civil Defence Department of the Home Office, said he could sympathize with what had been said about the Second World War, for some gas identification officers had undoubtedly been put in a difficult position; but it was hoped to benefit from the lessons which had been learnt. As to background, it was not intended that technical reconnaissance officers should take full basic training, and if this had occurred in some cases it must have been due to misunderstanding. In peace-time, scientists can make a valuable contribution by local studies designed to define the tactical problems resulting from different forms of attack.

In the civil defence organization there would be a chief reconnaissance officer at all control and sub-control centres, and he or his deputy would always be a technical reconnaissance officer, so that the controller would always have advice immediately available on the technical aspects of any problem. As regards recruitment, it is recognized that difficulties may have to be smoothed out in some cases; but it is in the local division that the technical reconnaissance officer is needed, so he must be part of the local organization. If success in any future war is to be achieved, civil defence services must be organized and trained now; for if the civilian population should give way a war would be lost even though the main military forces with all their equipment and resources still remained virtually intact. The real way to achieve this object is to see that knowledge of the right kind is available to all who should have it, and in this task the scientist can perform a most valuable work in creating the right attitude of mind among the general public.

The meeting was then thrown open for questions and general discussion, and many of the speakers elaborated the points made by the chairman in his opening address, particularly regarding the status of technical reconnaissance officers and their method of recruitment. Several speakers thought recruitment could be more effectively dealt with by making more use of the professional institutes. One speaker said that these particular difficulties are not universal, for, during the Second World War and again in the new arrangements, his relationship with his local authority was most satisfactory. Much emphasis was laid on the importance of giving scientific people the full technical details in all information furnished to them. A suggestion was made that an attack with biological agents after a heavy attack with high explosive might well produce an epidemic, since the standard of hygiene would be sub-normal and sanitation services would be disorganized. A question was asked about the arrangements for liaison with medical services, as some members feared that in certain circumstances difficulties were likely to arise. Another suggestion was made that radiotherapists, who had not apparently been considered for reconnaissance work, could be of value in the assessment of radiological hazards.

Sir Charles Ellis, senior scientific adviser in the London region, stressed the importance of the operational research approach to the type of problems which the technical reconnaissance officer would have to study. People trained to observe phenomena closely and to collate and interpret the data obtained could contribute a great deal to civil defence, and, whatever this type of work be called, such an officer should in effect be an operational research worker.

Dr. E. T. Paris, scientific adviser to the Home Office, in his summing up of the proceedings before answering some of the questions, said that the Home Office was much indebted to the three Institutes for organizing the meeting. Note would be taken of the points which had been made, and he was sure the discussion would be of value in further consideration of the problems involved. The need for scientists in civil defence had been clearly shown, as was confirmed by the discussion, since acceptance of the principle was implicit in the remarks of all speakers, however critical they might be on specific details.

The status of scientists in civil defence, Dr. Paris said, appears to be causing much anxiety. The position is that there are two distinct levels at which scientists are employed. The regional scientific advisers would assist the regional commissioners on all appropriate matters in each region, and in addition would have laboratory facilities and trained staffs for dealing with samples received from local authorities. On technical matters, they would work in direct collaboration with the Home Office and the appropriate Ministry of Supply research establishments. At the next level, the technical reconnaissance officers are in the headquarters section of the local division so that, as Sir John Hodsoll had explained, they are part of the local authority's organization and must in the long run be recruited through that machinery, though he would take note of the difficulties mentioned. The plea for full technical information was one with which every scientist would sympathize; though there is no secrecy in civil defence as such, it has to be recognized that information of a secret nature is used in the Home Office in the study of civil defence problems, so that it is not possible to pass on some kinds of information. From his own experience, he agreed with the principle that secret information should be given only to those who must have it in order to carry out their duties. He did not think there is any greater likelihood of an epidemic resulting from biological warfare attack after an attack with high explosives than in other circumstances. In any event it is necessary to guard against the tendency to conjure up complicated defence problems by piling one form of attack on another. A very great effort is required to deliver a modern attack on an effective scale, and any complication of the kind suggested must reduce the effectiveness of the first attack without greatly increasing the chance of the second attack being more effective than if it had been delivered alone on the appropriate scale.

Suggestions had been made about the possibility of the atomic bomb being 'played down' unjustifiably, and in particular a question was asked how this could be reconciled with the casualty figures published after the visit of the British Mission to Japan. There was no intention of minimizing the potentialities of the bomb; but what had been attempted was to show how the number of resultant casualties might vary in different circumstances. For example, if it was assumed that an unwarned attack on a city with the population all exposed in the open would result in, say, 50,000 casualties, then it could be shown that if everybody was in houses of an assumed standard of construction the casualties would be reduced to 30,000 under the same attack; and again, if they were all in special shelters of a specified standard of protection, the casualties would fall to 10,000.

In conclusion, Dr. Paris said the discussion had served a most useful purpose in providing evidence of the kind of difficulties that might arise in setting up the reconnaissance service, and of the lines on which interested scientists were thinking on these matters. Since the meeting, he has agreed to consider the problem in consultation with the three Institutes which organized the discussion. J. W. MARTIN

THE ALEMBIC CLUB

By PROF. JAMES KENDALL, F.R.S.

ON October 29, 1889, the five non-professorial members of the teaching staff of the Chemistry Department in the University of Edinburgh formed themselves, under the title of "The Alembic Club", into "an unassuming body which was destined later to play a useful part in bringing historical material connected with chemistry within the reach of interested readers". In order of seniority, the original members of the Club were:

1. John Gibson. The originator, with Prof. Crum Brown, of the famous Crum Brown–Gibson rule for determining the position of radicals entering a substituted benzene nucleus. Professor of chemistry in the Heriot-Watt College, Edinburgh, 1892. Died in 1914.

2. Leonard Dobbin. Distinguished for his research work in the history of chemistry and for his translations of Ladenburg's "Lectures on the History of the Development of Chemistry since the time of Lavoisier" (1900) and Scheele's "Collected Papers" (from Swedish and German originals, 1931). He was lecturer in chemistry in the University of Edinburgh, 1914; reader, 1920. Dr. Dobbin died in March 1952 in his ninety-fourth year. For seventy-one years he was a Fellow of the Royal Society of Edinburgh (Member of Council 1904–7 and 1913–16, Curator 1934–39, Vice-president 1939–42) and for more than sixty years a Fellow of the Chemical Society and the Society of Chemical Industry. Secretary of the Alembic Club from its inception to 1946, he was its guiding spirit throughout that long period.

3. Hugh Marshall. Discoverer of the persulphates: elected a Fellow of the Royal Society in 1904. After holding a lectureship in crystallography in the University of Edinburgh, he was appointed to the chair of chemistry in University College, Dundee, in 1908; he died in 1913.

4. James Walker. For many years the leading physical chemist of Great Britain. Professor of chemistry in University College, Dundee, 1894–1908, and in the University of Edinburgh, 1908–28. He was awarded the Davy Medal of the Royal Society in 1926, and the Gunning Victoria Jubilee Prize of the Royal Society of Edinburgh in 1932. President of the Chemical Society, 1921–23. Knighted in 1921 and died in 1935.

5. Alexander Smith. Famous for his research work on the allotropic forms of sulphur and for his series of text-books on inorganic and physical chemistry. Professor of chemistry in Wabash College, Indiana, 1890–94, in the University of Chicago 1894–1911, and head of the department of chemistry in Columbia University, New York, 1911–20. President of the American Chemical Society, 1911. Died in 1922.

Members elected afterwards were:

6. Ralph Stockman (1891). Professor of materia medica in the University of Glasgow, 1897–1936. Elected a Fellow of the Royal Society in 1889. Vice-President of the Royal Society of Edinburgh, 1939–42. Died in 1946.

7. James Kendall (1929). Professor of chemistry in Columbia University, 1914–26, in New York University, 1926–28, and in the University of Edinburgh, 1928 to date. Secretary of the Alembic Club since 1946.

8. Irvine Masson (1932). Professor of chemistry, University of Durham, 1924–38; vice-chancellor of the University of Sheffield, 1938–52. Knighted in 1950.

9. Oswald James Walker (1937). Formerly lecturer in chemistry, University College, London, now on the staff of Imperial Chemical Industries, Ltd. (Plastics Division), Welwyn Garden City.

At a very early stage in the existence of the Club, the important resolve was taken to publish some of the less easily accessible chemical classics in convenient form, as simple reprints (if in English) or as translations (if in a foreign language). It was fitting that the first of these "Alembic Club Reprints" should present in 1893 Joseph Black's world-renowned "Experiments on Magnesia Alba, etc.", in view of the author's occupancy for many years of the chair of chemistry in the University of Edinburgh. Succeeding reprints were: (2) "Foundations of the Atomic Theory", by Dalton, Wollaston and Thomson; (3) "Experiments on Air", by Cavendish; (4) "Foundations of the Molecular Theory", by Dalton, Gay-Lussac and Avogadro; (5) "Extracts from Micrographia", by Hooke; (6) "The Decomposition of the Alkalis and Alkaline Earths", by Davy; (7) "The Discovery of Oxygen", Part I, by Priestley; (8) "The Discovery of Oxygen", Part II, by Scheele; (9) "The Elementary Nature of Chlorine", by Davy; (10) "Researches on the Arseniates, etc", by Graham; (11) "Essays of Jean Rey"; (12) "The Liquefaction of Gases", by Faraday; (13) "The Early History of Chlorine", by Scheele and others; (14) "The Molecular Asymmetry of Natural Organic Products", by Pasteur; (15) "The Electrolysis of Organic Compounds", by Kolbe; (16) "Papers on Etherification, etc". by Williamson; (17) "Medico-Physical Works", by Mayow; (18) "Sketch of a Course of Chemical Philosophy", by Cannizzaro; (19) "The Foundations of the Theory of Dilute Solutions", by Van't Hoff and Arrhenius; (20) "Prout's Hypothesis", by Prout, Stas and Marignac; and (21) "On a New Chemical Theory, etc.", by Couper.

These twenty-one "Alembic Club Reprints" have enjoyed a steady sale (totalling more than 32,000) throughout the decades, and have undoubtedly proved of inestimable service to teachers, students and research workers in the domain of historical chemistry. They are issued by the Club's agents—E. and S. Livingstone, Teviot Place, Edinburgh—at a price just above the cost of publication, profits being deliberately restricted to a point that will permit the periodic replenishment of stock as particular numbers near exhaustion. No. 17 only is now out of print, because of its special expense.

In the months immediately preceding his death, Dr. Dobbin—frail in body, but with mind alert and unimpaired—became apprehensive as to the future of the Alembic Club, and the present secretary knew that he was acting as Dr. Dobbin himself would have desired when, with the approval of the other two surviving members, he proposed to the Council of the Royal Society of Edinburgh that the Council should accept the entire assets of the Club and the responsibility for the continuance of its series of reprints. This offer was cordially accepted by the Council on July 7, 1952, the general opinion being expressed that it would appear desirable not only to continue the existing reprints but also to extend the series by new issues of a similar nature in chemistry and adjoining fields of science. A committee was appointed, consisting of the president, the general secretary and the treasurer, to submit recommendations for the administration of the "Alembic Club Fund" on a broader and firmer basis under the ægis of the Royal Society of Edinburgh.

Before the Club passed under new management, however, its members decided to add to their number Norman Feather, professor of natural philosophy in the University of Edinburgh, in the hope that a precedent would thus be established ensuring the perpetuity of the Alembic Club within the Society.

The report of the Committee, approved by the Council on October 27, 1952, contained in fact a clause recommending that the Alembic Club should persist as a self-perpetuating body, fortified by the inclusion of the senior officers of the Society. Other recommendations were that an Alembic Club Prize of £50 should be awarded to a distinguished historian of science quinquennially, provided funds for it were sufficient, and that Alembic Club Lectures should be delivered at unspecified intervals. The first of such lectures will be formally entitled the Leonard Dobbin Memorial Lecture.

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

GENERAL ASSEMBLY IN AMSTERDAM

THE sixth general assembly of the International Council of Scientific Unions was held in the rooms of the Koninklijke Nederlandse Akademie van Wetenschappen in Amsterdam during October 1–3. Twenty countries were represented. Prof. H. R. Kruyt, president of the Division of Sciences of the Academy and a former president of the Council, welcomed the assembly on behalf of the Academy. He spoke of the importance of the work of the Unions with their freedom to organize scientific discussions unhampered by administrative and political influences, and pointed out that he has a special regard for the Council, having attended every meeting since 1922.

The president of the Council, Prof. A. von Muralt (Switzerland), thanked Prof. Kruyt for his welcome and the Netherlands Academy for its hospitality and help in arranging the meeting. He explained how his three years experience as president have given him a great respect for the Council and some of its activities; joint commissions, symposia, support of laboratories of international standing and of established scientific services, all are of great value at the present time. The Council owes a great debt to the United Nations Educational, Scientific and Cultural Organization (Unesco) for its financial aid, and it is glad to help the Organization to carry out part of its task; Prof. Muralt also acknowledged the help given throughout by Prof. Pierre Auger (head of the Natural Sciences Division of Unesco) and his staff. International congresses have begun to grow too large, partly owing to the great increase in the number of scientific workers and the rapid growth of fresh branches of science, and the point is being reached where the present organization is becoming inadequate. One must not be too reluctant to see new Unions formed, but this must lead to difficulties in the co-ordination by a central body. There must come a time when some federal groups should be formed, intermediate between the Council and its individual Unions. He felt obliged to mention one activity of the Council, namely, the starting of an abstracting board to help in improving what has become in many sciences a difficult situation. A limit has been set at first to one subject—physics (see p. 954 of this issue). One result of improved co-ordination between existing abstracting journals has been a considerable speeding-up of the publication of abstracts.

After a tribute to the work of the Council and its Unions on the scientific side, Prof. Auger pointed out a gap between the purely scientific aspects and the financial and administrative ones. Those responsible for the latter side, he said, do not always understand the needs of those responsible for the former. One instance of this is the lack of sufficient representation of science in the national delegations to Unesco. Prof. Auger put forward a proposal, which would be followed up in 1953, to form a scientific advisory committee on international scientific problems, and he thought that this might fill the gap.

Four countries which had joined the International Council of Scientific Unions since the last general assembly were then welcomed by the president, namely, Israel, Thailand, Spain and the German Federal Republic.

The International Mathematical Union was admitted as a new adhering organization. It was reported that the executive board had accepted provisionally an application from the Union of Physiology, and had not accepted applications from International Unions of Biochemistry, Nutritional Sciences, Scientific Psychology, Scientific Study of Population, and Philosophy of Sciences. A discussion followed in the case of the Union of Biochemistry, and it was agreed to recommend the continuance of discussions between representatives of the Union and of the Section of Biochemistry of the Union of Chemistry in the hope that an agreed solution of the problem might be found; a member of the Council would be ready to assist in these discussions as an independent observer.

Certain changes of statutes were made: these included the creation of the post of treasurer, to lighten the task of the general secretary; the removal of the figure of the annual contribution due from countries and unions from the statutes (power was given to the general assembly to fix it for three years at a time); and a tightening of the conditions governing the admission of newly formed Unions.

A discussion took place on the plans for an International Geophysical Year in 1957–58, a successor to the International Polar Years of 1882 and 1932. On this occasion observations would be made not merely in polar regions but also in low latitudes. The proposal came originally from the Joint Commission on the Ionosphere, but it was supported by the Unions of Astronomy, Geodesy and Geophysics, Radio-Sciences, Physics and Geography; the World Meteorological Organization is also co-operating. A small co-ordinating committee has been formed and it will meet very shortly, its convener being Col. E. Herbays, general secretary of the International Scientific Radio Union. Countries adhering to the Council have been asked to form national committees which would carry out the programme once it has been formulated, and the steering committee will, in due course, be enlarged. Other countries outside the Council are also being approached. Proposals for a redetermination of the network of world longitudes in the year 1957–58 were referred to the committee for inclusion in the general scheme. There was general agreement that a few special problems should be tackled: this was better than an attempt to gather a mass of observational data. As an example, the morphology of magnetic and ionospheric storms was mentioned by Prof. Berkner as a suitable problem. The year 1957–58 was selected as being one near sunspot maximum.

The assembly decided to urge its national adhering bodies to press for greater scientific representation on the national delegations to Unesco, and it also asked delegates to press for support of two international agreements drawn up by Unesco, on the importation and on facilitation of circulation of educational, scientific and cultural materials.

It was agreed to sever connexion with the Committee on Science and Social Relations, which has become a Joint Commission with the International Council of Philosophy and Humanistic Studies. The interests of the Committee had tended to move over from the purely scientific to the human and social side. After a discussion on the activities of the International Abstracting Board, it was agreed that to avoid confusion it should be known as the "I.C.S.U. Abstracting Board" or the "Bureau des Résumés analytiques de C.U.I.S.".

Sir Harold Spencer Jones, the Astronomer Royal, expressed the thanks of the assembly to the president for his distinguished services—the grace, humour and firmness with which he had presided over their meetings during the past three years, and also to the retiring general secretary, Prof. F. J. M. Stratton (Great Britain) for his devoted labours on behalf of the Council over a period of fifteen years.

The bureau of the Council for the next three years was elected as follows: *President*, Prof. B. Lindblad (Sweden); *Retiring President*, Prof. A. von Muralt (Switzerland); *Vice-Presidents*, Prof. H. Solberg (Norway) and Col. E. Herbays (Belgium); *Treasurer*, Prof. W. Albert Noyes (United States); *Secretary General*, Prof. A. V. Hill (Great Britain); *Members*, Prof. J. Pérès (France) and N. Kameyama (Japan).

SEVENTEENTH INTERNATIONAL GEOGRAPHICAL CONGRESS, WASHINGTON, D.C.

SINCE 1871 an International Geographical Congress has been held normally every three or four years, during the past half-century under the auspices of a continuing body, the International Geographical Union. The seventeenth Congress was held in Washington, D.C., during August 7–16 and attracted a record number of approximately fifteen hundred participants. Of these, more than twelve hundred were in personal attendance, and despite the difficulties of travel and dollar shortages some five hundred delegates from overseas countries were present, including approximately fifty from Great Britain.

To enable visiting delegates to see as much as possible of the work of their American colleagues, a number of other meetings were arranged at convenient times.

This is the centenary year of the American Geographical Society in New York, and the Society held open house during August 4–6 at its delightful premises in Broadway at 156th Street. At a special meeting of the Society, visiting scientific workers were honoured, Mr. J. M. Wordie, president of St. John's College, Cambridge, and president of the Royal Geographical Society and leader of the British delegation, receiving the Daly Medal.

During August 6–7 the Association of American Geographers and the National Council of Geography Teachers met simultaneously in Washington, D.C., and their meetings and joint banquet were attended by many delegates.

The attendance of so many from overseas in the United States was made possible by a generous provision of travelling fellowships and grants, particularly from the Wallace W. Atwood Senior Fund, administered with great generosity by his widow and family. Many American universities had previously arranged visiting professorships or lectureships, and those who gathered at Washington had, in many cases, already spent some time in different parts of the United States.

Nearly all the meetings were held in the Statler Hotel, where facilities had been arranged for a magnificent display of maps from many countries. After the official welcome, the opening general assembly and the official reception on August 8, the general arrangement was to have concurrent section meetings in the morning, and in the afternoons to have concurrent meetings of those commissions which had been carrying on the work of the Union since the preceding Congress at Lisbon in 1949.

Certain broad topics of current world importance were considered by a series of symposia, and for all these important meetings simultaneous translations into French, Spanish and English were available. The symposium on tropical Africa, under the chairmanship of Prof. Derwent Whittlesey (Harvard University), reviewed the progress of investigations in both the east and west. The necessity for continued study of those factors which naturally restrict possibilities of development was continually stressed.

Another symposium dealt with world food supply, and was under the chairmanship of Dr. C. E. Kellogg, chief of the United States Soil Survey. As so frequently happens, the speakers from the Old World, notably Prof. George Kuriyan (Madras), stressed the ever-present basic problem of shortage of land, whereas the speakers from the New World were concerned much more with technical problems of development or with economic aspects.

The retiring president, Dr. George Cressey (United States) gave his presidential address under the title "Land for 2·4 Billion Neighbors". The facts adduced leave no doubt that population is increasing far more rapidly than world food supply, and that the long-range solution, given the continued population increase, must be found in sources of food, for example from the sea, not yet regarded as practicable.

A large number of papers were presented at the section meetings which dealt respectively with geomorphology, the teaching of geography, climatology, urban and rural settlement, hydrography, resources, demography, cartography, biogeography, regional geography, historical geography, trade and transportation. In some marked contrast to previous meetings, there was strong support for the section on the teaching of geography, presided over by Prof. C. A. Alagoz (Turkey). Throughout the world there is the growing feeling that international understanding is threatened by the continued ignorance of the citizens of one country concerning the rest of the world, as well as, very often, ignorance of their home country. Instruction in this field is particularly weak throughout the schools and most of the universities of the United States; large gatherings of delegates pressed for a commission to examine the position and to make recommendations. Several of the sections showed an increasing awareness of the need for the application both of their methods of study and their research findings in the solution of some of the great problems of the day.

The same may be said of the afternoon meetings, when the reports of commissions, especially work carried out since the Lisbon Congress of 1949, were under consideration. The commissions reporting included those on industrial ports; medical geography (in the course of which Dr. Jacques May, head of the Medical Research Division of the American Geographical Society, displayed some of the magnificent maps he has in preparation); the international map of the world; regional planning; arid zones; world land use; periglacial morphology; and bibliography of ancient maps.

Normally a commission, limited to six full members, is appointed for one inter-congressional period but may, if its work is incomplete, be reappointed for a further period. No less than thirty-six proposals for commissions had to be considered by the executive, and many which might well have done useful work could not be appointed with any reasonable hope that even minimum financial support would be forthcoming. The final general assembly, having elected officers (see *Nature*, August 30, p. 347), set up eleven commissions to carry on the Union's work until the next Congress, which is planned to take place in Rio de Janeiro during August 1956.

The first four commissions are reappointments, and they are as follows (with the chairman shown in brackets): periglacial morphology (Prof. M. A. Cailleux, France); medical geography (Dr. Jacques May, United States); inventory of world land use (Prof. S. Van Valkenburg, United States); and bibliography of ancient maps (Prof. Roberto Almagia, Italy). A sub-committee on the study of arid zones was constituted as a full commission under the chairmanship of Dr. Peveril Meigs (United States). The new commissions are: coastal sedimentation (Dr. Axel Schou, Denmark); erosion surfaces around the Atlantic (Prof. Francis Ruellan, France); evolution of slopes, including relevant aspect of soil erosion (Prof. Pierre Birot, France, and Prof. Paul Macar, Belgium); geography in schools (Prof. Neville Scarfe, Canada); karst phenomena (Prof. Herbert Lehmann, Germany); and library classification of geographical books and maps (Prof. A. Libault, France).

The commissions are dependent to a considerable extent on the receipt of communications from those who are interested all over the world, and the chairmen may be communicated with through the secretary-treasurer of the Union, Dr. G. H. T. Kimble, American Geographical Society, Broadway at 156th Street, New York 32, N.Y. L. DUDLEY STAMP

INSTRUCTIONAL FILM RESEARCH

A SHORT account of the Pennsylvania State College Instructional Film Research Program was given last year in *Nature*[1], and now a report, written for this research programme, by Charles F. Hoban, jun., and Edward B. van Ormer, has been published*, which reviews the research work done on the instructional film during the thirty-odd years prior to June 1950 at the Pennsylvania State College, and also other work independent of it. In the preparation of this report more than two hundred experimental and survey studies have been examined and more than three hundred are noted in an appendix. These references are predominantly to sources of origin in the United States, where nearly all the research work has been done.

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* Instructional Film Research 1918–1950. Technical Report No *SDC* 269-7-19. Pp. 200. (Special Devices Center, Port Washington L.I., N.Y.)

Systematic criteria have been applied by the authors in making a selection from the material they have examined. Summaries of all suitable studies, grouped together in relation to various aspects of the instructional film, and the interpretations arising from each group, form the bulk of the report.

General findings previously reached by the Pennsylvania organization have much influenced the theoretical basis for the grouping of these summarized studies. In the present article some of the items in this new report that have not been mentioned before, or stressed, in the Pennsylvania Technical Reports will be indicated.

The film's contribution to comprehension, rather than to rote memory, constitutes one such item. People taught with films are found to be better able to apply their learning than people who have had no film instruction. In tests carried out by P. J. Rulon[2], pupils taught by text-plus-films excelled those taught on a text-only basis by a larger margin on 'eductive' than on 'rote' questions, the ratio being 24·1 to 14 8 per cent. Performance on eductive questions could be predicted more accurately from a knowledge of mental ability and previous achievement than could performance on rote questions. Differences between rote and eductive scores were in the same direction as differences between verbal-test and picture-test scores. From this Rulon concluded that "picture tests measure eduction to a greater extent than do the verbal tests". The contribution of films to comprehension is borne out by the work of P. E. Vernon[3], who conducted an experiment on the value of the film and filmstrip in the instruction of adults. and of J. J. Gibson[4], both of which are also summarized. In Rulon's investigation the superiority of the text-plus-films over the text-only group was found to be greater three and a half months after the films had been shown than it had been immediately afterwards. Several other summarized studies show the contribution of films to a long-term retention of knowledge.

There can be symbolic or mental practice when learning a motor skill from films. Verbal formulations seem greatly to facilitate learning for some individuals. These matters—linked to the larger one of the relationship between language and thought—affect practically the part that can be played by speech in films. The work of M. A. May[5] on the psychology of learning from demonstration films, W. E. Twining[6] on mental practice and physical practice in learning a motor skill, H. A. Ruger[7] on the psychology of efficiency, and several others, is summarized and considered.

Based on the evidence of all the studies, generalization is attempted in the last chapter of the report. According to the authors, people learn more quickly, and retain better what they have learnt, when appropriate films are used than when they are not used. More learning results from a combination of films with other instructional means than by either alone. The learning from films may be of facts, of motor skills, of concepts leading to increased comprehension, and of concepts leading to the formation of attitudes and opinions. Moreover, instructional films stimulate other learning activities. It is possible for a film to be equivalent "even to an excellent instructor in so far as the instructor's function is communicating the facts or demonstrating the procedures presented in the film".

"Films have greatest influence when their content reinforces and extends previous knowledge, attitudes, and motivations of the audience." Three of the ten principles of film-influence again stress the need for specific and confined objectives when designing instructional films, including careful regard for the characteristics of the audience. Four other principles are more distinctively related to the film medium: the influence of films is primarily in their visual presentation; pictorial context is important; the treatment of a film should generally be subjective; and the rate of putting forward new facts and ideas should be properly regulated. In the final principles the importance of introductions, summaries, etc., either built into a film or provided by the teacher, and of the teacher's leadership, are emphasized.

C. DENIS PEGGE

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[1] *Nature*, 168, 775 (1951).

[2] "The Sound Motion Picture in Science Teaching" (Cambridge, Mas Harvard University Press, 1933).

[3] *Brit. J. Educ. Psychol.*, 16, 149 (1940)

[4] Motion Picture Testing and Research. Report No 7 Army Air Forces Aviation Psychol. Prog. Res. Rep. (Washington, D C Gov Printing Office)

[5] *J. Educ. Psychol.*, 37, 1 (1940).

[6] *Res. Quart. Amer. Assoc. Hlth. Phys. Educ. and Rec.*, 20, 432 (1949)

[7] *Arch. Psychol.*, 19, No. 15 (1910).

THE ROCKEFELLER FOUNDATION

REPORT FOR 1950–51

A REVIEW of the work of the Rockefeller Foundation for the year 1950 was not published, because any definitive discussion of plans and programmes was impossible while the Foundation was being reorganized to meet the changing conditions of a world in transition. The review by the president, Mr. Chester I. Barnard, now published*, covers the two years 1950 and 1951, during which the Foundation's income was almost 30 million dollars, nearly 17 millions being received in 1951. Grants and appropriations totalled 11,247,964 dollars in 1950 and 21,158,880 dollars in 1951; of this, in 1951, 3,796,270 dollars went to the Division of Medicine and Public Health, which was formed in 1951 by merging the International Health Division and the Medical Sciences Division, these two bodies receiving in 1950 2,326,840 and 1,240,900 dollars, respectively. At the same time, as a further result of a survey of the Foundation's activities, the Natural Sciences Division, which received 2,092,515 dollars in 1950, was reconstituted as the Division of Natural Sciences and Agriculture, to which 3,680,208 dollars went in 1951. A closer co-ordination of all activities of the Foundation was also recommended by the Survey Commission, and Mr. Barnard reaffirms the belief that the broad basis of the Foundation's planning should be human ecology. The Division of Social Sciences received 4,585,895 dollars in 1951, and the Division of Humanities, 1,658,072 dollars; the corresponding figures for 1950 are 2,122,085 and 1,491,250, while a further 5 million dollars in 1951 went to the General Education Board.

Reviewing the work of the Foundation in public health and medicine, Mr. Barnard records that from 1914 to the end of 1951 the Foundation expended nearly 24 million dollars on medical education and research in the medical sciences; nearly 14 millions, more than two decades of work, costing the lives of six scientific workers, went to the isolation and identification of the causal agent of yellow fever and the development of a practical method of culturing the virus for the large-scale production of the vaccine. A definitive history of this work, edited by Dr. G. K. Strode, was published in 1951 under the title "Yellow Fever", and also in 1951 the Nobel Prize in Physiology and Medicine was awarded to Dr. M. Theiler, a virologist on the team which developed the vaccine. The programme of the new Division is now being developed with four objectives: the advancement of professional education; the study of medical care; the investigation and control of specific diseases and deficiencies; and the development of the health sciences.

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* The Rockefeller Foundation: a Review for 1950 and 1951. By Chester I. Barnard. Pp. 126. (New York: Rockefeller Foundation, 1952).

For the first, it is proposed to make relatively modest grants at strategic points within a faculty to strengthen its teaching, and an exploratory survey is now being made of the status of medical education in South America. The medical care programme will be concentrated on scientific aspects of training and research, especially in the biosociology of disease, in the expectation that, when research has accumulated and systematized the data into a scientific discipline, medical schools will introduce students to the practice of community medicine with an emphasis on 'social diagnosis' comparable to that on physical diagnosis. Under the third objective, special attention is being directed to the study of virus infections transmitted by mosquitoes, ticks, lice and other insects. A survey of the major virus problems of Egypt is being made in co-operation with the United States Naval Medical Research Unit, and a virus research laboratory has been established at Poona in collaboration with the Ministry of Health of the Indian Government. The fourth objective includes a grant to the University of Oregon Medical School for research in constitutional medicine, and grants for studies of child psychology and guidance, medical studies of old age, etc.

In December 1951 the trustees of the Foundation decided that experimental biology would continue to be an active interest in the natural sciences programme but on a reduced scale in the United States, and the greater part of the effort will be devoted to the promotion of scientific agriculture. The Mexican agricultural programme, on which the Foundation has spent more than 1·7 million dollars since its inauguration in 1943, is now operating on an annual appropriation of 320,000 dollars from the Foundation, with additional funds from the Mexican Government, and animal husbandry is being added to the programme in 1952, commencing with chickens and pigs. The Colombia project for the improvement of corn, wheat and other basic food crops, which received 50,000 dollars in 1950 and 135,000 dollars in 1951, has benefited in many ways from the pioneering in Mexico: some of the new varieties of wheat developed for Mexico proved to be remarkably well adapted to Colombia, and under the revised programme for the natural sciences it is proposed to extend similar operating projects in scientific agriculture to other Latin American countries. A further appropriation of 100,000 dollars was made in December 1951 to finance for three years the agricultural aspects of a six-year programme for the agricultural development of the State of Mexico, while a consultant of the Division of Social Sciences is surveying the social problems involved with the view of a co-ordinated 'human ecology' approach to the interrelated problems of food, health, education and social relations.

Apart from these agricultural programmes in Mexico and Colombia, grants made for experimental biology and related fields of science have averaged 2 million dollars in each of the six post-war years and, of this, 1·6 million dollars was distributed in the United States; this amount is to be decreased during the next few years to about 500,000 dollars, while the grants distributed in Europe and in Latin America will be increased to at least 500,000 and 700,000 dollars, respectively, with a further 1·5 millions for the programmes operating in agriculture.

During the period under review the main interest in experimental biology has been biochemistry, and during 1950–51 grants totalling nearly 1·5 million dollars were made for this purpose, including 168,615 dollars to the Polytechnic Institute of Brooklyn for an intensive attack on the problem of protein structure. Grants for enzymology totalled 589,000 dollars, including 35,000 dollars for Prof. H. A. Krebs's work at the University of Sheffield on sugar metabolism. Some 202,000 dollars has been contributed in support of the Conservation Foundation's programme for the study of the conservation of animal and plant life, water sources and productive soils.

In the social sciences the Foundation's programme seeks to assist all the disciplines which can contribute to the development of a science of social behaviour, the application of social science to human problems, the discovery and development of social science talent or the establishment of a firm basis for social philosophy. For research in economics 400,000 dollars were appropriated in 1950 to the National Bureau of Economic Research; 140,000 dollars went in 1951 to Harvard University for Prof. W. Leontief's study of economic structure, and 122,750 dollars went in 1950–51 to the Food Research Institute, Stanford University, partly to complete a five-year study of world operations in food and agriculture during the Second World War. An additional 420,000 dollars were appropriated in 1950 for support over five years of the Russian Institute of the School of International Affairs, Columbia University, and 180,000 dollars to the International Studies Group of the Brookings Institution for research, etc., on American foreign policy. Grants were also made for several studies of problems of ageing, while in December 1951 a capital grant of 1·5 million dollars was made to the Social Science Research Council. Grants totalling 242,500 dollars have been made to the American Law Institute of Philadelphia in furtherance of the preparation of a comprehensive criminal code for recommendation to the State and Federal governments. Altogether, grants for the social sciences totalled more than 2 million dollars in 1950 and more than 4·5 millions in the following year.

A survey of opportunities in the humanities, which commenced in 1950, has led to the selection of three types of humanistic studies for support: first, language, logic and symbolism, representing the Foundation's interest in means of communication of knowledge; intercultural understanding, with the emphasis on the dissemination of knowledge; and humane values. In the first group, 50,000 dollars were appropriated for a detailed analysis and description of the Russian language, under Prof. R. Jakobson at Harvard University, and 69,000 dollars for an integrated study of the theory of language and symbolism at the University of Michigan. In the second, 325,000 dollars were appropriated in 1950 for the studies initiated at Cornell University, with field headquarters at Bangkok, into the effects of technological and economic change on the peoples of South-East Asia, the effects of the United States and the United Nations programmes on the political structures and ideologies in the area, and the status of Chinese and Indian minority groups there. The Institute of Islamic Studies at McGill University, Montreal, has received 214,800 dollars for a five-year period, and grants totalling 194,000 dollars have been made in support of the programme of American studies, launched jointly in 1950 by the University of Tokyo and Stanford University.

The grants, totalling nearly 1·5 million dollars in 1950 and more than 1·6 million dollars in 1951, made through the Division of Humanities, were, Mr. Barnard points out, inspired by the belief that in this field, as in the social sciences, the emphasis is no longer on knowledge but rather on the contribution that may be made to the processes by which our attitudes, beliefs and judgments of value are developed, made more coherent and integrated into a harmonious pattern. If these processes are to be kept healthy in a free society, Mr. Barnard suggests that it is important, first, that the society have creative effort which is really producing new ideas and putting them into understandable forms. Criticism is also essential, to keep creative workers operating on constructive lines; lastly, what Mr. Barnard terms—for want of a more descriptive word —experience is also needed. These are among the reasons which lead the Foundation to foster research and writing in modern history—for example, dramatic writing—and to promote the freedom of the Press. Of the 3,149 applications for aid declined in 1951, 973 were for fellowships, scholarships and travel and training grants, and 618 for support of scientific research projects and teaching programmes.

UNITED STATES PULP AND PAPER INDUSTRIES

In a world where raw materials of all sorts are at a premium, a publication, No. 7 of the Royal School of Forestry, Stockholm, entitled "U.S. Pulp and Paper Industry with Special Reference to its Supply of Raw Material"*, is of particular interest. The consumption in the United States of paper and paperboard prior to the Second World War amounted to about 50 per cent of the total world consumption, and the corresponding figure has now risen to about 70 per cent, owing to the rise in the United States domestic consumption; this latter rose from 15·2 million metric tons in 1940 to 22·5 million metric tons in 1949, the equivalent of an increase from 114 kgm. to 153 kgm. per head of the population. In Sweden, where the consumption per head is probably the largest in Europe, the corresponding consumption for the same year was 80 kgm.

The question is, how are the United States to cover their long-term needs in the way of paper and board, and fundamentally this is a question of raw-material resources. How much can they obtain from their own forests? The balance must be imported. In 1949, 35 per cent of the paper and board consumption was covered by imports in the form of paper, wood pulp or pulp wood. The consumption of pulp wood rose from 14·5 million cubic metres in 1925 to 17·8 million in 1935 and 24·2 million in 1949. In the last-named year the United States imported 4·3 million tons of paper (the bulk of it newsprint), 1·6 million tons of wood pulp and 4·3 million cubic metres of pulp wood. All the pulp wood, the greater bulk of the newsprint, and three-quarters of the wood pulp came from Canada and Newfoundland, and the balance from Scandinavia and Finland.

At the same time the forests of the United States have been yielding a progressively increasing volume of raw material. Pulp wood has increased from 12·7 to 44·7 million cubic metres between 1925 and 1949. This is partly due to the amount coming from new forests in the southern States and Pacific northwest. More intensive valuations of the volume of timber in the coniferous forests are now available, and it is apparent that over-cutting, that is, exceeding the annual increments put on, is taking place in the coniferous forests. In the hardwood forests, for long neglected, the annual increment considerably exceeds the volume felled. It is in this latter type of forest that the United States will have to look in the future for some of their requirements. In how far the annually increasing demands will be met by Canada, Scandinavia and other European countries and so forth is problematical, for Europe requires a far larger amount of these materials than are at present available to her.

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* Kungl. Skogshögskolans Skrifter 7: Förenta staternas massa- och pappers-industri med särskild hänsyn till dess råvaruförsörjning (U.S. Pulp and Paper Industry with Special Reference to its Supply of Raw Material). Av. Th. Streyffert. Pp. 85. (Experimentalfältet, K.S., 1952.)

PROXIMITY OF GENES CONTROLLING THE FERMENTATION OF SIMILAR CARBOHYDRATES IN SACCHAROMYCES

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Four different genes in *Saccharomyces* controlling the hydrolysis of alpha-glucosidic saccharides are on the same chromosome. The genes *MA*, *MZ* and *MG* controlling the hydrolyses of maltose, melezitose and alpha-methyl glucoside are in one linkage group[1]: (1) *MA* and *MZ* were shown to be linked by frequency of recombination; (2) *MA* and *MG*, which usually recombine freely, were shown to be on the same chromosome by the spontaneous appearance of a crossing-over suppressor in one family. The observations presented here show that *SU* (which controls the fermentation of sucrose and raffinose by producing a beta-fructo furanosidase) is a member of the same linkage group. *Saccharomyces* chromosomes are extraordinarily long genetically, and in most experiments *MA*, *MG* and *SU* recombine independently. Linkage between *MG* and *SU* was revealed by the suppression of crossing-over between them, presumably due to the spontaneous occurrence of an inversion. The pedigree described below overlaps one described earlier[1], and the two cross-over suppressors, one involving *MA* and *MG* and the other involving *MG* and *SU*, may be of common origin.

Experimental. Culture 3608 − − + (non-fermenter of maltose and alpha-methyl glucoside and fermenter of sucrose) is a progeny of a hybrid between 3228 and 3091 (− − + × + − +). The progeny were analysed only for ability to ferment maltose (since the hybrid was homozygous for *mg* and *SU*); in 16 asci, 2 : 2 segregations for *MA*/*ma* were found.

A mating between culture 5519 − − − (non-fermenter of maltose, alpha-methyl glucoside and sucrose) and 7351 + + − (fermenter of maltose and alpha-methyl glucoside and non-fermenter of sucrose) produced the tetrads analysed in family 11. Since family 11 was homozygous for inability to ferment sucrose, only two tetrads were analysed for sucrose fermentation. All eight spores were negative. A high frequency of + to − conversion was encountered in both the *MA* and *MG* genes. The following different types of tetrads were found:

	MA/*ma*	*MG*/*mg*
+ + + −	1	0
+ + − −	29	21
+ − − −	2	6
− − − −	0	1

The concept of gene conversion[3] is applied throughout in analysis of the results.

Family 12 comprised a hybrid between 3608 and 7459; twelve asci showed 2 : 2 segregations of *MG*/*mg*. Only one ascus was characterized with regard to ability to ferment sucrose; all four cultures fermented sucrose despite the fact that one parent was sucrose-positive and the other sucrose-negative. (This situation was frequently encountered while stocks were being built up heterozygous for single pairs of genes controlling specific fermentations[4]. Since both *MZ* and *SU* control the fermentation of sucrose, ratios of this type occur in *MZ SU*/*mz su* hybrids[1].)

The first evidence of linkage between *MG* and *SU* appeared in family 14. The results are summarized in Table 1. In eighteen asci, the combination *mg SU*, characteristic of culture 7554, is accompanied by the alternative arrangement, *MG su*, characteristic of the other parent, 7517: *MG su MG su mg SU mg SU*. In ten other asci two rapid fermenters, one non-fermenter and one late fermenter of sucrose appear: *SU SU su su*^{L}. The analysis of late fermenters of galactose encountered in the Carbondale stocks by Mundkur[5] has shown that they were originally non-fermenters which mutated in the selective medium to fermentative ability. On this interpretation the initial genotype of the tetrads in class 2 would be the same as those in class 1. The close linkage of the two genes found in this family makes the interpretation reasonable and supports the view that late fermenters are originally non-fermenters which afterwards mutate to fermentative ability. The asci in classes 3 and 4 are evidently the same as those in class 1 except for the failure to identify the missing members. Similarly, classes 5 and 6 are identical with class 2 except for the failure to identify the missing members of the tetrad. The anomalous ascus listed in category 7 probably represents crossing-over in the inverted region, with other complications. The two asci in classes 8 and 9 are due to the reduction of tetraploid zygotes; this is indicated by the similar excess of dominants for other factors in the same tetrads.

TABLE 1. TYPES OF ASCI FROM FAMILY 14 SHOWING LINKAGE OF *MG* AND *SU*

Class	Genotype				Frequency
1	*MG su*	*MG su*	*mg SU*	*mg SU*	18
2	*MG su*^{L}	*MG su*	*mg SU*	*mg SU*	10
3	*MG su*	—	*mg SU*	*mg SU*	3
4	*MG su*	*MG su*	*mg SU*	—	2
5	*MG su*	*MG su*^{L}	*mg SU*	—	1
6	*MG su*^{L}	—	*mg SU*	*mg SU*	1
7	*MG SU*	*MG su*^{L}	*mg su*	*mg su*	1
8	*MG SU*	*MG SU*	*MG SU*	*MG SU*	1
9	*MG SU*	*MG SU*	*MG SU*	—	1

No linkage was detected between *MA* and either *MG* or *SU*. Thirty-two of the asci were characterized for capacity to ferment maltose with the following results: + + + −, 2; + + − −, 29; + −^{L} − −, 1. The two + + + − asci were those in classes 8 and 9, confirming the view that they were of polyploid origin.

Family 18 comprised a hybrid between culture 7517 and 8011. It was heterozygous for both *MG* and *SU*. A single ascus analysed from this hybrid showed independent segregation of the genes *MG* and *SU*. By contrast, these markers were almost completely linked in family 14. Since 7517 was used as a parent in producing both families, the linkage of the two markers in family 14 was not transmitted through culture 7517; it must have had its origin from 7554. Culture 7554 has the same combination of factors as culture 3608, supporting the view that the cross-over suppressor was present in family 10.

TABLE 2. TYPES OF ASCI FROM FAMILY 15 SHOWING INDEPENDENT SEGREGATION OF *MG* AND *SU*

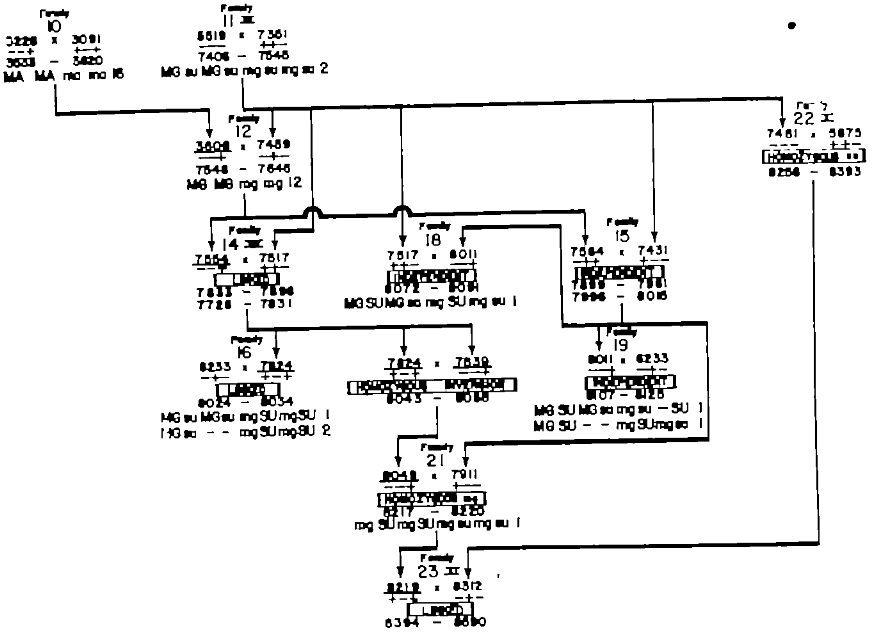
Genotypes				Classes			
				I	II	III	?
MG SU	*MG SU*	*mg su*	*mg su*	3			
MG SU	*MG SU*	*mg su*	*mg su*^{L}	1			
MG su	*MG su*	*mg SU*	*mg SU*		3		
MG su^{L}	*MG su*	*mg SU*	*mg SU*		1		
MG su	*mg*^{L} *su*	*mg SU*	*mg SU*		1		
MG SU	*MG su*	*mg* —	*mg su*			1	
MG SU	*MG su*	*mg SU*	*mg su*^{L}			1	
MG SU	*mg*^{L} *su*	*mg SU*	*mg su*			1	
mg^{L} *SU*	*mg*^{L} *su*	*mg SU*	*mg su*			1	
MG SU	*MG SU*	*mg SU*	*mg SU*				1
MG SU	*MG SU*	*mg*^{L} *SU*	*mg su*				1

Family 15 arose from a hybrid between 7564 and 7431. Culture 7564 is a sibling of 7554 (carrying the cross-over suppressor); 7431 is a sibling of one of the parents of 7554. The segregations of *MG* and *SU* from this family are shown in Table 2; the genes were independently assorted. When the late fermenters are considered as originally negative, the following types of tetrads are found:

	MG/*mg*	*SU*/*su*
+ + − −	12	13
+ − − −	2	0
− − − −	1	0
+ + + +	0	1
+ + + −	0	1

These results indicate that conversion of *MG* to *mg* and of *su* to *SU* was relatively frequent.

The high frequency of recombinations between *MG* and *SU* in family 15 shows clearly that the distance between the genes is greater than 50 morgans. This is confirmed by classifying the asci with regard to segregation of *MG* and *SU* (Class 1, + + + + − − − −; Class II, + − + − − + − +; Class III, + + − − + − − +). The frequency of 4 : 5 : 4 :: 1 : II : III does not differ significantly from 1 : 1 : 4, confirming the absence of linkage. In families 15 and 18, therefore, *MG* and *SU* are independently segregated, while in family 14 they are closely linked.



Pedigree showing the origin of a cross-over suppressor in the alpha-glucosidase chromosome in the Carbondale stock of *Saccharomyces*. Arabic numerals designate the families of interest; the Roman numerals indicate families described previously (ref. 1). The + and – signs under the serial numbers of the parent cultures indicate fermentative ability with regard to maltose, alpha-methyl glucoside and sucrose, in that order

Family 16 arose as a hybrid between 7824 + – + (directly descended from 7554 which carries the cross-over suppressor) and 6233 – + –. Three asci analysed from the hybrid showed that *MG* and *SU* were completely linked in this family.

Family 19 was produced by mating 8011 – – + by 6233 – + – and showed independent segregation of the genes *MG* and *SU* in two tetrads.

These results exclude 6233 as the carrier of the cross-over suppressor and establish 7824 as the carrier, since 6233 by 7824 produced a hybrid in which linkage was complete, while 6233 by 8011 (the latter also carrying the combination *mg SU*) produced tetrads in which independent assortment occurred.

A hybrid was made between 7824 and 7839, both of which carried the inversion. An offspring from this hybrid (8049) was mated to 7911 (descended from family 15 in which independent segregation of *MG* and *SU* occurred). All the *mg SU* offspring of family 21 should carry the inversion. Family 23 was produced by mating an *mg SU* culture from family 21 (8219) with culture 8312, descended from a line in which the inversion did not occur. Thirty-three asci were isolated and analysed (Table 3). No recombinations occurred in the twenty-seven tetrads of class 1. The su^L spores found in tetrads of class 2 suggest the conversion of a dominant gene to a recessive and a later back-mutation. Conversion of *mg* to *MG* occurred in asci of class 3 and *MG* to *mg* in those of class 4. Conversion of *su* to *SU* occurred in the class 5 ascus. Family 23, like family 14, was heterozygous for *MA*/*ma*. No linkage was detected between the *MA* locus and the tightly linked *MG SU* genes. The frequencies of the three classes of *MA MG* tetrads were: type I, 5; type II, 4; type III, 20; this is in complete agreement with the theoretical expectation of 1 : 1 : 4. The following tabulation shows the frequency of conversion of *MG* and *SU*:

	MG/*mg*	*SU*/*su*
+ + + –	2	1
+ + – –	30	30
+ – – –	1	2

The fact that regular segregation of one allele is accompanied by irregularities in the other shows that the two effects arise from different loci although they are completely linked in some families.

TABLE 3. TYPES OF ASCI FROM FAMILY 23 SHOWING LINKAGE OF *MG* AND *SU*

Class	Genotype				Frequency
1	*MG su*	*MG su*	*mg SU*	*mg SU*	27
2	*MG su*	*MG su*	*mg SU*	*mg* su^L	2
3	*MG su*	*MG su*	*mg SU*	*MG SU*	2
4	*MG su*	*mg su*	*mg SU*	mg^L *SU*	1
5	*MG su*	*MG SU*	*mg SU*	*mg SU*	1

It is inferred from these observations that the genes *MG* and *SU* are on the same chromosome; but since neither shows linkage with *MA*, both are more than 50 morgans from the latter.

Discussion. These observations indicate that the genes *MA*, *MZ*, *MG* and *SU* are on the same chromosome. All the substrates except one carry exposed (terminal) alpha-glucosidic linkages: maltose, alpha-methyl glucoside, melezitose, turanose, and sucrose. The exception is raffinose. The genes *MA*, *MZ* and *MG* cannot produce an enzyme capable of action on raffinose. *SU* produces a beta-fructo-furanosidase which hydrolyses both sucrose and raffinose (but not maltose)[5,6].

The high frequency of recombination between these loci does not indicate that the absolute distances between them are great. A single chiasma in each region at each meiosis would produce completely free assortment. No other loci linked to these genes have been found, and it seems difficult to escape the conclusion that their proximity to each other indicates a common origin.

Two other carbohydrases, galactokinase and melibiase, under the control of the genes *GA* and *ME*, are also linked. (The gene *GA* was formerly termed *G*; a two-letter symbolism for all genotypes has been adopted. Three-letter symbols indicate phenotypes.) Their linkage was revealed by recombination[4] and confirmed by the location of another gene for red pigment (AD_1) between them[7]. The fact that one gene controls an enzyme acting on galactose whereas the other acts on a molecule containing galactose suggests that they may have a common origin. *GA* controls the transformation of galactose into a utilizable hexose; *ME* controls the hydrolysis of melibiose into glucose and galactose.

The specially selected non-fermenting clones which were used to build up the Carbondale stock are distinguished from the fermenters by complete inability to ferment or utilize the specified carbohydrate.

These selected recessive stocks are completely without the enzyme necessary to effect utilization of the carbohydrate and are completely incapable of producing it by adaptation. Selection of the nonfermenter stocks has required an extensive, critical survey of a large variety of yeasts. In contrast with these unique, completely negative cultures, cultures are available which are genetically differentiated with regard to utilization of a specific carbohydrate by using it less rapidly than the fully potent culture. There are thus two strikingly different types of genic differentiation of *Saccharomyces* cultures in ability to utilize or ferment carbohydrates: one is unique and involves complete inability either to produce the specific enzyme or to adapt itself to the substrate; the other involves diminution in the ability to ferment the substrate due to a gene-controlled biochemical defect. Two cultures, both carrying the dominant gene controlling the fermentation of galactose, have been differentiated into strong and weak fermenters by such a gene, and segregation of strong versus weak fermentation of galactose has been demonstrated in such a system (Dr. Herschel Roman, personal communication). If defects were present which brought about the absence of specific co-enzymes, a hybrid might show regular segregation for strong versus weak fermentation of maltose and simultaneously show a regular segregation for strong versus weak fermentation of galactose. If more than one enzyme system were involved in the utilization of a single carbohydrate, as has been demonstrated by Leloir and his associates[8] for galactose, more than one gene-pair might be demonstrated controlling strong versus weak fermentation of that carbohydrate. In contrast to this condition, a gene resulting in the complete inability to produce a carbohydrate is inferred to involve the unique gene directly concerned with the formation of the enzyme itself—a gene which might be called the ***enzyme-template*** gene.

On the basis of this discussion, the genes *MA*, *MZ*, *MG* and *SU* (as well as *GA* and *ME*) are identified as enzyme-template genes. Evidence has been presented[6,9] showing that the action of several of these genes is inhibited by the presence of similar substrates, or by the by-products of hydrolysis, suggesting that the gene functions by direct contact of the gene-surface with the substrate, and it is this contact with a topographically specific surface which induces the adaptation. The proximity of the genes *MA*, *MZ*, *MG* and *SU* suggests that they have a common origin and that their number has been increased by unequal crossing-over and mutation of the 'extra' gene[10]. One may assume that *Saccharomyces* originally possessed only a glycolytic system and was incapable of hydrolysing saccharides. That the original novelty with regard to alpha-glucosides comprised either *MA* or *SU* may be inferred from the fact that ability to ferment alpha-methyl glucoside is relatively rare and ability to ferment melezitose is even more unusual. The ability to act on galactose and galactosides is a similar relatively recent novelty. It may be assumed that *GA* was the original novelty, since the ability to act on melibiose is not widespread, and that duplication of the *GA* locus led to transformation of the 'extra' *GA* into the *ME* locus. It has already been suggested[4], on the basis of the mutual exclusion in *Saccharomyces* of ability to ferment maltose and lactose, that the capacity to ferment lactose has its origin in the transformation of the *MA* locus to a locus controlling the capacity for lactose fermentation.

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A NEW METHOD FOR ACETYLATING PROTEINS

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RECENT studies by two of us on the chemistry of coenzyme A necessitated the preparation and examination of several acetylthiols[1]. These were required as models to establish a chemical basis for the suggestion that coenzyme A effects acetylations by acetyl transfer at its terminal SH group[2]. The simple acetylthiols were found to be quite effective acetylating agents towards amines in aqueous or alcoholic solution. It appears that acetylthiols in general are capable of acetylating amino compounds, and Wieland and his collaborators[3] have developed a method of peptide synthesis which involves the interaction of such compounds with the amino group of an amino-acid. Alcoholic and phenolic hydroxyl groups are unaffected by these reagents.

The ease with which some of these acetyl derivates reacted towards amines suggested to us their possible use in acetylating amino groups in proteins. The preparation of partially acetylated proteins is of considerable interest in relation to the possible modification of the specific biological activity of enzymes, toxins and hormones, the effect on the immunological specificity of proteins in general and also in connexion with structural investigations. Previously, acetylation was carried out with acetic anhydride, usually in dilute acid solution, or with ketene[4,5]. These reagents are, by their nature, rather unspecific with regard to the group or groups attacked, and the experimental conditions employed leave not a little to be desired, since proteins are often highly sensitive to small changes in their environment and chemical reagents may easily effect deep-seated structural alterations. The acetylation technique described in this article does not suffer from these disadvantages and is, we believe, highly selective.

The substance 2′acetylthioethylacetamide, $CH_3CO.NH.CH_2CH_2S.CO.CH_3$, was chosen for these investigations since it is readily soluble in water, is stable towards dilute acids and alkalis, and acetylates amines quite effectively. Approximate reaction conditions were determined by studying its action on simple amino-acids. An almost quantitative yield of acetylglycine was obtained when the reagent (c. 2 mol.) was added to a 10 per cent solution of the sodium salt of glycine (1 mol.) and the resulting solution kept for 12 hr. at 37°. In a similar experiment with alanine, reaction was only complete after three to four days at 37°.

It was thought that conditions should be chosen to ensure that a reasonable proportion of the amino groups in the substance to be acetylated was in the $—NH_2$ form, as distinct from $—NH_3^+$, in order that the reaction might proceed. Since in proteins the ω-amino group of lysine has a pK value of about 10·5, the earlier experiments were performed in a borate buffer at pH 10.

Human serum albumin isolated by the use of solvents at low temperature[6] was available to us as a protein of established purity (Fig. 1*a*). A 2 per cent solution in borate buffer at pH 10·0, to which had been added 2′acetylthioethylacetamide (to 1·5 per cent) was kept at room temperature during three days, then dialysed exhaustively against phosphate buffer (pH 8, $I = 0·2$) at 2° for examination in the ultra-centrifuge and electrophoresis apparatus. It was expected that the ω-amino groups of the lysine residues and the end α-amino groups in the protein would be acetylated by this treatment.

On electrophoretic examination at pH 8, the product showed two components (Fig. 1*b*), both of which had a mobility considerably greater than that of the untreated protein.

The increase in mobility is consistent with the acetylation of amino groups and consequent increase in net negative charge. In the ultracentrifuge also two components were observed (Fig. 1*b*), a main component sedimenting at approximately the same speed as untreated serum albumin and another component sedimenting more rapidly.

It was considered that the heavy component might have arisen through the reduction of some intramolecular disulphide bonds by the free thiol (2′-mercaptoethylacetamide) derived from the acetylating reagent, the protein —SH groups liberated afterwards reoxidizing to form intermolecular disulphide bonds leading to an increase in molecular weight. Such an explanation was made more probable by the observation that the addition of 2-mercaptoethylamine to a solution of serum albumin under the same conditions resulted in the formation of some faster-sedimenting material and the appearance of two electrophoretic components but without an increased mobility.

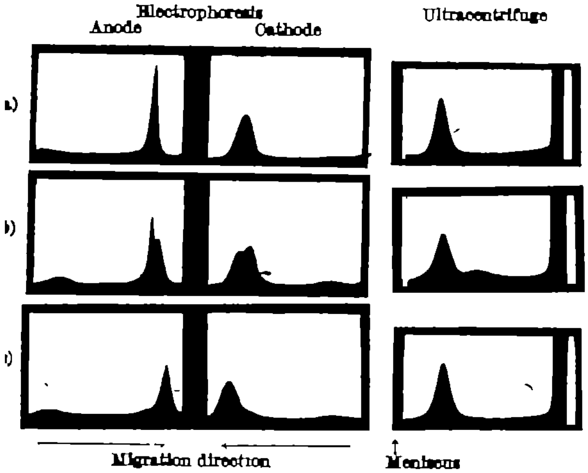

Fig. 1. Electrophoresis and ultracentrifuge diagrams of human serum albumin. (*a*) Untreated; (*b*) Acetylated in deep solution at pH 10; (*c*) acetylated in thin film under oxygen at pH 10. Migration times at 15 m.amp. (*a*) 178 min., (*b*) 98 min., (*c*) 118 min. Ultracentrifuge photographs all after 60 min. at 64,000 r.p.m.

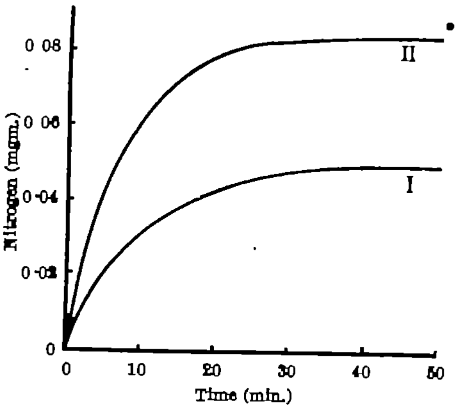

Fig. 2. Van Slyke estimation of amino-nitrogen on 5·25 mgm. samples of acetylated (I) and unacetylated (II) human serum albumin with increasing time of reaction with nitrous acid.

A preparation homogeneous both in the ultracentrifuge and the electrophoresis apparatus (Fig. 1*c*) was obtained by spreading the solution of reactants in a film approximately 2 mm. deep under oxygen to ensure that any thiol produced from the acetylating reagent was rapidly oxidized to innocuous disulphide. The mobility of the single component was 2·1 times that of untreated serum albumin. Furthermore, determination of the free amino groups by the method of Van Slyke indicated that about 34–39 amino groups/mole (70,000) had been acetylated (Fig. 2).

Repetition of this acetylation procedure on the once-treated albumin resulted in no further reduction of amino-nitrogen, as estimated by the Van Slyke method, and the electrophoretic mobilities of the once- and twice-acetylated albumin were identical. This indicates that the single treatment was sufficient to affect the acetylation of all the groups capable of reaction under the experimental conditions.

A further acetylation experiment using the thin-film procedure but at pH 8·5 again gave a product homogeneous in the ultracentrifuge and electrophoresis apparatus. In this instance the electrophoretic mobility of the product at pH 8 was 1·45 times that of untreated albumin, and Van Slyke measurements indicated that some 16–17 amino groups/mole had been acetylated.

It would appear from these results that the number of groups acetylated in the molecule is to some degree dependent on the pH of the reaction mixture, and also, in view of the electrophoretic homogeneity, that all the molecules are acetylated to about the same extent under specified conditions.

The nitrogen liberated from native serum albumin by the Van Slyke procedure was equivalent to 64 amino groups/mole, which is close to the value of 68 given by Brand[7]. After exhaustive acetylation at pH 10 the product still appears to have 25–30 free amino groups/mole. This would appear to imply that, of the fifty-nine lysine residues present in the molecule[7], about half are inaccessible to acetylation under the conditions of reaction employed, assuming that all end α-amino groups, which from the data of Brand[7] amount to 9 groups/mole, are acetylated. A higher reaction pH has not so far been studied, as it was felt that this might of itself cause irreversible changes in the protein.

We are indebted to Dr. Margaret Mackay for the gift of purified human serum albumin and to the Department of Scientific and Industrial Research for a special research grant.

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ROLE OF SULPHYDRYL GROUPS IN THE OXIDATION OF PYRUVATE

By Dr. E. C. SLATER

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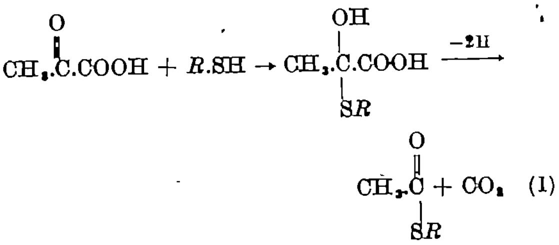
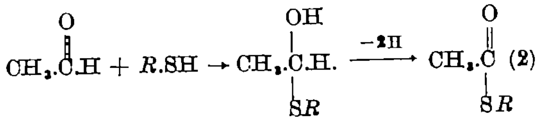
THE important part played by sulphydryl groups in the oxidation of pyruvate by tissue preparations was established by the work of Peters[1] and Barron[2] and their colleagues. Recently, two essential co-factors required for this oxidation, coenzyme A[3] and α-lipoic acid[4], have been found to contain sulphydryl groups, and Lynen and Reichert[5] have found that this grouping in coenzyme A is concerned in its transacetylation reactions. This prompted Lynen and Reichert to suggest that in the oxidation of pyruvate by pyruvic dehydrogenase, pyruvate or an acetaldehyde derivative formed by the decarboxylation of pyruvate actually combined with the sulphydryl group to form a compound which was oxidatively decarboxylated to acetyl-coenzyme A and carbon dioxide thus (R.SH = coenzyme A):



$$\mathrm{CH_3.}\overset{\overset{\mathrm{O}}{\|}}{\mathrm{C}}\mathrm{.COOH} + R.\mathrm{SH} \rightarrow \mathrm{CH_3.}\underset{\underset{SR}{|}}{\overset{\overset{\mathrm{OH}}{|}}{\mathrm{C}}}\mathrm{.COOH} \xrightarrow{-2\mathrm{H}} \mathrm{CH_3.}\underset{\underset{SR}{|}}{\overset{\overset{\mathrm{O}}{\|}}{\mathrm{C}}} + \mathrm{CO_2} \quad (1)$$

or



$$\mathrm{CH_3.}\overset{\overset{\mathrm{O}}{\|}}{\mathrm{C}}\mathrm{.H} + R.\mathrm{SH} \rightarrow \mathrm{CH_3.}\underset{\underset{SR}{|}}{\overset{\overset{\mathrm{OH}}{|}}{\mathrm{C}}}\mathrm{.H.} \xrightarrow{-2\mathrm{H}} \mathrm{CH_3.}\underset{\underset{SR}{|}}{\overset{\overset{\mathrm{O}}{\|}}{\mathrm{C}}} \quad (2)$$

This is similar to mechanisms proposed for the function of glutathione in the glyoxalase system[6,7] and in the oxidation of glyceraldehyde by cozymase and glyceraldehydephosphate dehydrogenase[7].

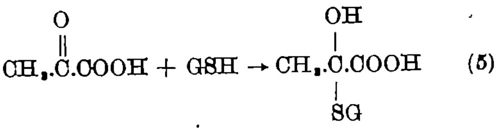
Korkes, Del Campillo, Gunsalus and Ochoa[8] agree with Lynen and Reichert's mechanism and bring forward in its support the experiments of Cavallini[9] on the coupled oxidation of pyruvate in the presence of glutathione (GSH) as a chemical model for the enzymic reaction. Cavallini found that, in the presence of pyruvate, the oxygen uptake exceeded that calculated for the equation:

$$2\,\mathrm{GSH} + \tfrac{1}{2}\,\mathrm{O_2} \rightarrow \mathrm{GSSG} + \mathrm{H_2O}, \qquad (3)$$

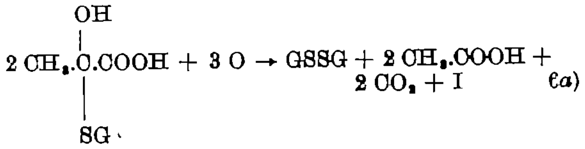
and carbon dioxide was produced in accordance with the oxidative decarboxylation of pyruvate to acetate and carbon dioxide:

$$\mathrm{CH_3.CO.COOH} + \tfrac{1}{2}\,\mathrm{O_2} \rightarrow \mathrm{CH_3.COOH} + \mathrm{CO_2}. \quad (4)$$

He proposed that an intermediate complex was formed which was oxidized thus:

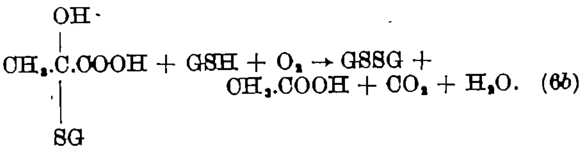


$$\mathrm{CH_3.}\overset{\overset{\mathrm{O}}{\|}}{\mathrm{C}}\mathrm{.COOH} + \mathrm{GSH} \rightarrow \mathrm{CH_3.}\underset{\underset{\mathrm{SG}}{|}}{\overset{\overset{\mathrm{OH}}{|}}{\mathrm{C}}}\mathrm{.COOH} \qquad (5)$$



$$2\,\mathrm{CH_3.}\underset{\underset{\mathrm{SG}}{|}}{\overset{\overset{\mathrm{OH}}{|}}{\mathrm{C}}}\mathrm{.COOH} + 3\,\mathrm{O} \rightarrow \mathrm{GSSG} + 2\,\mathrm{CH_3.COOH} + 2\,\mathrm{CO_2} + \mathrm{I} \qquad (6a)$$

or



$$\mathrm{CH_3.}\underset{\underset{\mathrm{SG}}{|}}{\overset{\overset{\mathrm{OH}}{|}}{\mathrm{C}}}\mathrm{.COOH} + \mathrm{GSH} + \mathrm{O_2} \rightarrow \mathrm{GSSG} + \mathrm{CH_3.COOH} + \mathrm{CO_2} + \mathrm{H_2O}. \qquad (6b)$$

In the light of experiments I have carried out on the copper-catalysed oxidation of 2 : 3 dimercaptopropanol[10], it appeared likely that an alternative mechanism not involving compound-formation between pyruvate and glutathione would explain Cavallini's experiments. The alternative mechanism is described by the following equations:

$$2\,\mathrm{GSH} + \mathrm{O_2} \rightarrow \mathrm{GSSG} + \mathrm{H_2O_2} \qquad (7)$$

$$2\,\mathrm{GSH} + \mathrm{H_2O_2} \rightarrow \mathrm{GSSG} + \mathrm{H_2O} \qquad (8a)$$

$$2\,\mathrm{GSH} + \tfrac{1}{2}\,\mathrm{O_2} \rightarrow \mathrm{GSSG} + \tfrac{1}{2}\,\mathrm{H_2O} \qquad (7 + 8a)$$

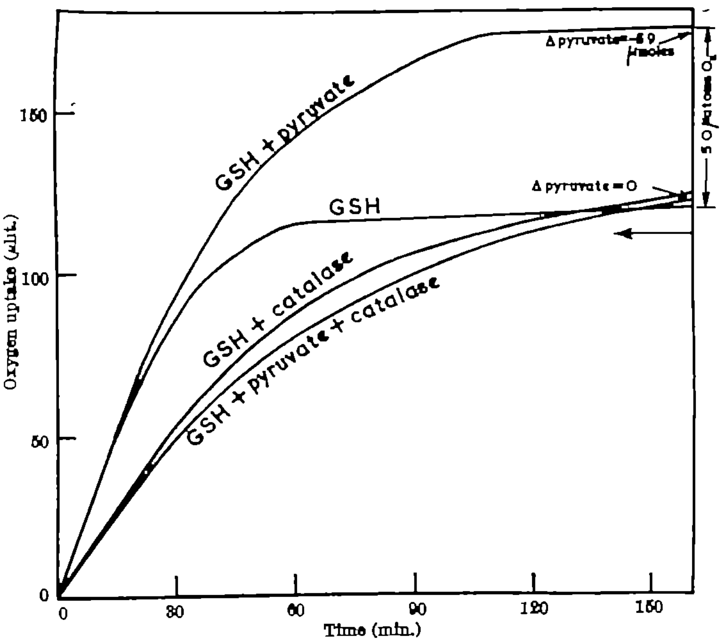
$$\mathrm{CH_3.CO.COOH} + \mathrm{H_2O_2} \rightarrow \mathrm{CH_3.COOH} + \mathrm{CO_2} + \mathrm{H_2O} \qquad (8b)$$

$$2\,\mathrm{GSH} + \mathrm{O_2} + \mathrm{CH_3.CO.COOH} \rightarrow \mathrm{GSSG} + \mathrm{CH_3.COOH} + \mathrm{CO_2} + \mathrm{H_2O}. \qquad (7 + 8b)$$

Hydrogen peroxide is invariably formed in oxidations catalysed by cupric ions. In the absence of pyruvate, this hydrogen peroxide will oxidize additional glutathione, so that there is little accumulation of peroxide at the end of the reaction (cf. Slater, ref. 10, Table 6). In the presence of pyruvate, however, hydrogen peroxide will also oxidize the pyruvate, according to a reaction first shown by Hollemann in 1904[11]. Negelein and Brömel[12] and Keilin and Hartree[13] showed that this non-enzymic reaction took place during the oxidation of D-alanine by D-amino-acid oxidase, both pyruvate and hydrogen peroxide being formed as a result of the action of the enzyme:

$$\text{D-alanine} + \mathrm{O_2} \rightarrow \text{pyruvate} + \mathrm{NH_3} + \mathrm{H_2O_2}. \quad (9)$$

Lipmann[14] showed that, in the oxidation of pyruvate by extracts of *Lactobacillus delbrueckii*, half the pyruvate molecules which were oxidized reacted with enzyme systems in the extract, in which hydrogen atoms eventually reacted with oxygen by means of an autoxidizable flavoprotein, while the remaining half were oxidized non-enzymically by the hydrogen peroxide produced in this autoxidation of the flavine.



Effect of catalase on the coupled oxidation of pyruvate and glutathione

The mechanism proposed in equations (7)–(8) was tested by determining the effect of catalase, which would be expected to have the following effects:

(*a*) Since the hydrogen peroxide produced by reaction (7) would be decomposed by the catalase, thereby liberating oxygen instead of oxidizing glutathione, the initial rate of the net oxygen uptake should be halved by the addition of catalase. In the absence of pyruvate, the final oxygen uptake should not be affected, since either in the presence or absence of catalase, oxygen is reduced to water, not hydrogen peroxide.

(*b*) In the presence of catalase, pyruvate should have no effect on the oxygen uptake, nor should any pyruvate disappear.

The accompanying graph shows the effect of catalase on the coupled oxidation of pyruvate and glutathione. All flasks contained glutathione, cupric chloride and phosphate buffer exactly in the quantities specified by Cavallini[9]; temperature, 38° C. Catalase (0·2 mgm. pure catalase) and/or pyruvate (20 μmoles) was added as indicated. The horizontal arrow shows the oxygen uptake corresponding to equation (3). Δ pyruvate refers to the difference between the contents of reaction vessels after 160 min. and controls incubated without glutathione. The pyruvate was determined spectrophotometrically with lactic dehydrogenase and reduced cozymase[15]. The graph shows that the effect of catalase is in accordance with the mechanism described by equations (7) and (8). In the presence of catalase, there is a slow oxygen uptake after the calculated value is exceeded, but this side-reaction (probably involving oxidized glutathione) does not affect the conclusion, since the curves with and without pyruvate, in the presence of catalase, are very close together.

In the absence of catalase, pyruvate caused the uptake of 5·0 μatoms oxygen in excess of that obtained without pyruvate, and this was accompanied by the disappearance of 5·9 μmoles pyruvate, in good agreement with equation (4). These figures show that, under the conditions of this experiment, approximately half the hydrogen peroxide produced by reaction (7) reacted with glutathione (reaction 8*a*) and half with pyruvate (reaction 8*b*).

The effect of catalase clearly shows that hydrogen peroxide is involved and is strong support for the mechanism proposed, which is, moreover, in accord with well-known reactions. Cavallini's mechanism does not explain the effect of catalase. The mechanism now suggested has the further advantage that it explains Cavallini's earlier experiments[16] in which ascorbic acid was also found to promote the oxidative decarboxylation of pyruvate. The explanation is undoubtedly the same as for the action of glutathione, since hydrogen peroxide is also produced during the copper-catalysed oxidation of ascorbic acid. Indeed, this was the explanation proposed by Cavallini[16] to describe the effect of ascorbic acid.

Since pyruvate is certainly oxidized in animal tissues by the cytochrome system, hydrogen peroxide will not be formed. Thus, there can be little resemblance between the coupled oxidation of pyruvate by glutathione *in vitro* and the oxidation of pyruvate *in vivo*. Cavallini's experiments cannot, then, be considered a satisfactory model of the enzyme. This does not, of course, necessarily mean that the mechanism proposed by Lynen and Reichert and by Korkes *et al.* is incorrect. But it does direct attention to the fact that evidence other than that provided by Cavallini's 'model' experiments must be found. In the case of the glyoxalase reaction, Racker[7] has obtained more direct evidence, since he found that the function of one of the two enzymes in the system is to promote the formation of a compound between methylglyoxal and glutathione. This compound was identified spectrophotometrically and found to be the substrate for the second enzyme of the system. In the present study, spectrophotometric measurements in the ultra-violet region gave no evidence of the formation of a compound between pyruvate and glutathione, under the conditions of Cavallini's experiments.

I wish to thank Prof. D. Keilin for his advice and the Agricultural Research Council for a personal grant.

[Aug. 19.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Secrecy and Industrial Research

In his presidential address to the British Association, on "The Ethical Dilemma of Science", Prof. A. V. Hill referred to the problem of secrecy in relation to the results of industrial research. I believe that the difficulty arises from confusion of technology with science.

These two fields of human endeavour are really quite distinct. Technology is the art of making things. It deals with the methods used for production. In this sense, even animals practise technology, and the evolution of men and the growth of civilization have depended upon the advance of technology. Technology advances by trial and error and by specific inventions. Much of the advance of technology is empirical, and, as Dr. J. B. Conant says, it is by the application of science to technology that the degree of empiricism in technology is reduced. Thus, when we speak of applied science, we mean science applied to technology. In industrial laboratories, the primary purpose of the laboratory is to advance technology, and, in order to do this, scientific work is undertaken so that the scientific results can be applied to advance the technology and reduce its empiricism.

This distinction between the technological work and the scientific work of an industry suggests a policy for the publication of new results. This is that industrial companies should publish their scientific work, but are under no obligation to publish their technological advances.

Scientific advances must be published even when they are applicable to technology because science advances as a whole, and any attempt to withhold the publication of scientific work reacts to the disadvantage of the withholder. Moreover, scientific men will not continue to do satisfactory work unless they can publish that work and feel they are taking part in the advancement of science. The great advance in applied science in the past fifty years is undoubtedly due to the general publication of scientific work done in industry as well as in the universities.

In my opinion, on the other hand, an industrial company is under no obligation to publish information as to its manufacturing technology. Publication is of value only to other firms who use that particular technology. In practice, however, it is impossible to keep technological methods secret for a long time. Often it is necessary to obtain the protection of patents, since otherwise a patent may be obtained by someone else, and a firm that has been using a secret process may find itself unable to use the process. To avoid this difficulty, firms often take out patents even though they desire no monopoly, and thus a great deal of technology is published which would otherwise remain secret.

Technical advances are also often published for purposes of prestige. Sometimes they are published because the applied science cannot be made known without publishing information as to the technology. Holding a technological process secret, therefore, merely delays the publication, and eventually the technology of a few years before it becomes public knowledge.

C. E. Kenneth Mees
Eastman Kodak Company,
Rochester 4, N.Y.
Oct. 14.

N-Nitration and *C*-Nitration by the Nitronium Ion

Aromatic *C*-nitration through attack by the nitronium ion was kinetically established by the work of Benford and Ingold[1], and of Hughes, Ingold and Reed[2]. The central point in the evidence was the observation of zeroth-order kinetics in the nitration of suitably reactive aromatic compounds, for example, of toluene, by a constant excess of nitric acid, in organic solvents such as nitromethane or acetic acid. All those aromatic compounds which are sufficiently reactive to take up the nitronium ion as fast as it is formed from nitric acid obey this law, and, for the same medium and temperature, can be observed to become nitrated at an identical rate, which is simply the rate of formation of the nitronium ion.

The zeroth-order form, and the associated absolute reaction-rate, constitute, therefore, a highly diagnostic test for the intervention of the nitronium ion in any reaction in which it is consumed as fast as it is formed. Thus the *N*-nitration of a secondary amine or the *O*-nitration of an alcohol, supposing the amine or the alcohol to be reactive enough, must, if the substituting agent is indeed the nitronium ion, be observable as zeroth-order reactions, having, in fixed conditions, rates identical with each other, and with the rate of nitration, say, of toluene.

We have used this criterion in order to show that the formation of nitroamines from secondary amines, and the formation of alkyl nitrates from alcohols by the action of nitric acid, involve attack by the nitronium ion on the nitrogen or oxygen atom. All kinetic measurements were made by the dilatometric method, controlled by chemical analysis. The course of the conversion of N-methyl : 2 : 4 : 6-trinitroaniline ('methylpicramide') into N-methyl-N : 2 : 4 : 6-tetranitroaniline ('tetryl') by 4 *M* nitric acid in nitromethane at 25° is illustrated in Fig. 1. This *N*-nitration is evidently a zeroth-order reaction. The con-

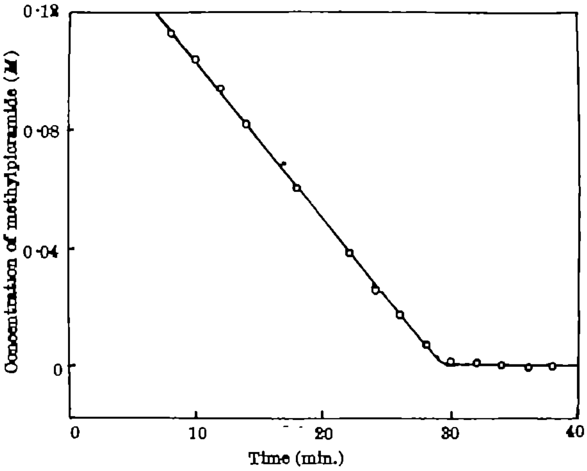

Fig. 1. Nitration of methylpicramide by 3·05 *M* nitric acid in nitromethane at 24·9°

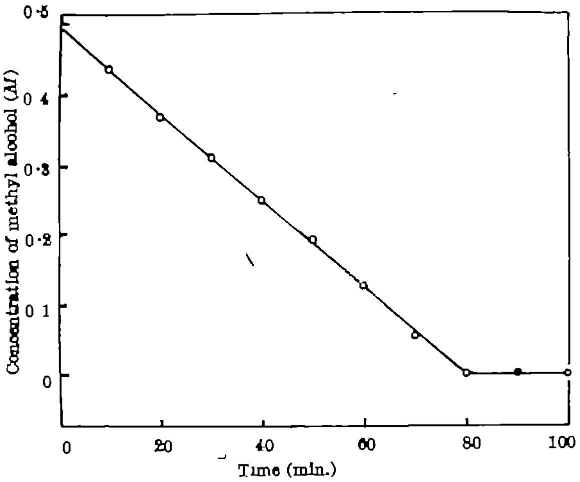

Fig. 2. Nitration of methyl alcohol by 4 0 M nitric acid in nitromethane at 24 9°

version of N-methyl : 2 : 4-dinitroaniline into N-methyl-N : 2 : 4-trinitroaniline proceeds in the same way at the same rate, though the product additionally takes up a *C*-nitro-group in a subsequent much slower reaction of first order, leading to tetryl. The conversion of methyl alcohol into methyl nitrate in similar conditions is likewise a reaction of order zero, as illustrated in Fig. 2. The absolute rate of any of these *N*- and *O*-nitrations is just the same as that of the *C*-nitration of any benzene derivative which uses the zeroth-order form of reaction, as has been shown by direct comparisons under several sets of conditions. Such a comparison with toluene is illustrated in Table 1.

Table 1. COMPARISON OF ZEROTH-ORDER RATES OF *C*-, *N*-, AND *O*-NITRATION BY 4 0 *M* NITRIC ACID IN NITROMETHANE AT 24 9°, WITH $[HNO_2] = 0{\cdot}0076 \pm 0{\cdot}0001\,M$ (UNCHANGED BY NITRATION) THROUGHOUT

Substance nitrated	Initial conc	Rate (mole $l.^{-1}$ sec $^{-1}$)
Toluene	0 099 *M*	10 3 × 10^{-6}
Methylpicramide	0·119 ,,	10 4 ,,
Methyl alcohol	0 491 ,,	10 2 ,,

We know that in *C*-nitration by the nitronium ion, only the more reactive aromatic compounds, such as toluene and benzene, take up the ion as fast as it is produced, and thus exhibit nitration in zeroth-order form. Less reactive aromatic compounds, such as chlorobenzene, take up the nitronium ion less quickly than it is produced, and the absolute rate of nitration is accordingly smaller, while the kinetics now approach first-order form. Similar changes in rate and order are to be expected for *N*- and *O*-nitration, where there is an appropriate suppression of reactivity towards the substituting agent. As illustration, neopentyl alcohol undergoes *O*-nitration by nitric acid in nitromethane much more slowly than does methyl alcohol. Furthermore, the reaction of neopentyl alcohol is approximately of first-order form, and, as is shown in Table 2, the absolute rate is comparable to that of the nitration of chlorobenzene, likewise a reaction of approximately first order, under the same conditions.

Table 2. FIRST-ORDER RATES OF *C*-NITRATION OF CHLOROBENZENE AND OF *O*-NITRATION OF NEOPENTYL ALCOHOL BY 3 77 *M* NITRIC ACID IN NITROMETHANE AT 24 9°

Substance nitrated	Initial conc	Rate constant (sec $^{-1}$)
Chlorobenzene	0·178 *M*	5 53 × 10^{-4}
Neopentyl alcohol	0 176 ,,	4 22 ,,

The *O*-nitration of glycerol and of cellulose is indirectly shown by such model experiments to involve attack on oxygen by the nitronium ion. A direct analysis of the reaction in these cases is complicated by reason of the number of successive steps involved, but progress is being made with the kinetics of nitration of some of the simpler polyhydric alcohols, including glycerol.

We wish to record our appreciation of the interest and help of Prof. C. K. Ingold.

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[1] *J. Chem. Soc.*, 929 (1938).

[2] *Nature*, 158, 448 (1946); *J. Chem. Soc.*, 2400 (1950).

Role of Water in the Structure of Psilomelane, $(Ba,H_2O)_2Mn_5O_{10}$

A SPECIMEN of psilomelane (*BM*.69,160) from Schneeberg, Saxony, was kindly made available for examination by the Department of Mineralogy, British Museum (Natural History). This material forms minute monoclinic crystals with $a = 9{\cdot}56$, $b = 2{\cdot}88$, $c = 13{\cdot}85$ A., $\beta = 92°\ 30'$, probable space group $A\ 2/m$. These values are a refinement of those previously reported by Vaux[1]. The unit cell contains two empirical formula units, $Ba_{0{\cdot}64}(Mn,R)_5O_{10}{\cdot}1{\cdot}36\ H_2O$, giving $d_{calc.} = 4{\cdot}82$, $d_{obs.} = 4{\cdot}71$; the ions R comprise Mn^{2+} and traces of other metals substituted for Mn^{4+}.

The structure, determined by Fourier methods, is based upon double and treble strings of manganese-oxygen octahedra linked in an approximately rectangular grouping by sharing corners to form tunnels parallel to the *b*-axis (Fig. 1). These enclose barium ions and water molecules which are crystallographic-

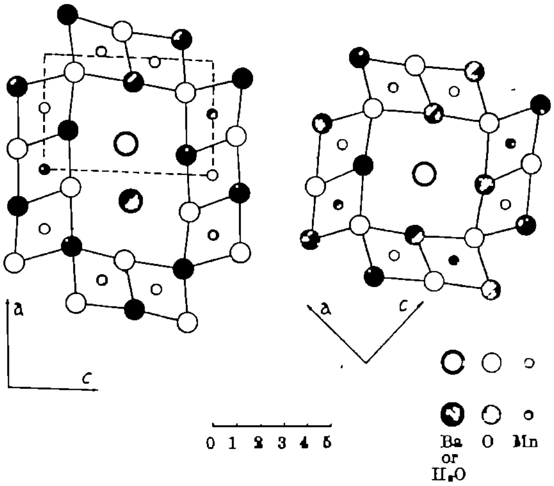


Fig. 1 Fig 2

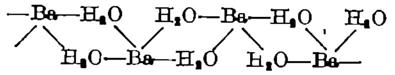
Fig. 1. Structure of psilomelane projected on the *b*-axis. The broken lines enclose an area ½*a* × ½*c*

Fig. 2. Structure of hollandite projected on the *b* (monoclinic)-axis

In each figure, open circles denote atoms at $y = 0$, shaded circles atoms at $y = \frac{1}{2}$

ally indistinguishable. Each of these is situated at the centre of fourteen ions or molecules, the ten approximately equidistant near-neighbours forming the corners of a prism and pyramid. Six are oxygen atoms, the remainder equivalent (Ba,H_2O) groups. The latter each has an identical fourteen-fold grouping, so that a double row of barium ions and water molecules is situated in a tunnel.

The ratio $Ba : H_2O$ is very nearly equal to 1 : 2. In order to prohibit two barium ions from being near-neighbours, the most logical stacking sequence in the double rows is :



There is no diffraction evidence to support this view, despite a sufficient difference between the scattering-power of two molecules of water and of one barium ion to demonstrate such a grouping if it existed. Nevertheless, this arrangement is the only one which is feasible on electrostatic grounds, and the double rows of (Ba,H_2O) units, therefore, are probably disordered with respect to one another.

The dehydration of psilomelane, which resembles that of the zeolites, is accompanied by a phase transition to hollandite (Fig. 2) when most of the water is removed. It is evident that too many vacant sites are created in the double row for structural stability, and the collapse to hollandite is effected by the rearrangement of treble strings of octahedra into double strings, and the double row of barium ions into a single row.

Despite the smaller unit cell of hollandite, there are insufficient barium ions to fill all the sites in a single row. The formula of hollandite, deduced from that of the psilomelane used in this investigation, is $Ba_{1\cdot01}(Mn,R)_8O_{16}$, in good agreement with that previously proposed by Byström and Byström[2], $Ba_{(2-x)}Mn_8O_{16}$, where x is approximately equal to one. It has been suggested[3] that discrete water molecules may be present in hollandite as occupants of vacant sites of otherwise perfect sub-rows :

—vac.—Ba—vac.—Ba—vac., etc.

This speculation receives support from the proposed structure of psilomelane.

A more detailed account will shortly be presented for publication elsewhere.

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[1] Vaux, *Min. Mag.*, **24**, 521 (1937).

[2] Byström and Byström, *Acta Cryst.*, **3**, 146 (1950).

[3] Byström and Byström, *Acta Cryst.*, **4**, 469 (1951).

Electronic Orbitals, Shapes and Spectra of Polyatomic Molecules

Our ideas and knowledge of the shapes of polyatomic molecules are largely confined to the ground electronic states. Comparatively little progress has been made in knowledge of the symmetries of electronically excited states. Not infrequently it has been tacitly, but unjustifiably, assumed that the excited state of a molecule has the same symmetry as the ground-state. Bound up with this, spectroscopists, having made a vibrational analysis of a spectrum, have often been content to leave it at that ; they have not tried to answer the question as to why particular vibrations occur. There have been exceptions, of course—the occurrence of the breathing vibration of benzene on electronic excitation near 2600 A. has been, for example, very reasonably attributed to an expansion of the benzene ring in the upper state—but, especially with non-totally symmetrical vibrations, it is usually true that no explanation has been offered for the occurrence of particular modes of vibration. Why, for example, do e_g^+ vibrations occur in the near ultra-violet spectrum of benzene ? That these enable an otherwise forbidden transition to become allowed is, of course, no explanation of why they occur.

For some time I have been interested in this problem of the shapes of electronically excited molecules. My procedure has been first to decide the molecular orbitals possible for two particular shapes of a particular molecule ; then to decide which orbital of the one symmetry class must transform to a particular orbital of the other symmetry class when some parameter is varied from its value for one shape to its value for the other ; and finally to decide whether a particular orbital becomes more or less tightly bound as that parameter is varied. The resulting correlation diagram is of great value, for it implies what will be the most stable shape for any electron configuration (including the ground-state) ; and hence what vibrations are likely to be aroused in a particular electronic transition and whether the maximum intensity will be close to or far from the origin of the system ; what will be the formulation of the longest wave-length transitions and hence whether these transitions will be allowed or forbidden ; and, if the former, how they will be polarized. This procedure has been applied first to triatomic molecules (AH_2, AB_2, BAC, HAB molecules) ; then to tetratomic molecules (AH_3, AB_3, H_2AB, B_2AC molecules) ; then to the methyl halide molecules ; then to ethylene and more complicated molecules. A brief verbal account of the work was given to the International Conference of Spectroscopists at Basle in June 1951 [1], and a full account is now being submitted for publication elsewhere. In this communication, I wish to summarize some of the outstanding results. Some of them have been obtained before, but not as part of a comprehensive treatment.

(1) AH_2 molecules containing 4 valency electrons should be linear in their ground-states. Those containing 5, 6, 7 or 8 electrons should be bent in their ground-states. The first excited states of 4-electron AH_2 molecules should be bent.

(2) Non-hydride triatomic molecules containing 16 valency electrons should be linear in their ground-states. 17, 18, 19, 20-electron molecules should be bent, the apex angle decreasing with increase in number of electrons. The first excited states of 16-electron molecules should be bent.

(3) HAB molecules containing 10 valency electrons should be linear in their ground-states. Molecules with more than 10 electrons should be bent in their ground-states. The first excited state of HCN should be bent. The first excited state of C_2H_2, which is *iso*-electronic with HCN, should be non-linear.

(4) AH_3 molecules containing 6 valency electrons should be planar in their ground-states, pyramidal in their first excited states. AH_3 molecules containing more than 6 valency electrons should be pyramidal in their ground-states.

(5) AB_2 or B_2AC molecules containing 24 valency electrons should be planar in their ground-states, but pyramidal (if stable) in their first excited states. 25-, 26- and 28-electron molecules should be pyramidal in their ground-states, the BAB or BAC angle decreasing as the number of electrons increases.

(6) If X is the centre of the mid-point of the H—H line, the first excited state of the HCHO molecule should have the XCO line bent both in the molecular plane and out of that plane. The distortion is insufficient for the classification of the levels according to the C_{2v} symmetry operations to lose its importance, but sufficient to cause the $\nu_5 b_2$ and $\nu_6 b_1$ vibrations to appear in the spectrum. It has been possible to give a complete vibrational analysis of the fluorescence bands and make plausible assignments of the long-wave-length absorption bands.

(7) The first excited state of the C_2H_4 molecule should have · (a) one CH_2 group twisted through 90° relative to the other, (b) a pyramidal arrangement of the bonds about each carbon atom. The first excited state of a molecule containing n electrons should have the same symmetry as the ground-state of the similar molecule containing $n + 1$ or $n + 2$ electrons. It therefore becomes possible to confirm these statements concerning the first excited state of C_2H_4 by comparison with what is known of the ground-state symmetry of N_2H_4.

(8) The first Rydberg state of the CH_3I molecule should have: (a) a considerably decreased HCH angle, (b) the iodine atom off the trigonal axis of the CH_3 group. (a) causes the totally symmetrical CH_3 deformation vibration to appear in the spectrum; (b) causes the $\nu_6 e$ vibration to appear. (a) is particularly striking since the excitation is of an iodine electron which, superficially, one might have expected not to affect the CH_3 group.

(9) The C_6H_6 molecule should be distorted in its first excited states both in the molecular plane and out of that plane. The distortion is insufficient for the classification of the levels according to the D_{6h} symmetry operations to lose its importance, but sufficient to cause the appearance of a wide variety of in-plane and out-of-plane deformation vibrations.

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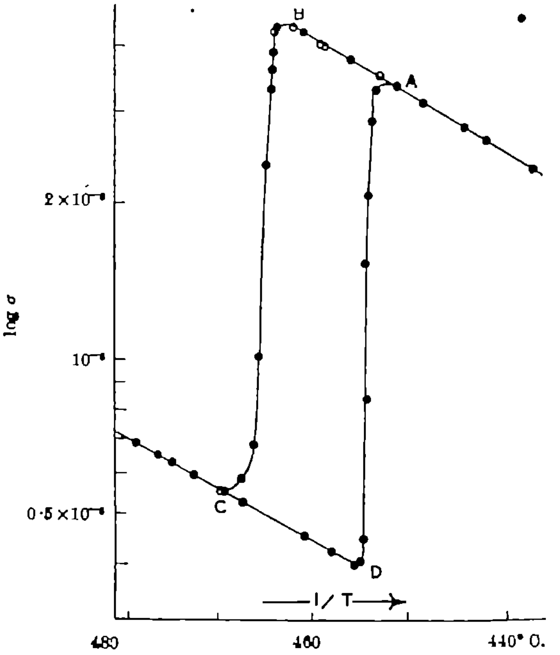
[1] See *Ang. Chem.*, 63, 430 (1951).

Electrical Conductivity of Cæsium Chloride near the Thermal Transition

AT normal temperatures, cæsium chloride is stable in a body-centred cubic lattice, and at higher temperatures in a simple face-centred lattice of the sodium chloride type. When single crystals were heated, it was found, using X-ray techniques, that a sharp transition occurred from one form to the other at 469°. Indications were, however, obtained that certain intensities of X-ray reflexions faded exceptionally rapidly on approaching the transition point[1]. This suggested that lattice defects of some kind might be increasing rapidly in number around the transition temperature. If these defects are of the type associated with ionic conductivity in crystals, a marked increase of electrical conductivity should be observed on passing through the transition point.



●—●—, Descending temperature, O—O—, ascending temperature

Measurements have now been made of the conductivity of cæsium chloride crystals in the form of a polycrystalline mass chilled from the melt between two platinum electrodes. Instead of a rise, a steep drop in conductivity is observed on passing through the transition point. Marked hysteresis is observed around the transition; but above and below it the results are quite reproducible (see graph). The temperature coefficient of conductivity is found to be very approximately the same above and below the transition point, so that the steep drop in conductivity on passing to the high-temperature form must be due to the influence of crystal structure on the temperature-independent parameter σ_0 in the semi-empirical expression for the conductivity, $\log \sigma = \sigma_0 - E/kT$. It seems clear that if there is any pre-transition break-up of the lattice, it cannot be of the kind associated with the defects responsible for ionic conductivity. A similar drop in conductivity has been reported for thermal transitions[2] in mercuric iodide (137° C.) and potassium nitrate (128° C.).

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Paper Electromigration of Flavonoids and Sugars using a High Constant-voltage Current

ALL but a few[1] of the numerous reports in the past few years on the application of electromigration or electrophoresis on paper have used a comparatively low voltage. Recently, however, a method of paper electromigration which uses a high constant-voltage current has been developed in these laboratories and appears to offer a more convenient and rapid procedure than ordinary paper chromatography.

The apparatus for delivery of a current of constant voltage from 100 V. to 1,000 V. is made by modification of that used by Heigl *et al.* as the constant-voltage generator for the photomultiplier of their Raman-spectrum apparatus[2]. In principle, the apparatus for determining migration distance is similar to that of Durrum, with, however, only one cabinet which contains the supporting glass rod for the filter paper and two vessels for electrolyte solutions into which carbon electrodes are dipped.

In use, a filter-paper strip 0·5–2 cm. wide and 40 cm. long is hung from the glass rod with both ends immersed in electrolyte. After applying the substance on the apex, current is passed for 2–4 hr. and the spots revealed by ultra-violet light (3650 A.) or spray reagents. The following examples illustrate the method.

(1) *Flavonoids*. The sample is dissolved in formamide, spotted on the centre of the strip and dried. To detect the spots after migration, the paper is immersed in a 5 per cent ethereal solution of lithium aluminium hydride, dried quickly by hot air, and sprayed with water or dilute hydrochloric acid. The spots appear reddish-yellow or dark green, possibly through the formation of lithium or aluminium complex salts.

In Table 1, where borax is used as the electrolyte, it is interesting to note the relation between the number of adjacent *cis*-hydroxyl groups of the sugar, or the number of vicinal dihydroxy groups of the aglycone, and the migration distance.

Table 1

Flavonoid	No. of adjacent *cis*-OH of sugar	No. of vicinal dihydroxy groups of aglycone	Migration distance to cathode (4 hr.) in mm
Myricitrin	1	1	30
Rutin	1	1	25
Quercetin	0	1	16
Myricetin	0	1	10
Luteolin-7-glucoside	0	1	3
Naringin	0	1	3
Hesperidin	0	0	3
Acacetin	0	0	3
Morin	0	0	2
Robinin	0	0	2

Current. 500 V., 1·5 m amp./cm. width. Paper Toyo filter paper No. 50. Electrolyte: 2 per cent borax solution.

(2) *Sugars*. By application of high-voltage electromigration, all types of sugars may be separated, borax solution proving the best electrolyte (see Table 2).

Table 2

Sugar	Migration distance (4 hr.) in mm.		
	I	II	III
Fructose	+ 67	– 18	– 34
Glucose	+ 56	– 28	– 47
Sorbose	+ 46		– 50
Galactose	+ 84	– 18	– 52
Mannose	+ 21	– 15	– 55
Rhamnose	+ 3	– 22	– 45
Arabinose	+ 21	– 37	– 51
Ribose	+ 57		
Xylose	– 63	– 19	– 46

I. Current 500 V., 1·6 m.amp./cm., 1 per cent borax.
II. Current 650 V., 0·1 m.amp./cm., 3 per cent boric acid.
III. Current 700 V., 0·2 m.amp./cm.; 1 per cent boric acid.
Paper: Toyo filter paper No. 50. Spray reagent: aniline hydrogen phthalate (cf. Partridge, ref. 3).

This work was described at the annual meeting of the Pharmaceutical Society of Japan, November 1951 and April 1952, at Osaka University. Thanks are due to Prof. T. Kariyone, of Kyoto University, and to Dean F. Seto of this College for guidance.

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[2] *Anal. Chem.*, 22, 154 (1950).

[3] *Nature*, 166, 997 (1950)

Colorimetric Determination of Formaldehyde under Mild Conditions

IN the course of work on the neutralization of formaldehyde in living bacterial cultures, it was found that the Hantzsch reaction between acetylacetone, ammonia and formaldehyde proceeded so readily at pH 6 that it afforded a good method of estimating microgram amounts of the latter. The yellow colour due to the formation of diacetyl-dihydro-lutidine is fully developed in two hours at room temperature, the molecular extinction being 8,000 at 412 mμ. The reaction will be fully described elsewhere; but a suitable reagent is known to be $M/20$ acetylacetone and $M/30$ acetic acid in molar aqueous ammonium acetate. The only unexpected interfering substance found was sulphite.

Detailed accounts of this work will be submitted elsewhere.

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A Substance in Animal Tissues which stimulates Ketone-Body Excretion

IT has been known for many years that the glycosuria of clinical diabetes can be prevented by feeding a very high fat diet. Petren[1] showed that if the fat content of the diet was sufficiently great and if the protein content was restricted, the ketosis of diabetes could likewise be abolished. This observation was confirmed by Marks and Young[2] in dogs rendered permanently diabetic by the injection of anterior pituitary extract. They showed not only that a diet consisting entirely of beef suet produced a remission of diabetic glycosuria and ketonuria, but also that the addition of raw horse meat to such a diet caused an exacerbation of ketone body excretion. They were able to extract the factor in the horse meat responsible for the ketonuria and demonstrated that this material was not present in significant quantities in casein. Burn, Lewis and Kelsey[3] showed that alloxan-diabetic rats could be maintained without glycosuria on a high fat diet. Bornstein and Nelson[4] extended these observations and noted that alloxan-diabetic rats exhibiting ketonuria on moderately high fat diets ceased to excrete ketone bodies when the fat content of the diet exceeded 70 per cent. Lazaris and Brzezhinskaya[5] demonstrated that the critical factor in the ketosis of diabetic rats on a high fat diet was the presence or absence of animal protein in the diet. When 'albumenous' material was added to the diet, ketosis ensued, whereas other dietary constituents had no ketogenic effect.

The present study has been devoted to the isolation and characterization of the substance in meat which produces ketonuria when administered to an animal on a high fat diet. Normal black-and-white male rats of the inbred laboratory strain and weighing approximately 180 gm. were placed on a diet consisting of margarine 70 per cent, protein 6 per cent, salt mixture 5 per cent and water 19 per cent, for a period long enough to produce a loss in weight equivalent to 35–40 per cent of the initial body-weight. The diet was then reinforced with all the known B-vitamins. The precipitous fall in weight produced by the unsupplemented diet was arrested by the addition of B-vitamins and, thereafter, the animals maintained their weight or grew slightly. When the protein of the diet consisted of vitamin-free casein, the animals showed little or no ketonuria after 10–14 days on B-vitamins, while animals receiving a washed heat-coagulated dried horse-meat preparation showed a moderate to severe ketonuria (see accompanying table).

Diet	No. of determinations	Total ketone-body excretion* as mgm. acetone/24 hr.
70 per cent margarine + casein	21	0·45 ± 0·22
70 per cent margarine + horse meat	14	11·04 ± 5·25

* Determined by the method of Greenberg and Lester (ref. 6)

The stimulating effect of tissue extracts on ketone-body excretion can be tested in rats fed on the high fat diet containing casein as the protein constituent. Using this test as a rough guide, a fractionation of horse muscle has shown that the ketone-body stimulating substance present in horse muscle resides in the lipid portion and can be recovered chiefly from the mono-amino phosphatide fraction.

Fractional precipitation of *n*-butanol extracts of lyophilized horse muscle has yielded a preparation the properties of which are constant. The preparation is white, crystalline and possesses a sharp melting point (53°) which does not change on repeated re-melting. A chloroform solution of the preparation is optically inactive, and the material is not subject to discoloration on prolonged exposure to air. Sodium fusion gives no evidence of nitrogen, phosphorus, sulphur or halogen, and an emission spectrum fails to demonstrate any significant metallic component. The material reacts with 2 : 4-dinitrophenylhydrazine and can be condensed with benzaldehyde to form a benzylidene derivative. It does not possess the reactions of an aldehyde and is therefore a ketone. The infra-red absorption spectrum (kindly prepared and interpreted by Dr. R. N. Haszeldine, of the Department of Chemistry) confirms chemical evidence suggesting the absence of other reactive groupings, and an absorption band at 5·73 μ supports the probability of a ketone structure. Elemental analysis (by Weiler and Strauss), C : 76·5, H : 12·8, O (by difference) : 10·6 per cent.

Lipid residues obtained from *n*-butanol extraction of calf intestinal mucosa kindly provided by Dr. R. K. Morton were subjected to a purification similar to that above. The material obtained had a melting point of 53°, and a mixed-melting point determination with material obtained from horse muscle showed no depression. The infra-red absorption spectrum of this material from calf intestine showed negligible differences when compared with that obtained from the horse-muscle ketone.

When the ketonic substance from muscle is fed or administered by stomach tube to rats receiving the casein-containing high fat diet, an increase in ketonuria lasting some days is consistently observed. It has not yet been possible to produce a response as great as that observed in animals receiving horse meat in place of casein; but methods of administration and dosage have not yet been completely explored.

It seems likely, therefore, that most of, if not all, the urinary ketone bodies excreted by rats receiving a high fat diet supplemented with meat protein result from the activity of a non-protein component of the meat. The earlier observations were made exclusively in diabetic patients or in animals rendered diabetic by experimental procedures. The present study, in which both alloxan-diabetic and normal rats have been used, indicates that this metabolic factor exerts its effect in normal as well as diabetic animals. The chemical nature of this substance and the means whereby it alters the metabolic pattern are under active investigation in this laboratory.

One of us (H. B. S.) would like to express his gratitude to the Merck Fellowship Board of the National Research Council of Canada, without the generous support of which this work would not have been possible.

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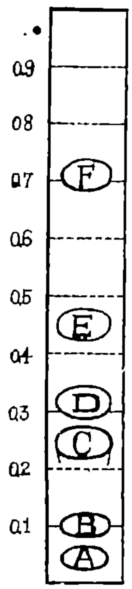
Relation of 3-Hydroxykynurenine to the Ehrlich Diazo Reaction of Urine in Severe Tuberculosis

IT is well known that the urines of cases of severe tuberculosis often show the diazo reaction and the urochromogen test of Weiss. Recently, we have been trying to separate and to identify the substance responsible for these reactions. The results obtained are as follows. 700 ml. of urine obtained from a severe case of tuberculosis, which gave a strong diazo reaction and the urochromogen test of Weiss, was, after being saturated with ammonium sulphate and filtered, shaken vigorously with 140 ml. of 90 per cent phenol. After standing, the separated phenol layer (115 ml.) was shaken with a mixture of 115 ml. of ether with 55 ml. of water. After standing again, we took the separated water layer, which showed a brown colour, and washed it repeatedly with ether until the ether washing showed no more colour. The water extract was concentrated *in vacuo* to 15 ml., in which the greater part of the substance in question was collected. Further purification was performed by chromatographing on filter paper No. 50 of the Tōyō Filter Paper Company, Tokyo, using a system of *n*-butanol, acetic acid and water (4 : 1 : 5) as the developer, ascending method. The concentrate was developed as spots on filter paper strips or wider papers (40 cm. × 40 cm.) for 20 hr. Under ultra-violet illumination, six strongly fluorescent spots appeared (*A*, *B*, *C*, *D*, *E*, *F* in diagram).



Approximate R_F values of fluorescent spots obtained from urine of the severe tuberculous patient on paper chromatography in butanol–acetic acid

Spot *C* represents 3-hydroxykynurenine; it gives an intense fluorescence, the ninhydrin reaction, a strong diazo reaction, and reduces permanganate solution. With the aldehyde reagent (a solution of *p*-dimethylaminobenzaldehyde in hydrochloric acid) it shows a red colour. Synthetic 3-hydroxykynurenine has the same R_F value (0·25) and the same colour tests with the reagents mentioned above.

In addition, the band showing this R_F on the developed filter paper was cut with scissors and extracted with water and the solution examined spectroscopically. Its ultra-violet absorption spectra ($\lambda_{1\,max.} = 270$, $\lambda_{2\,max} = 370$ mμ) were identical in type with those of 3-hydroxykynurenine.

Spot *D* was identified as due to kynurenine by comparison of R_F by paper chromatography with the synthetic compound, with the ninhydrin reaction and the Otani–Honda test. It shows no Ehrlich diazo reaction or the urochromogen reaction of Weiss. Spot *E* is a mixture of kynurenic and xanthurenic acids, because the spot shows the same R_F value on the paper chromatograph as that of these two acids (in our technique these two acids cannot be separated from each other) and gives an intense green colour with ferric chloride solution, Kretschy's colour test, an orange colour with Ehrlich's aldehyde reagent and the urochromogen reaction, but does not show the ninhydrin reaction.

As in the case of B_6-deficient rats[1] fed supplementary tryptophane, it seems probable that the urine of our tuberculous patient might contain, in addition to kynurenine, 3-hydroxykynurenine, kynurenic and xanthurenic acids and conjugation products of these substances.

In fact, the presence of N^{α}-acetyl-3-hydroxykynurenine and a conjugated product of xanthurenic acid might be postulated with high probability, though their amount seems to be small. Spot *F* corresponds to the former because its R_F resembles that of N^{α}-acetyl-3-hydroxykynurenine, which was indicated in the literature[1], and gives the diazo reaction without giving the ninhydrin reaction. Spot *B* corresponds to the conjugate of xanthurenic acid[1], and shows a fainter diazo reaction.

Spot *A* coincides with 3-hydroxykynurenine *o*-glycuronide described by Dalgliesh *et al.*[1] from its ultra-violet absorption spectra ($\lambda_{max.} = 269$ mμ), the R_F on the paper chromatograph, by giving the ninhydrin test but no Ehrlich diazo reaction.

In conclusion, we can say that the major substance which is responsible for the diazo reaction of Ehrlich and the urochromogen test of Weiss is 3-hydroxykynurenine, an intermediate of tryptophane metabolism. Here it must be added that some time since, Dr. S. Oka in this laboratory was able to separate a 3-hydroxyanthranilic acid-like substance by paper chromatography (R_F 0·84, the same as that of pure 3-hydroxyanthranilic acid; positive diazo reaction) from the fraction which was obtained by precipitation with mercuric sulphate from the alcoholic extract of the diazo urine.

We are much indebted to Mr. S. Taga for technical assistance. We thank Prof. T. Sakan for gifts of synthetic 3-hydroxykynurenine and kynurenine, and Prof. Yashiro Kotake and Prof. Yahito Kotake for gifts of kynurenic and xanthurenic acids. To Dr. C. E. Dalgliesh *et al.* we are also indebted for pointing out the identification of the various spots described by them in *Nature*[1] and the relevant ultraviolet spectra.

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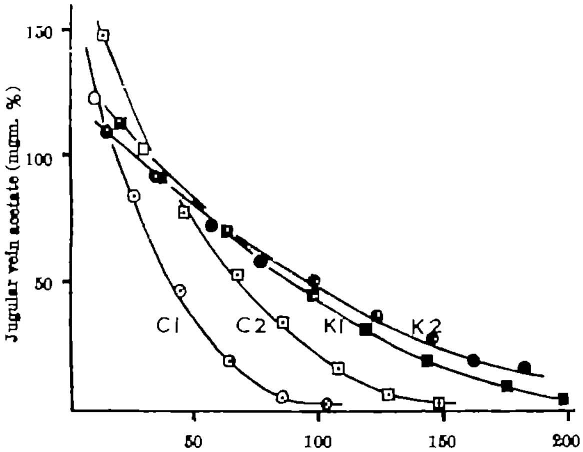
Acetate Metabolism in Ovine Ketosis

DURING the course of an investigation into ketosis in sheep, it was found that ketonæmia in the sheep is accompanied by a marked decrease in the rate at which injected acetate is metabolized.

The technique used was, in effect, an acetate-tolerance test: ewes for the control series were deprived of food for twenty hours before experiment, and then a standard dose of sodium acetate, equivalent to 500 mgm. acetic acid per kgm. body-weight, was injected into the jugular vein. The disappearance of acetate from the circulation and the appearance of ketone bodies were followed by taking samples of venous blood at intervals. Less than 5 per cent of the injected dose appeared in the urine in normal animals. Results have been obtained for sixteen normal ewes at different stages of pregnancy from 60 days to term, and for nine ewes, within two weeks of parturition, showing varying degrees of ketonæmia. The level of ketone bodies in the ketonæmic ewes varied from 9·3 mgm. to 25·5 mgm. per cent (measured and expressed as acetone per 100 ml. whole blood). The disappearance of acetate from the blood was slower in all the ketonæmic ewes than in the normal ewes. Four of the results have been plotted in the accompanying graph. The two curves. *C*1 and *C*2, show the fastest and slowest rates at which the injected acetate was metabolized in the group of sixteen control ewes. The other two curves, *K*1 and *K*2, were obtained from two cases of ketosis in ewes in which the level of ketone bodies were 15·4 mgm. and 17·5 mgm. per cent respectively.

In the ketonæmic animals studied, it was found that the higher the resting-level of ketone bodies. the more marked was the decrease in the rate of disappearance of acetate.



Disappearance of injected acetate. *C*1 and *C*2 give extreme findings in sixteen normal sheep during pregnancy. *K*1 and *K*2 are from two animals with ketosis in late pregnancy

Acetate has frequently been shown to be a precursor of ketone bodies. The injection into sheep of large amounts of acetate results in a small rise in the level of circulating ketone bodies[1]: in the control ewes of this series this was very reproducible both as regards magnitude and duration. In the ketonæmic animals, the acetate injection produced a different response, in that the rise in circulating ketone bodies was both delayed and smaller in amount to an extent which varied with the degree to which the metabolism of acetate was impaired. In these sheep the greater the degree of ketonæmia the less was the apparent conversion of exogenous acetate to ketone bodies.

There is a possible relationship between this derangement and the decreased rate of production of carbon dioxide from isotopically labelled acetate demonstrated *in vivo* in the fasting rat by Coniglio, Anderson and Robinson[2]. The significance of these findings in the sheep, in which the metabolism of absorbed acetate provides an important part of the energy requirements, and their possible relationship to the problem of ketosis, are the subjects of further investigation.

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Relation between Total and Exchangeable Sodium in the Body

EARLY workers, who studied the fate of sodium-24 administered to animals, showed that the isotope exchanged with the sodium of the tissues[1]. They assumed that all the body sodium participated in this exchange. That this assumption is incorrect was suggested by recent results obtained with dogs[2] and humans[3-5], in which 20–35 per cent of the body sodium was estimated to be non-exchangeable with plasma sodium-24.

In order to study directly the relationship between total sodium and exchangeable sodium, sodium-24 was injected intravenously into six adult, well-nourished rabbits. Blood samples were taken periodically and analysed for their radioactivity and sodium content. After varying times (6–96 hr.), the rabbits were killed and small samples of tissues were taken. The bodies were then minced. The tissue samples and portions of the well-mixed minces were dissolved in nitric acid and their radioactivity and sodium content determined[5].

The exchangeable sodium, obtained from analysis of blood samples, was 48 ± 0·75 (s.e.) m.mol. sodium/kgm. body-weight, the value given by analysis of the minces being 46 ± 1·13 m.mol. sodium/kgm. body-weight. These figures are not significantly different, and show that the usual clinical method of measuring exchangeable sodium, as the ratio of the total radioactivity in the patient to the specific activity of the plasma, gives valid results. The total sodium of the rabbits was 62 ± 1·5 m.mol. sodium/kgm. body-weight, that is, the exchangeable sodium was 69 ± 1·7 per cent of the total sodium. The non-exchangeable sodium of the rabbits therefore was 16 ± 1·9 m.mol./kgm. body-weight.

Studies of the exchange of plasma sodium-24 with the sodium of bone in dogs[2] and humans[3,4] have shown that 55–70 per cent of the bone sodium is non-exchangeable. In rabbits[6] this figure is 61–68 per cent. Since the average sodium content of the rabbit bones was 270 m.mol./kgm. bone, the non-exchangeable sodium of bone was about 170 m.mol./kgm. bone; and, as direct measurements exclude the presence of any other major store of non-exchangeable sodium in the rabbit, this means that the bones constituted approximately 10 per cent of the total body-weight, a figure in good agreement with direct determinations[7].

These experiments therefore show that virtually all the non-exchangeable sodium of the rabbit is located in bone and is about 28 per cent of the total body-sodium.

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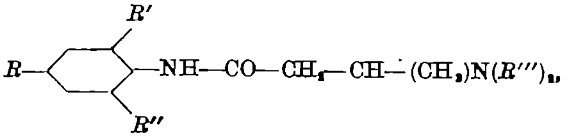
A New Type of Local Anæsthetic

Einhorn and Oppenheimer[1] more than fifty years ago synthesized a powerful local anæsthetic ('Nirvanin', the methyl ester of 3-diethylaminoacetylamino-6-hydroxybenzoic acid). Loefgren[2] prepared a similar compound ('Xylocain', 2-diethylaminoacetylamino-1-3-dimethylbenzene). Since this pioneer work in the field of local anæsthetics, many hundreds of effective compounds have been synthesized and tested; for a literature review on the subject, see Buechi, "Die Entwicklung der Arzneimittelforschung auf dem Gebiet der Lokalanaesthetica"[3].

A new series of compounds[4] of the type



where R = H or alkoxy, R' = H, CH_3 or alkoxy, R'' = H or CH_3, R''' = CH_3 or C_2H_5, has been prepared and shows marked local anæsthetic activity. One member of this series ($R = OC_2H_5$, R' and R'' = H, $R''' = C_2H_5$) was more active in guinea pigs than procaine and showed about half the toxicity in acute toxicity tests on mice. The other members prepared to date show approximately similar pharmacological properties to procaine, although their acute toxicity varies widely. Where R = H, R' and R'' = CH_3, $R''' = C_2H_5$ the toxicity in mice rises to about twenty times that of procaine.

Early attempts were made to synthesize the series from β-brombutyric anilide and dialkyl amines but resulted only in the formation of the anilide of crotonic acid. Treatment of this anilide, however, with excess amine under pressure gave the required substances in good yield.

Treatment of these β-dialkylaminobutyric anilides with concentrated hydrochloric acid yielded the corresponding aniline hydrochlorides and β-dialkylaminobutyric acid, thus establishing the position of addition of the amino group.

Full details of the chemistry and pharmacology of the series will be published elsewhere in due course.

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Sepsis and Cortisone

THAT cortisone is able to suppress the inflammatory reaction irrespective of the nature of the causative agent is now a generally accepted fact. The site at which it is able to exert this effect remains uncertain; but it has recently been shown that cortisone can prevent or nullify an increase in capillary permeability[1], and that its administration is associated with an increase of arteriolar tone[2]. The latter authors consider that these two vascular effects are the most significant factors in the modification of the inflammatory processes.

In order to ascertain whether the effects of cortisone in acute inflammation would be consistent with such a view, we have investigated its influence in pyogenic infection. Eight rabbits were given an intracutaneous injection of 0·1 ml. of a 24-hr. broth culture of a coagulase-positive staphylococcus. Five of the rabbits received intramuscular injections of 10 mgm. cortisone acetate daily during the period of the experiment (commencing 24 hr. before infection) and three animals served as controls. The rabbits were killed on the fourth day after infection; the affected area of skin and subcutaneous tissue was excised, and serial paraffin sections were cut and examined.

There was a marked difference between the appearance of the resulting lesions in the test and control animals, those receiving cortisone showing a sharply demarcated chancroid nodule, in contrast to the less circumscribed fluctuant lesion exhibited by the control. The most striking feature observed, however, was the absence in the cortisone-treated animal of the normal polymorphonuclear infiltration and associated tissue necrosis, which was replaced by a dense mononuclear infiltration with minimal tissue destruction. An additional finding of considerable significance was the complete absence of organisms in the lesions of the test rabbits, whereas all control animals showed their presence in large numbers.

Our findings suggest that the suppression of the inflammatory reaction enables the organisms to disseminate rapidly, as has been observed by Lewis[3] and Antopol[4]. This dispersion from a small focus might be responsible for the severe infections described by Seyle[5] and by Gledhill and Rees[6] in animals treated with cortisone.

Two possible explanations can be advanced for failure to localize the infection: either no inflammatory fibrin barrier is formed and the bacteria are carried away by lymphatic flow, as suggested by Seyle[5], or changes at the vessel wall arrest leucocytic diapedesis and so prevent phagocytosis. Both these factors are probably at work. The mononuclear infiltration, not being entirely dependent upon diapedesis, arises through proliferation or migration in the adjacent tissues.

The absence of necrosis in the cortisone-treated lesions may be attributed to the absence of polymorphonuclears and of exudate containing proteolytic enzymes.

All the above effects of cortisone are more readily and simply explained by an interference with the vascular phenomena of inflammation, as suggested by Ashton and Cook[2], than by postulating its intervention at some other stage. This view is supported by the observations of Moon and Tershakovec[7], who have shown that cortisone does not effect the margination of leucocytes in an inflammatory lesion.

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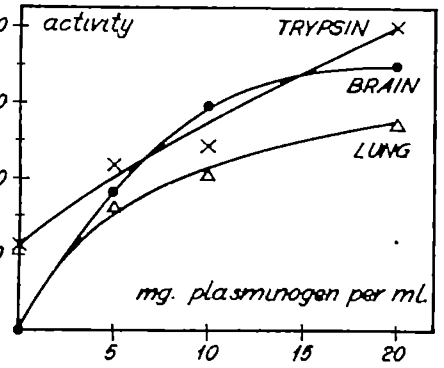
Fibrinolytic Activity of Tissue Extracts and of Trypsin

Macfarlane and Biggs[1] have reported on fibrinolytic enzymes in extracts of human tissues. The recent isolation of a soluble fibrinolytic activator from washed and dehydrated pig heart tissue[2] suggested a re-investigation of the fibrinolytic activity of such tissue extracts.

Saline extracts were prepared from the ground tissue from human lung and pig brain. The extracts were very active when estimated by the standard fibrin plate method[3], where the substrate (bovine fibrin) contains plasminogen. No fibrinolytic effect was observed when the extracts were tested on fibrin plates in which the plasminogen had been destroyed by heating as described by Lassen[4]. However, an effect was obtained when bovine plasminogen was added to the extracts, the size of this effect depending upon the amount of plasminogen applied (see graph).



Fibrinolytic effect of pig brain extract, human lung extract and crystalline trypsin on plasminogen-free fibrin when the concentration of bovine plasminogen in the active solutions is varied Abscissa · Concentration of the plasminogen preparation in the sample Ordinate · Activity recorded as the diameter product (in mm ²) of the lysed zones

It is evident that the fibrinolytic agent contained in these extracts is an activator of plasminogen and not a fibrinolytic enzyme proper. It may be recalled that in extracts prepared from heavily disintegrated tissue (Potter homogenizer, Waring blendor) the fibrinolytic activity is caused by an activator present in the small particles[5].

In similar experiments the effect of plasminogen on the activity of a number of proteolytic enzymes was investigated. An increase in plasminogen concentration had only a slight effect on the activity of chymotrypsin (cryst., Armour), of an *Aspergillus* protease obtained from Dr. W. G. Crewther[6], of a proteinase from *B. subtilis* (obtained from Prof. K. Linderstrøm-Lang, Copenhagen) and of bovine plasmin (prepared by activation with fibrinokinase or spontaneously[7]). However, when trypsin (cryst., Armour) was added, an enormous increase in activity was produced when the concentration of plasminogen was increased (see graph).

Trypsin, therefore, in addition to its effect as a proteolytic enzyme, appears to act as an activator of plasminogen. Most probably this activation depends upon a partial proteolytic splitting of the plasminogen molecule. This action resembles the known effect of trypsin in blood clotting, by which prothrombin is converted into thrombin.

This investigation has been aided by a grant from the Josiah Macy, jun., Foundation, New York.

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Migration and Gregarious Æstivation in the Bogong Moth, *Agrotis infusa*

IN 1834, Bennett[1] reported immense aggregations of the bogong moth, *Agrotis infusa* (Boisd.) (Noctuidae, Lep.), in the clefts and small caves of granite outcrops on mountain-tops in southern New South Wales. There the aboriginal tribes congregated to feast upon these moths, which constituted a valuable fat-rich food. Scott[2] and others confirmed these observations, but no satisfactory explanation for the moth assemblages has been offered.

Aggregations of *A. infusa* have been studied during the past two summers at several sites, between 4,000 ft. and 6,000 ft., on the Brindabella Range in the Australian Capital Territory. Moths began to assemble on the mountain tops late in October and the populations reached a maximum before mid-December. In late November, a large unidirectional flight in a southerly direction was observed at a point four miles north of the chief observation site, Mt. Gingera (6,092 ft.). There was no major decline in populations before the end of March, when all the moths disappeared. In early April, another large unidirectional flight, this time in a northerly direction, was observed near Mt. Gingera.

Strongly gregarious behaviour was indicated by the layer of moths which covered, in a compact imbricated pattern, large irregular areas of the rock surfaces in the crevices and caves. For about one hour night and morning, just after sunset and before sunrise, a small proportion of the moths became intensely active and many indulged in a milling flight over the summit of the mountain, even when the outside air temperature was 7 0° C. At no time during these periods of activity was copulation or feeding observed. Dissections of a hundred female moths taken from the caves at weekly intervals throughout the summer showed that spermatophores were never present in the bursa copulatrix, where they are normally deposited during copulation. Without exception the ovaries were immature and the fat body well developed. Although sugary food was apparently not sought, water may have been ingested from rock surfaces moistened by rain or dew. In the laboratory, moths taken from the assemblages at Mt. Gingera neither copulated nor laid fertile eggs when fed water alone but did so when fed a sucrose solution. Some 10,000 moths, confined to a small cave on Mt. Gingera by means of wire gauze on January 10, behaved in a similar manner to uncaged moths and did not attempt to escape until the end of March when the main moth populations had departed. Again, dissections of samples of the caged females taken at intervals showed that copulation had not taken place and the ovaries were undeveloped.

It seems clear that adults of the spring generation of *A. infusa* migrate in swarms to the mountains, where they æstivate gregariously. At the end of March the moths again migrate, presumably to their breeding grounds. Careful search has not revealed larvæ of this species in the vicinity of the adult æstivation sites although suitable food plants are abundant. The larvæ have, however, been recorded as pests of field crops and pastures over a wide area of the tablelands and western slopes of New South Wales, and in other southern States.

Although migration is now known to occur in many Lepidoptera, *A. infusa* is believed to be the first species in which gregarious æstivation following spring migration has been reported. The monarch butterfly (*Danaus plexippus* (L.)) of North America migrates south during the autumn to hibernate gregariously in southern California and in Florida, migrating north again in the spring[3]. Pepper[4] suggested that the sudden disappearance of the noctuid, *Chorizagrotis auxiliaris* Grote, from Montana and Alberta with the approach of summer may be due to migration to higher elevations where æstivation may be possible at lower temperatures. In Egypt and India, *Agrotis ypsilon* (Rott.) is believed to migrate northwards to the mountains for the summer months[5], but there have been no reports of æstivation.

Detailed results of these studies will be reported elsewhere.

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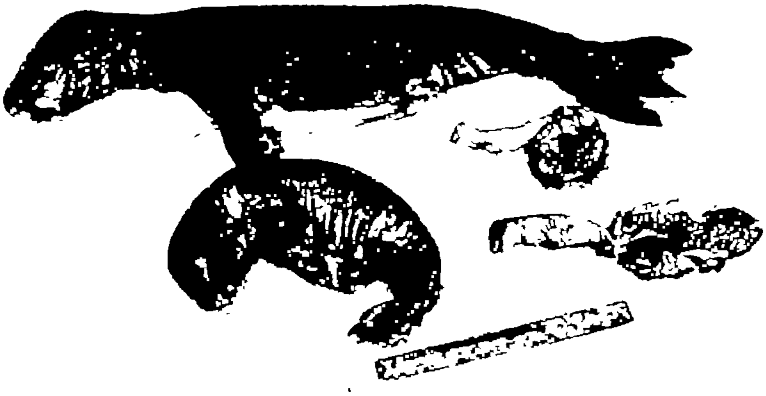
Observations on the Newly Born Leopard Seal



(A.N.A.R.E. Photo)

Leopard seal foetuses aged 2½, 3, 5 and 7 months respectively

PART of the biological research of the Australian National Antarctic Research Expedition at Heard Island during 1951 was aimed at solving the unknown factors about the leopard seal, *Hydrurga leoptonyx* (De Blainville). The rate of fœtal growth for the complete gestation period was investigated and specimens were obtained from February onwards. No newly born pup had previously been seen, because the pregnant females migrate during September–October to the southern pack-ice where the pup is born. To overcome this difficulty, the men at Heard Island constructed a large mobile cage and drove a pregnant female leopard seal into it on September 12 1951. Every three or four days the cage was dragge into the sea at low tide and left for the rest of the day The seal would not feed during captivity, but it wa noticed that she drank large quantities of sea wate on being placed in the ocean.

Some days before pupping, the female assumed characteristic position, lying on its side. Uterine an vaginal contractions were easily discernible an movements of the fœtus reached a maximum as th date of birth approached. Contractions were sometimes accompanied by moaning noises and considerable restlessness. Whether or not parturition was rapid process is unknown since, in this case, birt occurred unseen between 9 p.m. and 6.45 a.m. o November 14.

From the position of the mother, pup and placenta it is assumed that the pup was born head first in manner similar to the sea elephant and the othe three Phocids. The umbilical cord attached to th placenta was probably broken by the pup in it movements and remained as a stub about 4 in. i length. The newly born pup was 62 in. in length an weighed 65 lb.

Measurements were :

Flipper length (inside)	16 in.	Girth before tail	19 i
Tail flipper length (inside)	16 ,,	Neck circumference	17 ,
Girth behind flippers	24 ,,	Width at flippers (ventral)	12 ,

The eyes were open at birth and the adult dentitio was well developed, the tips of the canines and on incisor being visible externally. The placenta showe no special peculiarities and weighed 6 lb.

The behaviour of the parent to the pup after birt must be regarded conservatively in this case, sinc the pup was dead during its observation. Two fact are apparent, however : first, the mother was affe tionate towards the pup and indignant at intrusion and secondly, she displayed a definite desire to kee the pup warm. This latter point was most noticeabl the mother lying alongside the pup and keeping th closest possible contact with it.

The birth of the sea leopard pup would appear follow the pattern of parturition in other types seals. The advanced developmental stage of the adu dentition indicated that the period of lactation wou be very short, probably from ten to fourteen day If the rate of growth followed the trends of oth

Phocids, the pup would have a weight of about 125 lb. at weaning.

Apart from rate of fœtal growth, many other investigations were carried out. The milk dentition, which it reabsorbed before birth, was ascertained by taking X-rays of fœtuses. More than a hundred animals were branded and their movements studied for migration, etc. All the information is now being prepared for a comprehensive paper on the biology of the leopard seal.

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Melbourne.
April 28.

Terramycin in the Treatment of Experimental Rabies in Mice

The following experiment was carried out to test the value of terramycin[1] in the treatment of experimental rabies in mice.

The strain of rabies virus used in this experiment was Paris fixed strain. It was obtained in 1935 from the Public Health Laboratories in Jerusalem. Since that time it has been maintained in rabbits and sheep and used in these laboratories for the routine preparation of antirabic vaccine. It never failed to produce paralytic rabies in sheep, rabbits and mice in 6–7 days. Its potency is such that the L.D.50 for mice, calculated by the method of Reed and Muench, is $0 \cdot 03$ ml. $\times 10^{-5}$ brain emulsion[2].

The mice used were albino Swiss mice which were originally obtained from Dr. Mahaffy, of the Virus Reference Laboratory, Entebbe, and bred locally in Khartoum for the past twelve years. The average age of the mice used in this experiment was three weeks. Each mouse was weighed and the dose of terramycin required was calculated. Each mouse received 150 mgm. of terramycin per kgm. body-weight twice daily with an interval of four hours between the two doses.

Crystalline terramycin hydrochloride in capsules manufactured by Chas. Pfizer and Co., Inc., was used. The contents of one capsule (250 mgm.) were put in a 100-ml. conical flask and 25 ml. of McIlvaine's phosphate–citric acid buffer solution, *p*H 7·0, added. The flask was then shaken thoroughly until a fine emulsion was obtained. A fresh preparation was made daily and kept at 4° C. in the refrigerator until required.

Three groups of mice each consisting of ten mice were used. Each mouse was lightly anæsthetized with ether and then injected intracerebrally with 0·03 ml. of 1 per cent brain material emulsified in normal saline. Group 1 was left without further interference to serve as controls. Group 2 was treated with intramuscular injections (150 mgm. per kgm. body-weight) of terramycin twice daily. Treatment was started half an hour after the intracerebral injection, repeated four hours later and continued twice daily for six days. Group 3 was similarly treated with terramycin for six days, but the intraperitoneal route was used in this group.

On the sixth day of injection, all the thirty mice in the three groups developed paralysis, which started in the hind legs and then became generalized. The mice died of typical paralytic rabies on the sixth or seventh day. No difference whatsoever was noted between the mice treated with terramycin and the untreated control mice, either in the incubation period or in any other feature of the disease. Hence we conclude that terramycin has no value in the treatment of experimental rabies in mice.

M. A. Haseeb

Stack Medical Research Laboratories,
Khartoum, Sudan.
June 4.

[1] Finlay, A. C., *et al.*, *Science*, 111, 85 (1950).

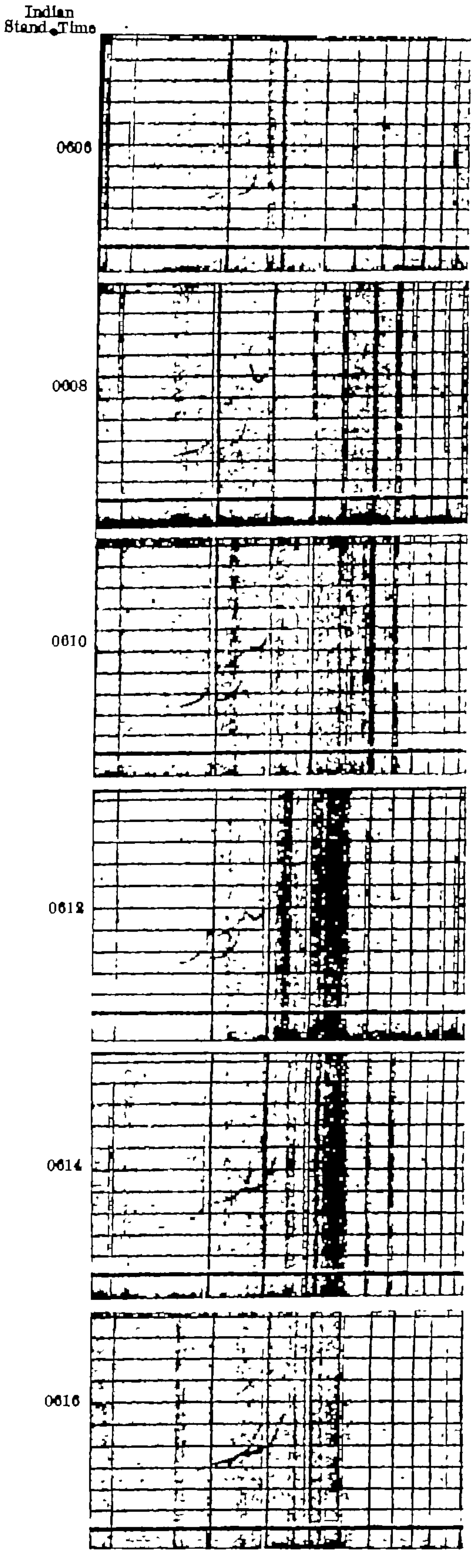
[2] Kirk, R., Haseeb, M. A., and Davis, A. T., *Trop. Med. and Hyg.*, 78, 167 (1950).

A New Early-Morning Ionospheric Phenomenon

Early in January 1952, when ionospheric observations were started at Kodaikanal (10° 14′ N., 77° 28′ E.), an interesting phenomenon, which, to my knowledge, has not hitherto been reported, was observed in the vertical-incidence virtual height/critical frequency records. It was found that on most of the mornings ionospheric echoes ceased to return some minutes to several hours before sunrise and reappeared at about ground sunrise time. Systematic daily observations were started early in March and *h′f* records taken at short intervals beginning about an hour before sunrise daily with the view of examining the frequency of occurrence and any possible seasonal characteristics of this 'no echo' phenomenon.

The observations consisted in photographing the *h′f* patterns at 1- or 2-min. intervals with the *C.R.P.L.* type *C*-3 recorder of the Kodaikanal Observatory covering 1–25 Mc./s. and with peak pulse power of approximately 10 kW. The antenna system consisted of two multiple-wire deltas having reasonably flat impedance over the operating frequency-range and the desired vertical direction of maximum radiation. The records thus made cover a period of five months (March–July 1952) and on examination indicate that on about 60 per cent of the days during these five months ionospheric echoes ceased for some time during the pre-dawn period. The overnight stratum in the *F*-region present at virtual heights of 200–300 km. disappeared gradually without showing any appreciable sharp drop in critical frequency (which is of the order of 1–3 Mc./s. during early mornings). The 'no echo' condition lasted until about the ground sunrise time, when reflexions began to be received from markedly greater virtual heights of 300–500 km. Records taken at 15-min. intervals on the morning of April 30, 1952, show that pulse returns ceased between 0500 and 0515 hr. and did not begin again until shortly before 0545 hr. (All times are given in Indian Standard Time, which is 5 hr. 30 min. ahead of G.M.T.)

On other mornings when ionospheric echoes were received throughout, high-speed ionospheric soundings showed remarkably characteristic sunrise effects in the *F*-region. Almost simultaneously with the ground sunrise, a stratum formed somewhere between 300 and 600 km. The virtual height of the new stratum decreased rapidly until it merged with the overnight layer, usually present at a virtual height of about 200–250 km. The accompanying photographs are of a sequence of *h′f* records obtained on one such morning; they were taken at 2-min. intervals on March 9, 1952, and illustrate the characteristic sunrise effect observed at this location.



A study of sunrise effects in the ionosphere has been made by Wells[1] at Derwood Experimental Laboratory, D.T.M., Carnegie Institution of Washington. Sunrise effects have been defined as the initial characteristic rise of ion density in the neighbourhood of sunrise. At Kodaikanal, the abrupt appearance of echoes from relatively great virtual heights, such as shown in the records for March 9, 1952, has enabled the determination of the precise times of these effects. A study of successive $h'f$ records at 1- or 2-min. intervals on selected days when such records were available indicates that, notwithstanding a certain amount of scatter, the sunrise effect and the ground sunrise were simultaneous during the month of March; during April, the ionospheric effect occurred 2 min. after the ground sunrise, and during May, June and July it occurred 3½ min., 6 min. and 5 min. respectively before the ground sunrise.

I wish to thank Dr. A. K. Das, director of the Kodaikanal Observatory, for his advice in writing this note.

B. N. Bhargava

Kodaikanal Observatory,
India. Aug. 15.

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[1] Wells, H. W., *J. Geophys. Res.*, **54**, 277 (1949).

Automatic Particle-Sizing by Successive Countings

Walton[1] has recently summarized informal discussions among workers in Great Britain on methods for the automatic counting and sizing of particles dispersed on microscope slides. The field is normally scanned with a beam of light, and the changes in transmission or reflexion as the scanning beam (for example, a slit or a spot) encounters particles, or parts of particles, are detected photoelectrically. The quantities that can be measured are the pulse-heights (related to the areas of the particles), the pulse-lengths (related to the lengths of particles) and the number of pulses. Methods of counting have been based on measurements of the number of pulses occurring in the area swept by the scanning aperture; but all proposals for sizing have been based on the measurement of pulse-heights or pulse-lengths. It is the purpose of this communication to point out that sizing also can be carried out by recording only the number of pulses. The relatively simple instruments designed for counting can therefore be employed for sizing.

It is obvious that if the geometry of the scanning aperture or the response-level of the detecting device can be arranged so that the number of pulses recorded is dependent on the size of the particles, then the size distribution can be obtained by repeated counting with different scanning apertures or response-levels. For example, if the field is scanned with a slit and a count is recorded only when the slit is totally obscured, the number of pulses recorded is clearly dependent on the size of the slit relative to the size of the particles; there will be no count for a very large slit, whereas every particle in the scanning track will produce a recorded pulse with a sufficiently small slit. In the general case, the scanning aperture may have any shape and any orientation relative to the direction of scan or may consist of several apertures such as a pair of scanning spots. In addition, the response-level of the detecting device may be set to any finite value.

In one of the simplest applications, the field is scanned, not necessarily systematically, with a slit of width w (perpendicular to the direction of scan) which is varied in repeated scans from w less than a, the size of the smallest particle present, to w greater than b, the size of the largest particle. The number of times, $m(w)$, the slit is totally obscured in unit length of scan is recorded for each of several scanning track widths, w. If the number of particles (of all sizes) per unit area of the field is N, it can be shown that the size distribution is given by $1/N$ times the second derivative of the observed frequency distribution $m(w)$.

An alternative method, especially suitable for use with the 'flying-spot' microscope[2], is to scan the field with two spots (each smaller than the smallest particle present), the distance apart of which, w, is similarly varied over the range a–b in repeated scans of the field. The frequency $m(w)$ is the number of times per unit length of scan that both spots are simultaneously obscured. It is not necessary, however, to provide separate detecting devices for the two spots or coincidence circuits for recording simultaneous pulses. It can be shown that $m(w)$ is equal to the difference between *twice* the number of pulses observed with a *single* spot (in a separate scan) and the number of times that two spots encounter particles simultaneously or separately. The latter number is measured by a single detecting device behind the two spots, so that simultaneous interceptions produce only single pulses.

The theoretical treatment, although simple, can only be outlined here. A slit describing a scanning track of width w across a field of particles intercepts, in unit length of track: m_1 whole particles of size d less than w; $2m_2$ part particles of any size overlapping one or other edge of track; and m_3 part particles of size d greater than w lying right across the track. Since the number, $m_2 + m_3$, of particles lying on either edge of the track is, on the average, equal to the number per unit length occurring in a strip of width given by the average particle size $\overline{d}$, the effective width of the scanning track is $w + \overline{d}$. We have also that $m_2 + m_3 = N\overline{d}$. Thus, the number per unit area is $N = (m_1 + 2m_2 + m_3)/(w + \overline{d})$, and hence

$$\overline{d} = (m_2 + m_3)/N \text{ and } N = (m_1 + m_2)/w.$$

These relations, being independent of the particle-size relative to the slit-width, are applicable to particles of any given size d when N and m refer to the numbers of that size. The relation above between $m(w)$ $(= m_3(w))$ and the size distribution follows readily. There are corresponding relations for $m_1(w)$ and $m_2(w)$. The significance of the 'size' measured cannot be discussed here, but it may be noted that the average size $\overline{d}$ is the average Feret diameter, which Walton[4] has shown, for particle-shapes having no re-entrant angles, to be equal to the perimeter diameter (the diameter of a circle having the same perimeter as the particle).

The number of particles per unit area, N, and also the average size $\overline{d}$, can be found by several methods. For example, with a slit of width w, the number of pulses per unit length is $m_1(w) + 2m_2(w) + m_3(w) = N\overline{d} + Nw$; and N and $\overline{d}$ may be deduced from measurements with two slit-sizes or with a slit and a guard spot. The slits may be of any size and need not be larger than b, as Wolff[3] implies. Again, with two spots at a spacing w less than a, the number of pulses is $2m_2(w) + m_3(w)$; while the number of pulses for a single spot is $m_2(w) + m_3(w)$; the difference $m_2(w)$ is equal to Nw, since $m_1 = 0$ when w is less than a. This method is more general, and experimentally simpler, than the double-spot counting procedure described by Roberts and Young[5], which requires systematic scanning with two 'labelled' spots having separate detecting devices.

Experimental investigations are in progress, and a full account will be published elsewhere.

P. G. W. Hawksley

British Coal Utilization Research Association,
Randalls Road,
Leatherhead, Surrey.
Sept. 1.

[1] Walton, W. H., *Nature*, 169, 518 (1952)
[2] Young, J. Z., and Roberts, F., *Nature*, 167, 231 (1951).
[3] Wolff, H. S., *Nature*, 165, 967 (1950)
[4] Walton, W. H., *Nature*, 162, 329 (1948)
[5] Roberts, F., and Young, J. Z., *Nature*, 169, 962 (1952).

Four-strand Crossing-over

T. C. Carter and A. Robertson, in a recent publication[1], have discussed a model of genetical interference in diploids, introducing explicitly postulated components of chiasma and chromatid interference. It appears, however, that their work is accompanied by certain misconceptions and erroneous pronouncements.

Carter and Robertson object to my view[2,3] that in many situations it is unnecessary to consider explicitly the detailed interaction of the four strands of a meiotic bivalent in bringing about genetical recombination. Such situations are those in which the observed frequencies are determined only by the probability distribution of exchange points on a single strand. The great majority of genetical studies on diploids do, in fact, relate to such situations, and it is much more rarely that an organism provides evidence concerning the simultaneous distribution of the exchange points on two, three or four strands of the same bivalent. Consequently, attempts to set up *detailed* models of four-strand interaction will, in the majority of cases, necessarily require an abundance of *ad hoc* hypotheses which are incapable of verification from genetical data, and therefore impose artificial restrictions on theory, entailing an undesirable lack of generality.

With these considerations in mind, I asserted that in such cases (admitting only of the examination of single strands) it is sufficient in formulating a mathematical description to confine attention to the probability distribution of exchange points upon any single one of the four strands produced in meiosis. This view, which seems to me to express merely an exceedingly simple and obvious logical proposition, is regarded by Carter and Robertson as "unsupportable". They say that in my treatment I was tacitly employing a two-strand model, and was, moreover, describing the distribution not of exchange points but of chiasmata. There is, however, no foundation for these statements.

Since the major difficulty experienced by Carter and Robertson is a logical one, I would like to put forward a simple analogy. Suppose that a quality control inspector has to check the dimensions of aluminium rods. I, together with most people, would say that all he requires is a single specification applicable to any rod produced by the manufacturing process. Carter and Robertson would seem to insist that he be provided with a specification descriptive of batches of rods as produced simultaneously by the machines.

In my own treatment[2-4] I did, in fact, deal with four-strand recombination and *not* two-strand. I dealt with exchange points and not with chiasmata as Carter and Robertson assert. Further, I have given various formulæ which in my papers[2,3] are labelled explicitly as referring to exchange points. These have been quoted by Carter and Robertson (out of context) as referring to chiasmata. As I shall show, this course, which seems to have been adopted as a result of a primary misconception, is likely to lead to error.

My treatment was first developed in terms of an unspecialized interference function $f(t)$, relating to exchange point intercepts, which can be specialized in ways considered most likely to fit experimental data. At the next stage in the argument I selected a special form, $4te^{-2t}$, which remarkably unites two advantages. First, it is mathematically very convenient, and secondly has been found to accord well with empirical evidence[3-5]. Now it so happens that the *general* theory (prior to specialization) is formally applicable to chiasmata as well as to exchange points. But at the stage where specialization of $f(t)$ becomes necessary, I deliberately chose the form $4te^{-2t}$ as descriptive of exchange points and *not* of chiasmata. At a critical stage in the construction of their own model, Carter and Robertson find need to insert in their formula some theoretical chiasma statistics, and 'solve' this problem by taking over formulæ of mine (based on the function $4te^{-2t}$) which, in fact, were chosen by me as appropriate to exchange point statistics. No critical examination is made of the suitability of these formulæ with regard to empirical justification when applied to chiasmata. To say the least, this slip seems likely to impair the value of the mathematical structure they have erected.

I might add, in conclusion, that at the time my paper was published, I had investigated the compatibility of the function $4te^{-2t}$ with the mechanism of four-strand exchanges, and confirmed that it was consistent with a variety of models involving different intensities of chromatid and chiasma interference[5].

A. R. G. OWEN

Department of Genetics,
Cambridge.

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[1] Carter, T. C., and Robertson, A., *Proc. Roy. Soc.*, B, **139**, 410 (1952).
[2] Owen, A. R. G., *Proc. Roy. Soc.*, B, **136**, 67 (1949).
[3] Owen, A. R. G., "Advances in Genetics", **3**, 117 (1950).
[4] Owen, A. R. G., *Nature*, **168**, 208 (1951)
[5] Owen, A. R. G., Ph.D. dissertation, University Library, Cambridge (1948).

DR. A. R. G. OWEN has developed the mathematical treatment of linear sequential events. He applied it to the occurrence of exchange points in a gamete, that is, those chiasmata at the preceding meiosis in which the strand entering the gamete took part: chiasmata involving only other strands were not considered. To describe this as a four-strand model is true only in so far as three emergent strands are disregarded; it can equally well be described as a model with two, three or any number of strands. The resulting equations are formally identical with those of a two-strand model; for this reason chromatid interference, which is a multi-strand phenomenon and of which there is sound cytological evidence[1], cannot be distinguished from chiasma interference.

This model seemed to us biologically unsatisfactory; we therefore applied Owen's treatment of sequential events to chiasma formation in a four-strand model, which allowed an explicit treatment of chromatid as well as chiasma interference.

T. C. CARTER
ALAN ROBERTSON

Institute of Animal Genetics,
West Mains Road,
Edinburgh 9.

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[1] Huskins, C. L., and Newcombe, H. W., *Genetics*, **26**, 101 (1941).

Computing Machine Terminology

IN a recent letter in *Nature*[1], Prof. R. O. Kapp raises a protest against the use of certain expressions current in the vocabulary of computing machine designers. The chief burden of Prof. Kapp's remarks is directed against the use of anthropomorphic terms, and it is perhaps of interest to see how these arose. The earliest idea for an all-purpose computing machine, in the modern sense, was due to Charles Babbage[2], who used the terms: mill = portion of machine which operates on numbers; store = portion of machine which holds numbers and emits or absorbs them at the direction of the machine.

When the actual construction of an electronic calculator was first considered, by von Neumann and his group, the logical design was made to depend, to a considerable extent, on what were, at that time, conceived to be the neurological mechanisms o animals. This led to the development of a nomenclature which had the characteristics deprecated by Prof. Kapp.

In fact, most designers (as distinct from the "enthusiasts" of Prof. Kapp) now favour a more down-to-earth vocabulary in which, for example, 'memory' is replaced by the less exceptionable word 'store'. On the other hand, Prof. Kapp is not correct in stating that the words 'setting' and 'adjustment' are synonymous with the 'instruction' and 'teaching' of computer parlance. Neither does the word 'readings' have much relationship to the 'information' given to a computer.

So far as Prof. Kapp's 'code' is concerned, this word is very widely used in computer technology, and the equivalent 'machine language' has been added by linguists and semanticists who have recently 'discovered' these machines.

It has not been possible, in a short note, to conside in detail the technical meaning of the words give above; but it is worth pointing out, in conclusion that the word 'decision'—or as we prefer it, 'conditional transfer of control'—does not necessarily impl that the machine follows a pre-determined sequen of events. On the contrary, the conditional transfe is frequently used in order that the machine shoul select between alternative courses of action in manner which may never become known to the huma operator.

ANDREW D. BOOTH

Birkbeck College Computation Laboratory,
London, W.C.1.
Oct. 16.

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[1] Kapp, R. O., *Nature*, **170**, 547 (1952).
[2] Babbage, H. P., "Babbage's Calculating Engines" (Spon and Co. London, 1889).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, December 6

North of England Institute of Mining and Mechanical Engineers (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—General Meeting.

Monday, December 8

Physical Society, Acoustics Group (at the Science Museum, Exhibition Road, London, S.W.7), at 5 p.m.—Mr. G. Bradfield: "Measurement of Elastic Constants of Solids".

British Society for the History of Science, Philosophy of Science Group (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. E. Schrodinger, For.Mem.R.S., and Prof. Max Born, F.R.S.: Discussion of Prof. Schrodinger's paper "Are there Quantum Jumps?"

Manchester Literary and Philosophical Society (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Mr. W. B. Fagg: "The Nature of African Art".*

Society of Chemical Industry, Corrosion Group (joint meeting with the Yorkshire Section of the S.C.I., and the Sheffield Metallurgical Association, at the Grand Hotel, Leopold Street, Sheffield), at 6.45 p.m.—Dr. U. R. Evans, F.R.S.: "The Corrosion Resistance of Stainless Steels".

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr G. W. Murray: "Land of Sinai".

Tuesday, December 9

University of London (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 1.15 p.m.—Prof. A. H. Smith. "English Place-Names".*

Chadwick Public Lecture (at the Wright–Fleming Institute, St. Mary's Hospital Medical School, Norfolk Place, London, W.2), at 4.30 p.m.—Dr. A. I. G. MacLaughlin: "The Prevention of Dust Diseases of the Lungs" (Malcolm Morris Memorial Lecture).*

Institution of Mechanical Engineers, Automobile Division at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. H. E. Merritt: "The Place of Research in the Engineering Process with particular reference to the Automobile Industry".

Institution of the Rubber Industry (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Mr. N. C. H. Humphreys: "Matching Rubber Compounds"; at 7 p.m.—Mr. G. F. Morton and Mr. P. Hatfield. "Recent Applications of Physics to Inspection Methods in the Rubber Industry".

Illuminating Engineering Society (at the Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. H. C. Weston: "Visual Fatigue".

Society of Chemical Industry, Plastics and Polymer Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Discussion on "Bulk Polymerization".*

Wednesday, December 10

Royal Society of Medicine, Pathology and Medicine Sections (at 1 Wimpole Street, London, W.1), at 5.15 p.m.—Discussion on "Chemotherapy of Tuberculosis".

Institute of Petroleum (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Symposium on "Liquefied Petroleum Gases" (Mr. E. Squire: "Production"; Mr. S. Shaw: "Distribution"; Mr. T. H. Taylor: "Applications").*

British Institution of Radio Engineers, North-Eastern Section (at the Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne), at 6 p.m.—Mr. G. D. Clifford: "The Development of the Radio and Electronics Industry in India".

Institution of Electrical Engineers, Education Discussion Circle (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "The B.B.C. School, Evesham" and "The Post Office School, Stone" (to be opened by Dr. K. R. Sturley and Mr. H. R. Harbottle).

Society of Chemical Industry, Nutrition Panel of the Food Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Discussion on "The Problem of Future World Food Supply". (Speakers: Mr. F. Le Gros Clark and Dr. E. W. Russell.)

Thursday, December 11

British Society of Rheology (at the Institute of Physics, Belgrave Square, London, S.W.1), at 2 p.m.—Symposium on "The Rheology of Foodstuffs".

Physical Society. Optical Group (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Scientific Papers.

Royal Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. A. W. Merrison and Mr. E. R. Wiblin: "The Total Neutron Cross-section of Cobalt, Silver, Iodine, Aluminium, Nickel and Gallium between 1 eV. and 5 keV."; Mr. J. Dyson: "An Interferometer Microscope for Opaque Objects".

Royal Meteorological Society (in the Beveridge Hall, University of London, Senate House, Malet Street, London, W.C.1), at 5.30 p.m.—Dr. G. M. B. Dobson, F.R.S.: "The Upper Atmosphere". (Meeting is open to Sixth Form students.)

Friday, December 12

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

Institution of Mechanical Engineers (joint meeting with the Applied Mechanics Group, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. Nicol Gross. "Experiments on Short-radius Pipe-bends".

North-East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. Hayne Constant, F.R.S.: "The Application of Research to the Gas Turbine" (David Laing Lecture).

Society of Chemical Industry, Fine Chemicals Group (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Mr. E. L. Streatfield: "Ion Exchange and its Application in the Fine Chemicals Industry".

Royal Institution (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. W. H. Pearsall, F.R.S.: "Habitat, Vegetation and Man".

Friday, December 12—Saturday, December 13

Universities of Great Britain and Northern Ireland (in the William Beveridge Hall, University of London, Senate House, Malet Street, London, W.C.1).—Conference.

Friday, December 12

At 2.30 p.m.—"Halls of Residence and Student Amenities".

Saturday, December 13

At 10.30 a.m.—"Success and Failure at the University"; at 2.30 p.m.—"Vacation Employment".

Saturday, December 13

British Psychological Society (in the Anatomy Theatre, University College, London, W.C.1), at 2.30 p.m.—Mr. Philip L. Short: "Some E.E.G. Findings in relation to Psychological Factors".

British Association of Chemists (at the Waldorf Hotel, Aldwych, London, W.C.2), at 3 p.m.—Thirty-fifth Annual General Meeting

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APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Bacteriologist (honours graduate, preferably with research experience) to work on problems of hygiene in the dairy industry—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 52/15 (December 13).

Lecturer in Chemistry at the Technical College, Coatbridge—The Director of Education and Deputy County Clerk, Lanarkshire House, 191 Ingram Street, Glasgow, C.1 (December 13).

Scientific Officer (with an honours degree in biochemistry or physiology) in the Nutrition Department, to take part in work that will include the determination of the biological value of proteins, the study of calcium and phosphorus metabolism using radioactive tracers, vitamin D assays and general nutritional experiments with rats—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 52/14 (December 13).

Supervising Geophysicist to be responsible for the supervision and direction of all field, laboratory and office operations regarding geophysical prospecting for radioactive minerals, a Senior Geophysicist to take charge, under direction, of field, laboratory and office investigations of a group engaged in air-borne scintillometer survey, a Geophysicist (Grade 3) to take charge, under direction, of a party engaged in the field and/or laboratory on radio-metric investigations in connexion with the search for deposits of radioactive minerals, a Geophysicist (Grade 2) to carry out, under direction, field, laboratory and office investigations concerning deposits of radioactive minerals; a Supervising Geologist to be responsible for the supervision and direction of field operations of the radioactive group of the metalliferous deposits sub-section, a Geologist (Grade 3) to carry out, under direction, the more advanced types of petrological and mineralographic investigations and compile reports thereon, or to take charge, under direction, of a party engaged in the geological mapping of deposits of radioactive minerals, a Geologist (Grade 2) to carry out in the field, under direction, mapping of deposits of radioactive minerals, and assist in the preparation of reports; in the Bureau of Mineral Resources, Geology and Geophysics, Australia—The Deputy High Commissioner, Australia House, Strand, London, W.C.2, endorsed 'for attention of The Senior Representative, Division of Industrial Development' and stating position applied for (December 20).

Fellowship in Pure or Applied Mathematics—The Registrar, Trinity College, Dublin (December 31).

Senior Lecturer or Lecturer in Physics at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (January 1).

Statistician in the Department of Agriculture and Horticulture at Long Ashton Research Station—The Registrar and Secretary, The University, Bristol 8 (January 3).

Lecturer in Physical Chemistry at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 17).

Biochemist at the South Devon and East Cornwall Hospital, Greenbank Road, Plymouth—The Group Secretary, Plymouth, South Devon and East Cornwall General Hospital Group, 7 Nelson Gardens, Stoke, Plymouth.

Chemist (Senior Scientific Assistant) at the Central Laboratory, Chiswick, with responsibility for section dealing with paints and surface protection—The Staff Officer (F./EV.223), London Transport, 55 Broadway, London, S.W.1.

CHEMISTS at Ministry of Supply research establishments in Southern England for (*a*) work in laboratory providing chemical services, including effluents testing, process control, and boiler-water treatment (industrial experience desirable), (*b*) inorganic analysis (experience of radiochemistry desirable), (*c*) general chemical work (some experience of paint technology of advantage), and (*d*) physical chemistry research—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting E 735/52A.

ELECTRICAL ENGINEER for the Central Electrification Scheme, Cyprus—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M 29024 B.

PLANT PATHOLOGIST (with honours degree in botany and at least two years' postgraduate experience), Nyasaland, for advisory and investigational work, mainly at Lilongwe Research Station—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSC.63/4/01.

PRINCIPAL—The Clerk to the Governors, Loughborough College of Technology, Loughborough

SCIENTIFIC OFFICERS (with first- or second-class honours degree, or equivalent, in physics, engineering or mathematics) for operational research on a wide variety of problems in London and provinces, under direction of Scientific Adviser to the Air Ministry—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.285/52A.

SILVICULTURAL ECOLOGIST (with good honours degree with two years' postgraduate experience which must include work on soils) in Malaya, for research in the reclamation of degraded soils and waste-land, to restore fertility and productivity, possibly by introduction of suitable forest cover—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CSC.87/60/01

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EDUCATION AND TRAINING OF METALLURGISTS

A JOINT Committee on Metallurgical Education was formed in 1945 by the councils of the Iron and Steel Institute, the Institution of Mining and Metallurgy, the Institute of British Foundrymen, the Institute of Metals and the Institution of Metallurgists to advise them on all matters concerning metallurgical education in the United Kingdom. This Committee has previously issued two reports ("Qualifications for Entrance to University Schools of Metallurgy" (February 1948) and "Recommendations on University Full-time Degree Courses in Metallurgy" (1950)) dealing with the university education of metallurgists, and has now issued a third* which covers the whole field of metallurgical education and training, ranging from the training of operatives in the techniques they practise, to the university education and subsequent training in industry of the highest grade of professional metallurgists. The view expressed in an earlier report that "The Universities are at present, are likely to be and should continue to be the chief source of high-grade technologists" is reaffirmed, and the university schools are urged to expand their output to the utmost of their ability. In line with a growing feeling in industry, it is recommended that university courses in metallurgy should provide education in management and administration, and that undergraduates reading metallurgy should have more opportunity for contact with cultural and humanistic subjects. These are important and significant recommendations which may well point the way which university courses in metallurgy will follow during the next few years.

So far as industry is concerned, the Committee makes two recommendations with regard to graduates. The first is that employers should make the fullest possible use of postgraduate studies available in Britain by financing attendance of suitable employees at one of the recently established Postgraduate Schools of Metallurgy at Birmingham or Sheffield. The second is that formal methods for training graduates immediately they enter industry should be adopted more widely.

Undoubtedly the most important part of the report, and one which is likely to influence future developments most profoundly, is that which is concerned with technologists who obtain their education by part-time study. It is probably not going too far to say that such men are the backbone of the metallurgical industry in those regions of Great Britain where, for many years, there have been part-time courses leading ultimately to a local 'associateship' of a very high standard. Unfortunately, not all regions have provided equal educational facilities; unfortunately, too, not all students have been able to complete the course, and the unsuccessful ones have received no formal qualification when they have reached the limit of their capabilities. The Joint Committee now recommends the rationalization of such part-time education on a national scale, with corporate membership of one of the professional metallurgical institutions (generally the Institution of Metallurgists) as the ultimate goal of all technological pupils in metallurgy. Thus, the Ordinary and Higher National Certificates in Metallurgy and the licentiateship and associateship of the Institution of Metallurgists could be successive rungs on the ladder for those aiming at becoming professional metallurgists by part-time study. The education of such men would be the responsibility of the colleges of technology and the technical colleges, and the report suggests a number of steps that should be taken to enable these institutions to play their part more effectively.

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* The Education and Training of Metallurgists. A Report of the Joint Committee on Metallurgical Education of the Iron and Steel Institute, the Institution of Mining and Metallurgy, the Institute of Foundrymen, the Institute of Metals and the Institution of Metallurgists. Pp. 56. (Joint Committee on Metallurgical Education, 4 Grosvenor Gardens, London, 1952.)

The Committee takes the view that at present the technical colleges of Britain as a whole are not making an adequate contribution to the stock of high-grade technologists and quotes figures in support. It considers that these colleges must be made into better teaching institutions by raising the present standard of staffing. ". . . The provision of good teaching-staff is the first essential in improving the output of high-grade technologists. Compared with this, such matters as technological universities, institutions of technology and degrees in technology are relatively unimportant. . . ." It is a sad reflexion on the present position that the Committee finds it necessary to say that ". . . all who teach technological metallurgy should have been trained and become qualified in the theory and practice of the subject. . . ."

A number of clear recommendations are made on the measures that should be taken to enable the technical colleges to attract staff of the necessary high quality. The difficulty is not a financial one, for salaries in technical colleges are, on the whole, comparable with those in the universities; it is much more likely that the conditions of work are not sufficiently attractive. At present most technical colleges are responsible for the instruction of both technicians and technologists. It is recommended that these two functions should be separated and that instruction in metallurgy at a high level should be restricted to a few selected colleges in the important centres of metallurgical activity, such as London, Birmingham, Glasgow, Manchester, Sheffield, either Cardiff or Swansea and either Newcastle upon Tyne or Middlesbrough. Such colleges would be concerned purely with technology and would be fed with students by the remaining technical schools and colleges, which would be responsible for less advanced teaching

Much has been said in recent years about the desirability of research being done in the technical colleges, but little progress can be made in this direction if the teaching staffs are overburdened with teaching; the Joint Committee urges that the staffs of technical colleges should be given real opportunities both for research and for spending periods in industry from time to time to keep up to date with developments in industrial technology.

Where the training and education of technicians and operatives are concerned, the report is less definite. The work of the British Iron and Steel Federation in this field is highly praised, and the non-ferrous industry is urged to adopt properly planned training courses on similar lines. Employers are advised to give a real incentive to study by making it known that in filling leading technical positions in the productive departments they would take into account any awards which a candidate had acquired from a recognized educational authority.

The report as a whole is readable and can be recommended to all who are interested in technological education. Those who read it will realize that, as might be expected, the Committee is familiar with conditions in industry and with the educational facilities in Great Britain. The majority of the recommendations are likely to receive widespread acceptance; and they must be given careful consideration by all those who are concerned with the education or training of metallurgists. The views expressed on the technical colleges are realistic, and of particular interest in the light of recent discussions on the need in Britain for a university of technology.

BOTANICAL ASPECTS OF THE FORM PROBLEM

Morphogenesis in Plants

By Prof. C. W. Wardlaw. (Methuen's Monographs on Biological Subjects.) Pp. xi+176+4 plates. (London: Methuen and Co., Ltd.; New York: John Wiley and Sons, Inc., 1952.) 10*s.* 6*d.* net.

THIS is a small book about a very large subject. Morphogenesis is a much more familiar word than it was not many years ago, and the discipline it denotes is coming to be recognized as one that involves in its pursuit all the major fields of biological science, culminating in an attempt to explain the integrated 'wholeness' of the organism. The present volume is an examination of some of its problems that are exemplified in the development of the higher plants.

A distinctive feature of these plants is that much of their growth takes place through the activity of meristems. These regions, and particularly the apical meristem of the shoot, provide experimental material for a study of plant morphogenesis somewhat analogous to the young embryo in corresponding studies of animal development. It is this apical meristem with which Prof. C. W. Wardlaw's own work has been particularly concerned, and it naturally occupies a conspicuous position in his book. The author describes with clarity the structure of these growing points and the development of lateral organs from them, together with some of the delicate and beautiful experiments that he and others have performed there.

Emphasis on this aspect of morphogenesis has necessitated the omission, or a much abbreviated treatment, of some others that are also important The present reviewer would like to see in such a book as this a somewhat fuller presentation of the basic facts of differentiation, polarity, symmetry regeneration and teratology, for example, together with the morphogenetic problems raised by these phenomena. The discussion of the various factors involved in the control of plant development is also somewhat unbalanced. The author devotes a good deal of space to growth substances and to the action of genes; but very much less to such important factors as light, temperature, water relations, inorganic chemical substances and mechanical influences. Even to state all the many and varied problems of plant morphogenesis within the limits of a book as small as this one is obviously impossible; but there is danger that an inexperienced reader will get from it a rather one-sided picture of the subject as a whole.

At a time when biologists so strongly emphasize the purely chemical factors in development, it is refreshing to read the author's statement that "a knowledge of chemical processes alone, however precise and detailed it may be, does not and cannot tell us how a particular form comes to be assumed", but that "it is to biophysical and other physical forces . . . that we should look for the immediate or proximate cause of the specific form or structure". Most thoughtful students of the subject will agree with these conclusions.

The author does not minimize the profound complexities which still confront morphogenetic research. "It is a chastening thought," he remarks, "that after so many decades of work, our knowledge of the factors which determine the form of these organs (leaves) is still as incomplete as it proves to be." This might well be said of all the structures of the plant. It is a recognition of this wide and essentially unpenetrated frontier, beyond which lie solutions to so many of the basic problems of biology, that gives to the study of development its challenging appeal.

EDMUND W. SINNOTT

THE MATHEMATICS OF EXPERIMENTATION

The Design and Analysis of Experiments

By Prof. Oscar Kempthorne. (Wiley Publications in Statistics.) Pp. xix+631. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1952.) 68s. net.

FOR all who design and analyse experiments, Cochran and Cox's "Experimental Designs" has rapidly become a standard work of reference. So extensive has the subject grown, however, that even this large volume, a manual of instruction with comparatively little explanation of principles, cannot deal adequately with confounded and incomplete block designs. Prof. O. Kempthorne's book attempts to fill this gap by presenting the general statistical theory on which all uses of experimental designs rest, together with instructions for constructing, analysing and interpreting some of the more complex designs.

The first two chapters contain a survey of the philosophy of scientific experiment that must surely be too brief for a newcomer to the subject, yet scarcely necessary for the more experienced. A short chapter outlining standard statistical procedures is followed by two important chapters on the theory of least squares, with particular reference to linear hypotheses; the emphasis throughout is on the Markoff approach. From this point onwards, the book is more directly concerned with the structure of different types of design and with the calculation and interpretation of the corresponding analyses of variance. Randomized blocks, Latin squares, and other fully orthogonal systems of classifications are discussed, as are the modifications in analysis required when 'plots' are missing. Full presentation of factorial design, including confounding and fractional replication, occupies several chapters; these relate primarily to 2^n and 3^n arrangements, but the general p^n is included, as also are those with factors at different numbers of levels. Another series of chapters is concerned with lattices; the structure and general method of analysis is explained and related to factorial design, and formulæ appropriate to each type are displayed. This leads naturally to similar discussion of the non-lattice incomplete block designs, balanced and partially balanced. Finally, two short chapters are concerned with problems that arise in the analysis of groups of experiments and of experiments with several treatments applied in succession to the same 'plot'; the accounts given are less complete, but provide an interesting introduction to difficult matters.

The argument is set out mainly with reference to agricultural field trials; but its applicability is in no way restricted to these. The author shows how the mathematical model underlying observational data determines the form of the analysis of variance, and how knowledge of the expectations of mean squares is essential to the interpretation of the analysis; he presents several illustrations of the way in which naïve comparisons of mean squares can mislead. In early chapters, he appears to insist that only randomization tests of significance are legitimate, though he never explains why the assumption of a normal distribution for the error in an additive model should be so objectionable; in much of the later part of the book this principle seems to be conveniently forgotten. "It is, perhaps, unnecessary to state that, if a transformation is used, the best estimates of the treatment means on the untransformed scale are obtained by transforming back the means of the transformed variate"—'untrue' would be preferable to 'unnecessary'. Such errors are happily rare; but the writing is not always clear, and the index is unworthy of so ambitious a book.

This book will unquestionably be valuable to statisticians, yet perhaps its value lies in the details of methods that it contains rather than in the whole view of experimental design that it presents. For routine computation, special formulæ for each design are a convenience; provided that the principles governing their derivation are understood, they are of little interest to the reader of a book which seeks to explain the theory of design and may obscure the unity of the subject. Possibly Prof. Kempthorne has attempted too much, even for a large volume. The great need to-day is for a book that displays the fundamental ideas of experimental design and analysis fully and systematically for the serious student while retaining the comprehensive outlook of Fisher's "The Design of Experiments"; "The Design and Analysis of Experiments" tries to combine with this a manual of detailed instructions for analysis and, in so doing, fails to attain the highest level for either. Prof. Kempthorne is to be congratulated on so nearly succeeding in a difficult task; the ideal book has yet to be written, and ought to make experimental design appear an easier subject than does this one.

D. J. FINNEY

PHILOSOPHICAL AND BIOGRAPHICAL ESSAYS

Ethics and the History of Philosophy

Selected Essays. By Prof. C. D. Broad. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xiii+274. (London: Routledge and Kegan Paul, Ltd., 1952.) 21*s*. net.

PROF. C. D. BROAD here reprints selections from articles and public lectures produced between 1925 and 1949. They are very welcome. The first, biographical, section of the book contains essays on Isaac Newton, John Locke, Henry Sidgwick, J. M. E. McTaggart and W. E. Johnson. The first two celebrate centenaries of famous men, and fulfil their function gracefully. The last two are useful reminders of thinkers recently dead, who were never fashionable and are never likely to be. Yet, when all the more fashionable philosophers are forgotten, they may be remembered—McTaggart for penetrating criticism and daring attempts in philosophical method, and Johnson for fertile conceptions not yet fully developed. Prof. Broad knew them personally and gives a pleasing sketch of their characters as well as a useful brief account of their work. Sidgwick belonged to an earlier generation of Cambridge philosophers, one of the most distinguished, and yet he stands even more in need of commemoration.

The essay on "The Philosophy of Francis Bacon" is the most valuable feature of the section headed "Philosophy of Science". Bacon has been extravagantly praised and extravagantly defamed; very few have stopped to consider carefully what he had to say, and nobody has summed it up better than does Prof. Broad here. The second essay, called "The New Philosophy: Bruno to Descartes", is a clear straightforward account of the main features of Thomist cosmology and of what Descartes proposed to put in its place. Bruno does not come into the story except by being born in 1548, when cracks in the old cosmology were beginning to be visible. In the third essay, "Leibniz's Last Controversy with the Newtonians", Prof. Broad analyses the argument of his correspondence with Samuel Clarke, and gives also some interesting information about Clarke himself. This correspondence makes a difficult and disappointing book. Neither disputant seemed able to see what the other was trying to get at, and both acted in accordance with Disraeli's advice—"Never argue with an opponent; repeat your original statement". This advice is not as useful in philosophy as in politics. Many who have been baffled by the book will welcome Prof. Broad's account, and particularly his analysis of the rival theories of space and time.

The section headed "Ethics" begins with Prof. Broad's inaugural lecture as Knightsbridge professor in Cambridge. This must have made it clear to hesitant undergraduates that during his tenure of the chair the subject of moral philosophy would not be a soft option, but a strenuous intellectual exercise in the analysis of ethical concepts. All four constituents of this section are examples of this. The second one, on "Egoism as a Theory of Human Motives", shows that it is a far more difficult theory than simple-minded egoists suppose. The one entitled "Ought We to Fight for our Country in the Next War", besides its intrinsic interest, must have provided an effective douche of cold water for young intellectuals of the 1930's who were too clever and up to date to fight for anything but ideologies. The last essay, on "Conscience and Conscientious Action", is an admirable example of clarity and good sense on a theme where confusion and nonsense too often prevail, equally on the side of those who claim conscience as an infallible guide and those who claim that it is an illusion of the bourgeoisie.

A. D. Ritchie

TIME AND EVOLUTION

Time's Arrow and Evolution

By Harold F. Blum. Pp. xi+222+4 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1951.) 25*s*. net.

DURING most of the period in which people have argued about things, the legal, medical and military importance of the distinction between a living and a dead animal or man was recognized; but no advantage was seen in erecting the metaphysical concept of the living or non-living state. During the seventeenth and eighteenth centuries a liking for the distinction developed and hardened into a complete dichotomy at the end of the last century. The hardening is often attributed to Pasteur, but this is unfair to him; he demolished with humour and emphasis all the claims made for "spontaneous generation" but still said he thought it could happen. This attitude of believing in a possibility while disbelieving in alleged examples of it permeated the writings of Huxley and Tyndall and has now become common among biologists.

The older writers realized that they knew too little about the primitive state of the earth to make speculation on the origin of life profitable; but as knowledge increases the temptation to speculate increases too, and we now have a steady stream of books on the subject. Dr. H. F. Blum has written one of the better books in this category. He surveys cosmogony, geochemistry, thermodynamics and biochemistry briefly but in a manner adequate for his purpose. He then sensibly points out that primitive forms of life might well pass unrecognized if present-day standards are used, and that a point of origin could arbitrarily be placed almost anywhere along a thousand million-year stretch in the Pre-Cambrian. Making use of this permitted arbitrariness, he chooses as the origin of life the time when proteins first appeared; but he does not explain how, rigidly, he would define a protein. This is the main weakness of the book, for there is no reason for assuming that proteins are the basis of the only possible mode of existence of organisms on the earth. It is obvious that they play a basic part in the most successful way of living, and it is probable that they have done this throughout the five hundred million years of morphological evolution which is the only period about which we have any evidence. But it is a pure assumption that this was also so during the earlier millennia of biochemical evolution. We have so often been led into error by assuming that biology is simple that we should be wary of all unjustified, and it may be said unnecessary, assumptions.

This book achieves what it sets out to achieve. It is popular, written in a popular manner and embellished with some very popular analogies. The author only claims originality for the idea that in the pre-vital phase of the earth's history the adenosine triphosphate cycle evolved and that it engineered the synthesis of primitive nucleoproteins. This is a distinction that few will grudge him. Nevertheless, much of the argument is presented as if it were novel, and many readers may not realize that all the significant parts appeared long ago in the writings of Huxley, Tyndall and Schafer, for these are neither quoted nor mentioned in the book.

N. W. Pirie

AFRICANA UPSALIENSIA

Contribution to the Ethnography of Africa

By Sture Lagercrantz. (Studia Ethnographica Upsaliensia, 1.) Pp. xix+430. £9.

Origin of Death

Studies in African Mythology. By Hans Abrahamsson. (Studia Ethnographica Upsaliensia, 3.) Pp. vii+178. £3.

(Uppsala: Almquist and Wiksell; London: Routledge and Kegan Paul, Ltd., 1950–51.)

We are indebted to the Humanistic Foundation of Sweden for the publication of a series of six anthropological studies dealing with the comparative ethnology of Africa. The two which are reviewed here, "Contribution to the Ethnography of Africa" and the "Origin of Death", are weighty and erudite studies of the diffusion of culture in Africa. The aim of the two authors, who follow the Continental diffusionist school of Graebner and Schmidt, is to test the theories of this school regarding the successive cultures of Africa by a comprehensive examination of all the literature that has been published on African anthropology since the theories were first propounded. S. Lagercrantz, the general editor of the series, does this, in the first and largest volume, by examining particular culture traits grouped under the general headings of food, ornaments, weapons, commerce, art, medicine, divine kingship and religion. Abrahamsson, in the "Origin of Death", which is actually the third volume in the series, makes a similar examination of particular themes of African folk-lore which seek to explain how death came to the world.

Lagercrantz, in his introduction to the first volume, briefly surveys the successive culture theories held by the leaders of this school, ending with those of Baumann, who in 1940 distinguished seven hypothetical cultures—pygmy, Eurafrican steppe, old African (Ankermann's old Sudanese), west African, east Hamitic, north Hamitic and a young Sudanese—which last is also claimed to have a counterpart in the Zimbabwe culture of Rhodesia. Lagercrantz's conclusion is that Baumann "may probably be said to have resolved some of the most important problems of African research in a way that on the whole is likely to prove of permanent value". It is very doubtful if this opinion would be shared by most British or American Africanists, but their aims and methods are entirely different. British social anthropologists are concerned with the study of contemporary African societies as they exist at present or in the historic past. The Uppsala ethnologists are concerned with the interpretation of contemporary African cultures in terms of their origins, and their endeavour is to deduce these origins from a study of the distribution of isolated culture traits which are regarded as the survivals of these earlier hypothetical cultures.

Readers who are interested in the diffusion of particular culture traits will find in these volumes, particularly the first, a mass of interesting material; those who wish to study contemporary African societies will merely be irritated by them; and the scientifically minded will note the absence of any first-hand archæological or anthropological field-work and will wonder whether this technique of culture analysis, useful as it may be in the case of European ethnography where it can fall back on corroborative archæological and historical research, can validly be applied to a continent so deficient in such research.

G. I. Jones

FRONTIERS OF ORGANIC CHEMISTRY

Progress in Organic Chemistry, 1

Editor: Prof. J. W. Cook. (Progress Series.) Pp. viii+287. (London: Butterworths Scientific Publications, Ltd., 1952.) 50s. net.

A glance at the current journals of the chemical societies of the world will show that organic chemistry remains an immensely fruitful and popular branch of science. A correspondingly heavy burden is placed on organic chemists and others concerned in keeping afloat in the cataract of literature. Fortunately the position is relieved by the increasing tendency to publish reviews of comparatively small sections of the subject. Among such reviews the collection of monographs entitled "Progress in Organic Chemistry, 1" is among the most authoritative.

Eight articles are included, all written by active workers in the different fields. To attempt a brief classification: four deal with natural products (Sir Robert Robinson on strychnine; H. Erdtman on heart-wood constituents; H. H. Brockmann on photodynamic pigments; I. A. Preece on starch); two deal with general synthetic and industrial organic chemistry (S. F. Birch on petroleum chemicals; B. C. L. Weedon on acetylene chemistry); one deals with reaction mechanisms (D. H. Hey on free radicals as intermediates); and one with chemotherapy (F. Bergel and A. S. Parkes on drugs inhibiting symptomatic stimulators). As might be expected from this list of authors, the general level of the contributions is remarkably high. It is of particular value to have from the highest authority a logical summary of the elucidation of the tangled structure of strychnine, coming as it does immediately after the final solution. Among the other monographs one notes particularly those of Erdtman and of Brockmann as authoritative reviews of most interesting groups of compounds. Bergel and Parkes's article is remarkable for its range, and Birch's for its timeliness.

A readable book of less than three hundred pages dealing with progress in organic chemistry can only touch on a few topics, and Prof. J. W. Cook has done well to limit these so that the treatment may be thorough. Nevertheless the book as a whole suffers from the defects of its qualities: it admirably describes *examples* of progress rather than the progress as a whole. It is probably true that the subject is now so wide that it can only be reasonably covered by a number of volumes like this, each dealing with one important aspect, such as natural products, synthetic methods, reaction mechanisms and so on.

The book is well printed and free from errors.

R. P. Linstead

IONIZATION, pH AND BIOLOGICAL ACTIVITY*

BIOLOGICAL activity is known to be influenced by many physical and chemical factors; of these the degree of ionization is recognized as outstandingly significant. A change in biological response has often been observed to accompany a change in the degree of ionization of a drug, or of its biological receptor. Many common drugs, and other biologically active substances, are capable of undergoing this change in ionization somewhere within the physiologically interesting pH range. This would not be significant if both the molecule and the ion had the same biological action; however, in all cases that have been investigated, ions and the corresponding neutral molecules have been found to behave differently.

Chemistry of Ionization

With few exceptions, salts are completely ionized when in solution, and thus they can have no biological properties other than those of the individual ions of which they are composed. This simple conception is not always recognized by biological workers.

Unlike salts, acids and bases need not be completely ionized in solution. Strong acids and strong bases (for example, sodium hydroxide and hydrochloric acid) are completely ionized in the pH range of 0–14, but many biologically active substances are weak acids or bases and thus show variable ionization within this pH range. The degree of ionization in solution depends on only two factors, the pH and the pK_a. The latter is a constant for any acid or base, and thus, if the pH is controlled, the degree of ionization depends only on the nature of the acid (or base) being investigated.

By application of the law of mass action to the ionization of weak acids we obtain a quantity known as the acidic ionization constant (K_a), sometimes, but not so correctly, called the 'dissociation constant'. The degree of ionization of weak bases also can be described by acidic ionization constants. These ionization constants are small and inconvenient figures, and it is usual to employ their negative logarithms which are known as pK_a values. Thus, pK_a values provide a convenient way of comparing the strengths of acids (and of bases): strong acids have low pK_a values, strong bases have high ones.

An acid or base when half-ionized has a pH equal to its pK_a. On passing from a pH value which is one unit on one side of the pK_a to a pH value one unit on the other side, a given drug is converted from a substantially ionized to a substantially non-ionized condition. Hence, quite small changes in the pH of a solution can produce large alterations in the degree of ionization of a drug, and this may well result in a modified biological effect.

Influence of Ionization on Biological Action

The organic chemist frequently finds that chemical reactivity depends upon the degree of ionization. For example, dimethylaniline normally nitrates in the *ortho* and *para* positions; but if sufficient concentrated sulphuric acid is present for the substance to be entirely converted to the cation, the nitration occurs exclusively in the *meta* position. Similarly, the degree of ionization can influence biological action.

The ready reversibility of drug action by dialysis indicates that the drug and receptor appear to be held together by readily breakable bonds (for example, ionic bonds but not covalent bonds). Hence changes in the pH of the medium bathing a receptor, or use of an analogue of the drug with a different pK_a, might be expected to bring about a change in biological response in many cases.

Adsorption at surfaces is a second method by which ionization can affect biological action. Ionization is usually unfavourable to non-specific adsorption, where the neutral molecule is adsorbed and the more highly hydrated ion tends to remain in the water. On the other hand, specific adsorption, which depends upon the drug being complementary in shape or charge to the receptor, may favour preferential adsorption of the ion.

The degree of ionization can also influence greatly the ability of a drug to penetrate natural membranes. In general, the ionic form of a substance penetrates membranes much more slowly than the neutral molecule, as the ionic group is held by unlike charges on the outer surface of the membrane and repelled by like charges. However, certain ions, such as those of sodium and chlorine, appear to penetrate by special mechanisms, and the penetration of ionic drugs can often be assisted by the addition of lipophilic substituents such as chlorine or alkyl side-chains.

The action of a drug obviously depends not only upon its ability to combine with some vitally important substance in a certain tissue, but also upon the ability of the drug to reach that tissue. Many important drugs have a pK_a between 6 and 8, and this means that, at the physiologically important pH of 7, the drug is always in equilibrium with at least 10 per cent of its ionic form. Such drugs can pass through a membrane which would exclude ions, and yet they can regenerate some ions (by mass action) on the far side of the membrane.

It was once thought that the degree of ionization could not be of great importance in biology. It was considered that, as the biological receptors removed the toxic ionic species, more would be generated in accord with the law of mass action. However, many cases are now known where biological activity is highly dependent upon the degree of ionization. This indicates that the combination between drug and receptor is usually weak and completely reversible in nature. In a system in which a biological receptor is in equilibrium with a low concentration of a toxic ion and a high concentration of the corresponding molecule, a stability constant (K_s) can be assigned to the drug-receptor complex:

$$K_s = \frac{[\text{drug-receptor complex}]}{[\text{toxic ion}]\,[\text{receptor}]}.$$

Thus the concentration of toxic ion in solution is controlled by this relationship, and it is also controlled by the ionization constant (K_a) of the drug. Where K_s and K_a are of similar magnitude, it is obvious that any deficiency of toxic ions in the solution will be replenished from the drug-receptor complex as easily as from the non-ionized drug. Under these conditions, the degree of ionization of the drug governs its efficiency; the greater the number of ions present, the greater will be the number forced into the drug-receptor complex. It must also be noted that the toxic ion may combine with non-vital groups, and this can lead to wastage of large quantities of the toxic agent.

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* Substance of three University lectures by Prof. Adrien Albert, delivered at University College, London, on October 13, 20 and 27.

The acridine antibacterials provide the best-known example of a positive correlation between ionization and biological activity. For example, only five different mono-aminoacridines can exist. Of these, two are highly ionized at pH 7 (5-amino- and 2-amino-), whereas the other three ionize to only a small extent. The two isomers which are well ionized have a powerful antibacterial action, whereas the three isomers which are poorly ionized have only a feeble action. The same correlation has been demonstrated in more than one hundred acridines, and, provided that the ionization is cationic and is not less than 50 per cent at pH 7·3, the chemical nature of the substituents in the acridine nucleus makes little difference. By examination of the effect of these antibacterial acridines over an extended pH range, a direct competition between acridine cations and hydrogen ions has been revealed. The simplest interpretation of this interesting fact is that some vital anionic group in the bacterium is blocked by combination with the acridine cation and is thereby prevented from discharging its normal metabolic function.

In certain cases, however, ionization appears to be disadvantageous to biological activity. For example, the action of salicylic acid, which inhibits cell-division in echinoderm eggs, has been shown to be strictly proportional to the neutral molecules present. Between these two extremes we also find a number of cases of biological action in which the molecule is more active than the ion, but in which the ion does show some activity.

Not only is the ionization of the drug important, but also the ionization of receptors. A biological receptor is regarded as a molecule, or portion of a molecule, the normal function of which in metabolism can be blocked by combination with an appropriate drug. There is evidence that receptors are often co-enzymes or the protein component of enzyme systems. The receptors which are relevant to the present discussion are those which can combine with drugs by ionic bonds, and which only ionizable drugs can block. The pK_a values of receptors cannot be predicted in advance of experiment, as their chemical nature is largely unknown.

Not all receptors are actually within the cell. For example, amœbæ are narcotized when undecane is injected into the external membrane, but not when it is injected into the amœba. The pK_a of a receptor which is on the outside of a cell can be studied by the response to drugs over a range of pH values, provided that the cell is otherwise unaffected by the pH range and that the ionization of the drug does not change within the range. It is known, for example, that the receptors for cationic antibacterials are on the outside of cells because the addition of lipophilic groups to the molecule does not increase the efficiency of the drug. Further, derivatives which yield 70 per cent of cation at pH 7 are no more active than those which yield almost 100 per cent. The point which must be borne in mind is that the receptor may be expected to change its degree of ionization as the pH is changed.

Ionization studies become more difficult when the receptor is within the cell. Very little is known of the pH within animal cells, and the results obtained from experiments with indicators must be treated with reserve. By an enzyme-activity method it has been shown that the pH within the cell, in at least one case, roughly corresponds to that of the buffer in which it is placed.

Thus it is desirable, in biological experiments, to work in buffer, which ensures that the drug is presented to the cell in a standard state of ionization, and also maintains, in a standard state, the mechanisms for the adsorption of the drug and its penetration into the cell.

Further Aspects of the Chemistry of Ionization

Many ionization constants vary with temperature. This effect is most marked with strong bases, which become much weaker as the temperature rises. Mention must also be made of zwitterions, that is, ionic forms which carry both positive and negative charges. Zwitterions are usually rather inert biologically; for example, histidine has none of the marked physiological properties shown by the corresponding cation, histamine.

A small potential has been found to exist between biological surfaces and water. This is the electrokinetic, or zeta, potential, and its existence has been held to imply that there must be a slight difference between the pH at the surface and the pH of the solution.

It has been found that some few cations are capable of combining with hydroxyl ions by means of covalent bonds to give non-ionized substances known as 'pseudo-bases', from which the original cation can be regenerated by acid. This reaction, unlike normal ionic equilibria, is rather slow, and it may require from an hour to a week for equilibrium to be achieved. It is impossible for the biologist to correlate ionization with biological response if pseudo-bases are involved, unless he has first ascertained the pK_a at equilibrium and the time taken to achieve equilibrium. The most common examples of pseudo-base formation are furnished by heterocyclic quaternary compounds and by triphenylmethane dyes.

A further example of ionization which must be considered is due to the thermodynamic activity effect. When anions and cations are present in concentrated solution, they tend to form ion-pairs and thus behave as though a small fraction of their total concentration were absent. This effect is reflected in pK_a values, both acids and bases appearing slightly weaker in strong solutions. Ions of formula weight more than two hundred have a greater tendency to form ion-pairs than simple ions and thus show considerably greater activity effects, that is, the proportion of free to bound ions becomes very low. Drugs which are desired to provide a depot effect, for example, globin-insulin and procaine penicillin, can be formed by combining a therapeutically active ion with an oppositely charged ion, both being of fairly high molecular weight. Such compounds are slow to release curative ions because of their large thermodynamic activity effect.

Organic molecules having two neighbouring groups, one an anion and the other an electron donor such as a nitrogen or oxygen atom, can form chelate compounds with metallic ions. These are essentially salts the activity of which is maintained far below their concentration, and metallic complexes of this type play an enormous part in biochemical processes.

It will be apparent from this discussion that knowledge of the ionization constants of biologically important substances is of great importance to the biologist. This information allows one of the most common variables to be brought under control and thus can add greatly to the scientific knowledge derivable from a biological experiment.

H. C. S. Wood

COMPARATIVE PHYSIOLOGY OF MUSCLE

On September 5 at the British Association meeting in Belfast, Sections D (Zoology) and I (Physiology) held a joint half-day session on the comparative physiology of muscles, under the chairmanship of Prof. R. C. Garry, president of Section I. The meeting was well attended, and it admirably fulfilled the two purposes of presenting part of an important modern field of research to non-specialists, and of providing a meeting ground for research workers concerned with different aspects of the behaviour of muscles. At the end of the morning, Prof. Garry commented on the success of the discussion, saying that this joint meeting of the two Sections had shown the importance of research into comparative muscle physiology, and the importance of considering structural changes at the same time as investigating the more physiological aspects of muscular contraction.

The discussion was introduced by Prof. A. V. Hill, who briefly reviewed the features that appear to be common to all contractile tissues, and their specializations for different purposes. He then directed attention to the important results, now published[1], which Dr. T. Weis-Fogh has recently obtained on the metabolism of flying locusts. Measurements of the amounts of fat and glycogen in the body before and after tethered flight indicate that migrating locusts (*Schistocerca gregaria* Forskål) are mainly dependent on fats for the fuel to sustain long periods of flight. Thus their flight muscles appear to be atypical: carbohydrates are generally considered to be the fuel used by most muscles. Locusts probably deplete most of their reserves of muscle glycogen during the 'warming up' activity preceding each day's flight; and when migration begins, they have mobilized other fuel reserves held elsewhere in the body, especially the fat in the fat bodies. Dr. Weis-Fogh has pointed out that the hydration of stored glycogen makes it about eight times heavier than isocaloric quantities of fat. Fats are thus very suitable food reserves for animals that fly for long periods, provided that they can be mobilized, and provided that the muscles have an adequate supply of oxygen. It is calculated that migrating locusts must eat at least one and a half times their own weight of food each day. A large swarm, weighing 13,000–19,000 tons, uses 500–800 tons of fat for its daily flight, and needs to consume a quantity of food that would supply one and a half million human beings with the calories they need each day. The metabolic rate of the flight muscles of locusts is very much higher than that of other striated muscles: for example, 400–800 kcal./kgm./hr. for locusts, as compared with 50–60 kcal./kgm./hr. for human leg muscles. Flies and bees and other insects have even higher metabolic rates, but their muscles use carbohydrates. It appears that many other muscles, not only those of locusts, are able to use fats as well as carbohydrates, but this faculty is especially highly developed in locusts. These specializations in muscle metabolism may ultimately be dependent on specializations in the enzyme systems of the muscle mitochondria.

Mr. J. Lowy (Laboratory of the Marine Biological Association, Plymouth) presented the results of his work on the smooth muscles of bivalve molluscs, particularly of the mussel *Mytilus edulis*. These animals, in their natural environment, are exposed to the air for long periods when the tide is low, and although the elastic ligament at the hinge of the shell tends to make the two valves gape apart, closure is maintained by the adductor muscles. Mr. Lowy's work has indicated that the adductor muscles can maintain a state of active contraction throughout long periods, and that it is probably unnecessary to postulate a special 'catch mechanism' in these muscles to account for their ability to maintain prolonged closure of the shell. Simultaneous recordings were made of shell movements and of the electrical activity in the posterior adductor muscle, both when the animals were exposed to the air (shells closed) and when they were in sea water (shells opening and closing at irregular intervals). Records of action potentials, some of them as large as 100 μV., were obtained not only when the muscles were contracting to close a gaping shell, but also throughout long periods of as much as two hundred hours when the shell was kept closed and the animal out of water. That the records of electrical activity pertain to the muscles and not to the nerves is suggested by the results of experiments on nerve-muscle preparations made from the pedal retractor muscle and pedal nerve of *Mytilus* and the anterior adductor muscle and its motor nerve in *Mya arenaria*: the electrical activity recorded from these muscle preparations when they were indirectly stimulated was similar to that recorded from these muscles or from the posterior adductor muscle of *Mytilus* during spontaneous activity, and it was dissimilar to that recorded from the nerves. It was also shown that there are no intramuscular nerve cells. It therefore seems to be clear that both intermittent and prolonged closure of the shell is brought about by typical contractions of the adductor muscle fibres.

Mr. Lowy has also found that electrical activity in the posterior adductor muscle ceases when the visceral ganglia are extirpated, although it continues if the visceral ganglia remain in place but the pallial nerves and the cerebro-visceral connectives are cut. These experiments suggest that nerve elements in the visceral ganglia are responsible for maintaining contraction of the posterior adductor muscle, and other experiments suggest that the visceral ganglia are also concerned in the initiation of relaxation. Relaxation could be brought about by appropriate tactile stimulation of the visceral ganglia, or of the mantle edge or cerebral ganglia. In some cases relaxation was accompanied by electrical activity in the adductor muscles, but in other cases electrical activity was suppressed while the muscles were relaxing.

The neuro-muscular mechanism of the insect leg was the subject discussed by Dr. G. M. Hughes (Department of Zoology, Cambridge). Most of his observations have been made on cockroaches. Analysis of cinematographic records of walking and running cockroaches shows that these insects modify their gait according to their speed; but both speed and gait change gradually, and there is no sharply defined change-over from walking rhythm to running rhythm. Records of the electrical and contractile activity in isolated preparations of the flexor muscle of the tibia have led to the conclusion that the individual muscle fibres have a multiple innervation and can contract at different speeds. There are at least three different patterns of action potential records, correlated with different speeds of contraction. It is suggested that changes in the number or type of nerves involved in stimulating the muscle fibres can produce changes in the speed of contraction of the fibres, and thus bring about the graded changes in the speed and gait of the whole insect.

Much can be learned about the performance of a muscle by finding what force it can exert in contraction, and by analysing the relationship between the force exerted and the velocity of shortening. The equation relating force to velocity is

$$(P + a)\,(V + b) = \text{constant} = (P_0 + a)b,$$

where P is force, V is velocity, a and b are constants, and P_0 is the force exerted under isometric conditions, that is, where velocity is zero. A. V. Hill has shown that this equation not only fits the force–velocity curve but also expresses the way in which heat is emitted during contraction. It is therefore important to find how far different kinds of muscles and the muscles of different animals have mechanical properties which can be expressed by this equation. B. C. Abbott and D. R. Wilkie (Departments of Biophysics and Physiology, University College, London) have studied this question. Their experiments were made on isolated muscles from snails, dogfishes, rays, tortoises, frogs and toads, and results have also been obtained for human muscles by experiments on intact subjects. In all these muscles the tension developed during isometric contraction depends on the length at which the muscle is held, being greatest at about the length the muscle has in the body. During isotonic contraction, the greater the weight that the muscle has to lift the smaller is the amount of shortening. The velocity of shortening is greatest when the weight is least, and the equation relating force to velocity is the same for all the muscles investigated. The most striking difference found was in the maximal velocity the muscle could attain: this varied over a sixty-fold range from snail to man.

In the last paper, Dr. E. Jean Hanson (Medical Research Council Biophysics Research Unit, King's College, London) dealt with two aspects of muscle cytology relevant to comparative studies of muscle physiology. The cross-striations of isolated vertebrate and insect myofibrils have been studied in positive phase-contrast illumination, in polarized light and in the electron microscope. Isolated fibrils have been induced to contract by treatment with adenosine triphosphate, and the process of contraction has been watched in the microscope and the changes in the pattern of cross-striations studied. The conclusion has been reached that a material, provisionally called the 'A substance', which is segregated in the isotropic bands of relaxed fibrils, migrates during contraction along the long axis of the fibril, and most of it comes to lie in a set of new bands, the contraction bands, at the end of contraction. In spite of this change in the distribution of materials, the alternation of anisotropic and isotropic bands along the length of the fibril remains unchanged, and the factors responsible for birefringence are unknown.[1] Contraction of myofibrils induced by adenosine triphosphate is irreversible, but there is reason to suppose that in other respects it is similar to normal contraction and that a migration of the unknown 'A substance' takes place when a muscle contracts ***in vivo***. Finally, some observations on the smooth muscles of molluscs and annelids were briefly reported; the muscles investigated included those discussed earlier in this meeting by Lowy, Abbott and Wilkie. Fibres of these invertebrate smooth muscles, unlike the fibres of striped muscles, contain large quantities of proteins of the paramyosin type, about which little is yet known. Whereas a striped muscle fibre consists predominantly of actin and myosin, the two structural proteins concerned in contraction, molluscan and annelid smooth muscles have complex fibres consisting both of contractile myofibrils and of bundles of paramyosin or related fibrils. These bundles are responsible for the characteristic double oblique striation of these fibres. Paramyosin is very unlikely to be contractile, and it may be mainly responsible for many of the peculiar properties of these smooth muscles, for example, their extensibility and 'viscosity'.

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[1] *Phil. Trans. Roy. Soc.*, B, **237**, No. 640 (1952).

CLASSIFICATION OF THE FUNGI

LIEUT.-COLONEL R. B. SEYMOUR SEWELL took the chair at the meeting of the Linnean Society on October 23, when a discussion was held on the "Classification of the Fungi".

Dr. B. Barnes said that the lower fungi, or Phycomycetes, are a heterogeneous group, separated from the other fungi by the usually cœnocytic vegetative body. This may be a rounded or lobed sac, a branched structure of characteristic shape, or, in the higher forms, a spreading mycelium. Septation in the vegetative body usually accompanies the formation of reproductive organs. In origin, septation may have been associated with the production of reproductive structures carried above the bacterial slime on the submerged substrata inhabited by many of these fungi. It seems likely that, during the course of evolution, septum formation has moved backwards in ontogeny; in some existing species, septate vegetative bodies occur in juvenile specimens. The septate vegetative body may well be in a physiological condition intermediate between that of the vegetative state and of the reproductive state.

Phycomycetes show some peculiar features distributed rather haphazardly among the members of the group, features scarcely of adaptive significance and more probably inheritances from the remote past. Notable among these features are: the persistent empty wall of the zoospore, the occurrence of two phases of motility with differences in morphology of the zoospore (diplanetism), and the assumption of amœboid characters by the zoospore. These features occur chiefly in a number of the Chytridiales and the Saprolegniales. From these two stocks, rather vague connexions may be traced to the other alliances of the Phycomycetes.

The Monadineæ Zoosporeæ occur as parasites or as saprophytes in algæ, fungi and bryophytes, and probably as common saprophytes in the soil. They are very simple, and can scarcely be regarded as fungi, though in life-history and in organization they agree well with the simpler members of the Chytridiales and Saprolegniales. They differ in the tardy formation of a wall around the trophic body and in the ingestion of solid food with the ejection of solid residues of digestion. In the Monadineæ Zoosporeæ and in the Phycomycetes, series may be traced, characterized by uniflagellate, biflagellate and non-flagellate spores: this appears very significant. Some of the Monadineæ Zoosporeæ leave persistent empty zoospore walls, and some show signs of diplanetism; amœboid stages are common. These points also are significant. Many members of the group are very common and they deserve more study than they have yet had. If this shows that features of life-history and behaviour are common to some of the simplest organisms yet known, and to the Phycomycetes, it must follow that the fungi are not plants, but lie on lines of development separate from those which run through the animals and the green plants. It must follow that the fungi are not decolorized algæ. Such research must be directed to the tracing of tendencies, and not to an effort to show that an existing species or genus is ancestral to, or derived from, another existing species or genus.

Dr. E. J. H. Corner pointed out that the purpose of classification is the identification of organisms and the recognition of their positions in an evolutionary system. Artificial systems frustrate research. Classification is concerned with genera, tribes and families. Speculation about phylogeny is an essential part of the work, for speculation is the ignition of taxonomy.

The classification of the higher Basidiomycetes is very backward. It is too artificial to stimulate research, and too inaccurate to permit the reliable identification of the organisms. The physiology, genetics and ecology of the higher fungi must be brought into the account, for these are living topics.

The higher fungi have a mycelium and a fructification. The mycelium is too generalized to be of use in classification; it is very uniform, and doubtless very efficient. The fructification must be used. What is a mushroom? It is a precise device for the production and liberation of spores. The gills are put out of action when they are immersed in water, and the basidia collapse; therefore, drawings of basidia are usually artificial. The mushroom is an umbrella which protects the gills from rain but maintains humidity around the spores; the polypore is a bracket which acts similarly. In contrast, the discomycetous apothecium is a cup which holds water.

Clavaria has no protection for its spores, and shows the primitive arrangement. A survey of the world flora of clavarioid fungi shows that they contain at least six natural series of genera or groups of genera. The Clavariaceæ, as currently understood, is therefore an artificial assemblage. There is a set of tropical Clavariaceæ which shows a general agreement with the polypores. A great group of species, with yellow-brown fruit bodies, cuts right across the accepted lines of classification, and contains clavarioid, stereoid and hydnoid forms. In some members of this group, the hyphal walls thicken early. This hinders growth, and would prevent the development of a fructification of mushroom type, for that depends on thin-walled hyphæ.

The genera of the higher fungi need to be dissected out into phylogenetic units. For example, *Fomes applanatus*, *F. igniarius* and *F. fomentarius* look much alike; but microscopic analysis shows them to be very different. Use of the method of hyphal analysis will reveal many other examples, and may yield good evidence of relationships.

If *Clavaria* is primitive, the ends of the lines of development in the Gasteromycetes are doubtless mixed groups. It seems certain that the resupinate Thelephoraceæ are to be derived along a number of lines of development within the Hymenomycetes; even *Pterula* may have resupinate fructifications.

Dr. J. Ramsbottom said that the objects of classification are the identification of organisms and their arrangement in a scheme showing relationships; differences in physiology and in chemistry must be taken into account. Schemes of classification based on presumed affinities may be valuable aids to identification, just as are artificial keys, though these can be deceptive because they often give meagre details. In large herbaria, an artificial scheme can be justified on grounds of convenience; even an alphabetical arrangement can be defended.

Morphological characters may be of little use, as in the yeasts, where it has been necessary to use the methods developed by the bacteriologists in classification.

Fungal cultures often produce saltations, mutations and strains, and these new forms may remain constant in subsequent cultures. Parasitic fungi, such as the rusts, have biological races, which may arise by mutation or by natural hybridization. Some of the biological races of *Puccinia graminis* are very virulent. Natural or induced variation has been of great importance in the production of penicillin. After the Americans had found that *Penicillium notatum* would not grow in submerged culture, they found a good strain on a rotting melon, and improved it by treatment with X-rays and other means. These strains and biological races cannot be neglected by the taxonomist, if only because of their economic significance. Experience gained during the search for antibiotics has shown that the fungi cannot be classified on their products; mycology and biochemistry are not synonymous.

Attempts have been made to identify toadstools by the use of sulphovanillin and other chemicals; but such tests have not been used with discrimination. Nothing seems to be known of the results of applying these chemicals to the same species at different stages in development. The tests are crude, and they are not critical.

Little is known of natural variation in the fungi. *Laccaria laccata* is well known to vary greatly; but is it variable because it is common, or common because it is variable? *Armillaria mellea* is variable; but little has yet been done on its systematics. It has forms with and without rings. In the old classification, the ring was held to be of great importance, and it is still held in respect. The old classification of the agarics was based on spore colour and on gross morphology. It is quite artificial, but we must continue to use it, for there is nothing to replace it. The logical method would be to associate all species with comparable developmental histories, no matter what the spore colour or the arrangement of the gills. Spore-sculpture needs much more study, as has been pointed out by some French workers.

Most of the phylogenetic schemes proposed for the higher fungi are of no importance; they may be described as "evolution in our time". Certainly, fungi are not decadent algæ.

Much more detailed knowledge is required before good theoretical schemes can be constructed. Even before the idea of evolution was accepted, mycologists had recognized circles of affinity within the fungi. Evolution cannot be both the key to the problem and also the lock. A study of phylogeny may indicate what forms are primitive, and these are probably the simplest. But the evolutionary history of the higher fungi is still a mystery. A study of fairy rings suggests that the mycelium is much more important in reproduction than is the spore, and yet we have elaborate and extremely fertile fruit bodies.

Microscopic characters are of great significance in dealing with species, and hyphæ, as in the strands of *Merulius lacrymans*, may show much diversity of structure; they may have taxonomic significance. Biological characters must not be stressed too much. For example, the predacious fungi show a general and similar pattern of behaviour, but the predacious habit is to be found among Phycomycetes, Basidiomycetes and Hyphomycetes. B BARNES

ASH AND CLINKER IN INDUSTRY

By T. F. HURLEY, O.B.E.

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DURING October 28–29, a conference described as "A Special Study of Clinker and Ash in Industry" was held by the Institute of Fuel at the Institution of Mechanical Engineers. Twelve papers were discussed which covered the origin and nature of the mineral matter in coal; its laboratory examination; the extent to which it is responsible for atmospheric pollution; the methods by which it can be removed either from the coal itself or from the products of combustion; and its effect upon the utilization of coal in various types of industrial plant. The papers had been published in advance in the *Journal of the Institute of Fuel*, and the Institute hopes to publish the text of the papers and discussions in the near future (£1 1*s*.).

In the field of utilization, small industrial boilers, gas producers, steel works plant, and, looking ahead, the industrial coal-fired gas turbine were considered, but most attention was devoted to the large water-tube boilers used by the British Electricity Authority, which is the largest single user of coal. This one organization now consumes 35 million tons of coal per annum, and as the average ash content of the rough slack supplied to it is about 15 per cent, it has to deal with about 5 million tons of ash per annum. Merely to handle this quantity of waste material is a formidable task, but during recent years the problems associated with ash and clinker have been further increased as a result of the present tendency to generate electricity in mammoth power stations employing very large and costly boilers working at extremely high temperatures and pressures. Among other consequences, the size of the stations requires more elaborate and expensive plant to avoid excessive atmospheric pollution in their vicinity, the higher temperatures in the boilers lead to a more objectionable type of deposit upon the heating surfaces, and to take one of a small number of very large boilers off the line for cleaning out of its turn affects materially both the output of the station and the cost of the electricity generated.

Taking industry as a whole, the importance of ash is steadily increasing as a result of changing mining conditions, which have led to more and more mineral matter being included in the coal brought to the surface. Various reasons were given at the Conference, the chief of which were, first, that the better seams have been worked out and those now being mined not only contain more ash but also include more dirt bands; and, secondly, increased mechanization causes more dirt to be mined and at the same time reduces the quantity which can be removed from the coal underground. Excluding free dirt, British coal seams still contain on the average only 5·5 per cent of ash and probably compare favourably in this respect with those of other major coal producing countries; but for the reasons given, run-of-mine coal now includes on the average about 15 per cent of free dirt. This represented about 33 million tons of the 'raised and weighed' output for 1950.

It is obvious that the cost of mining dirt and bringing it to the surface is comparable with that of winning coal; but no suggestion was made at the Conference that the quantity of dirt brought to the surface could, or should, be reduced. In fact, a future increase in the ash content of coal was accepted as natural and inevitable.

Ash costs just as much as coal to convey from the pit head to the point of utilization, and at each stage beyond that it is a costly nuisance. Again taking modern power station practice as an example ash costs more to pulverize than coal and it causes more wear in the machinery; it affects adversely the efficiency of combustion; it requires the size and therefore the capital cost of the boilers to be larger and at the same time it increases the difficulties of design and operation; it necessitates the provision of ash-handling equipment comparable in size and cost with the boilers themselves, some of it forms objectionable deposits which reduce both the efficiency and the availability of the boiler; it requires the installation of expensive dust collectors to minimize atmospheric pollution and, even when it has been collected, its disposal is a major difficulty.

Many, but not all, of these effects can be reduced materially by using known methods of cleaning the coal at the pit, but this involves a high cost in capital equipment, power and labour. So recently as 1950 the National Coal Board asked in its annual report whether "it may sometimes not be more economical to save some or all the cost of coal preparation at the price of reduced efficiency in the final stage of conversion". To this question the National Coal Board itself now appears to provide its own answer by stating that when all the cleaning plants ordered between vesting date and the end of 1951 are in operation, they will deal with about 42½ million tons of coal per annum. More than 100 million tons of coal are already cleaned mechanically each year

On the other hand, the Conference showed that there is considerable divergence of opinion with regard to the extent to which it is economical to wash coal instead of dealing with the ash during utilization. This lack of agreement may arise from the wide variations which occur in the chemical composition of the mineral matter in coal and in the manner in which it is associated with the coal substance. Both the ease with which coal can be cleaned and the influence exerted by a given quantity of ash upon different industrial processes are affected by these variations.

Most coal-cleaning processes are based upon the difference between the specific gravities of coal and dirt, and some are capable of making a close 'cut' at any predetermined density. When, therefore, the material to be cleaned consists partly of coal particles containing little dirt and partly of dirt particles containing little coal, it is easy to separate it into 'clean' coal and 'pure' dirt. On the other hand, when the coal substance is 'intergrown' with mineral matter, the yield consists of three fractions: relatively clean coal, middlings and dirt. The washery manager then has to balance the overall cost of cleaning against the requirements of his market and to decide what proportion of ash he should allow to appear in each fraction—a task requiring great skill and experience.

With these broad principles in mind, the general opinion of the Conference appeared to be that in present circumstances the more easily cleaned coals should be washed, and the dirty coals, middlings and even the refuse should be burned in the colliery boilers or in power stations erected in the vicinity. Plant is already being installed to burn what would formerly have been regarded as waste material.

The quantity of ash in the coal most easily supplied to a particular industrial plant may well determine the type of combustion appliance to be employed. Thus a chain-grate stoker would not usually be used with coal containing more than about 15 per cent of ash, whereas pulverized fuel containing more than 25 per cent of ash can be used in large boilers. On the other hand, it is very difficult to collect and dispose of the large quantity of fine ash made from pulverized fuel.

The composition of the ash has an equally important bearing upon the type of equipment to be used. Thus, boilers fired with pulverized fuel are usually immune from troublesome bonded deposits; but severe deposits frequently occur in boilers fired with mechanical stokers when the coal contains relatively small quantities of chlorine (more than 0·3 per cent), sulphur (more than 1·8 per cent) or phosphorus (more than 0·03 per cent).

In the same way, the amount of iron in the ash influences its tendency to fuse and form clinker or slag in the furnace. In most cases this is a source of trouble; but in some modern designs the ash is fused deliberately to enable it to be disposed of more easily.

For control purposes, it is obviously desirable to be able to predict the clinkering properties of an ash by a preliminary laboratory examination; but this is rendered difficult by the fact that when the mineral matter in coal is heated it changes its composition in a manner depending on the conditions of heating. In addition, the distribution of its constituents in a finely divided laboratory sample is different from that in the original lump coal. It is, therefore, impossible to devise one laboratory test for ash fusion temperature which would simulate all industrial conditions, and it is not surprising that varying opinions were expressed as to the practical value of ash-fusion temperatures determined by the standard method, which is necessarily empirical.

In spite of the variable nature of ash and its varying importance when coal is burned in industrial plant, it is clear that, if fuel is to be marketed on a national scale, a fair price can be assigned to any particular coal only after a quantitative allowance has been made for its ash content. Various methods of doing so were described, but every paper read could be used to illustrate the difficulty of devising a universal formula to meet all cases.

In general, the Conference showed that practical means have been found for dealing with the industrial problems associated with the presence of mineral matter in coal and that considerable knowledge is available concerning its nature and its behaviour in industrial plant. Nevertheless, the difficulties caused by it tend to increase, rather than to decrease, and there can be little doubt that they will continue to present major problems so long as coal is used as a fuel.

NEWS and VIEWS

Mineralogy at the British Museum (Natural History): Dr. W. Campbell Smith, C.B.E.

Dr. Walter Campbell Smith retired at the end of November from the post of keeper of minerals at the British Museum (Natural History) after forty-two years service. Joining the staff of the Department of Mineralogy in 1910, he became deputy keeper in 1931 and succeeded to the keepership in 1937. He was mainly instrumental in the expansion of the rock collections and in applying modern optical techniques to their identification and nomenclature. His well-known guide to the Museum's rock collections and his arrangement and labelling of them in the Mineral Gallery are models of clarity and accuracy, objectives no less difficult to achieve in petrology than in other sciences. Dr. Campbell Smith's numerous publications have included studies both in petrology and mineralogy, notably his pioneer investigations on hybridism in igneous rocks, his contributions on the petrology of rocks collected on famous expeditions such as the British Antarctic (*Terra Nova*) 1910, and his descriptions of new minerals from the manganese mine at Benallt, North Wales. He served as president of Section C (Geology) of the British Association in 1950, and on that occasion presented a survey of knowledge on the stony meteorites. During his keepership he was promoted to the post of deputy chief scientific officer (1948), and as deputy director of the Natural History Museum he found further scope for his interests in natural history. The knowledge that Dr. Campbell Smith will be able to continue his researches in his chosen field after his retirement will give much pleasure to his numerous colleagues and friends, both at home and abroad.

Dr. F. A. Bannister

Dr. Frederick Allan Bannister, who succeeded Dr. Campbell Smith on December 1, joined the British Museum (Natural History) staff on September 1, 1927, filling the vacancy caused by E. D. Mountain's appointment as lecturer at Grahamstown, South Africa. Dr. Bannister went from the Whitgift School, Croydon, to Clare College, Cambridge, in 1920. He won a Goldsmith Exhibition in 1921 and was placed in the first class in both parts of the Natural Sciences Tripos, studying physics under Rutherford and mineralogy under Hutchinson. After a year of research work under the direction of Sir Edward Appleton in the Cavendish Laboratory, Cambridge, he joined the Western Electric Co. in 1924, an experience which stood him in good stead in his later work. In 1928 he spent a short time studying the methods of X-ray investigation of crystal structure under Sir William Bragg at the Royal Institution. On his return to the British Museum, Dr. Bannister set up apparatus for this work and very soon established a highly efficient laboratory in a partitioned-off corner of one of the rooms in the Department. This laboratory has been very active in the X-ray study of minerals and has a very high reputation for thoroughly accurate work among mineralogists at home and abroad. His lectures given at the Royal School of Mines in 1935 will still be remembered by those who were privileged to attend them. Dr. Bannister was honorary secretary of the X-ray Analysis Group of the Institute of Physics during 1945–48, and he attended the first general assembly of the International Union of Crystallography at Harvard in 1948 and the second assembly held in Stockholm in 1951.

A. A. Michelson (1852–1931)

ALBERT ABRAHAM MICHELSON, who was born a century ago, on December 19, 1852, at Strelno, in Prussia, near the Polish frontier, was perhaps the greatest authority of modern times on optics, and one of the most ingenious and accurate workers in experimental science. His family emigrated to the United States when he was two years old, and at the age of twenty-one he graduated from the United States Naval Academy, Annapolis, where he served as instructor in physics and chemistry during 1875–79. After studying at Berlin, Heidelberg and Paris, he held various posts before his appointment in 1892 as head of the Department of Physics at the new University of Chicago. His chief abiding interest was light, particularly the accurate determination of its velocity, and the study of optical interference. One of his greatest accomplishments was the construction of the interferometer known by his name, and among the many uses to which he put this instrument the most important were the determination of the international metre in Paris, the measurement of the angular diameter of a star, and the attempt to detect the relative motion of the earth in the ether. The negative outcome of the last-named experiment, carried out in collaboration with E. W. Morley, gave birth to a new philosophy of physical science, which culminated in Einstein's theories of relativity. With the aid of his échelon spectroscope Michelson examined the fine structure of spectral lines. The first American scientific worker to win the Nobel Prize for Physics (1907), he was a foreign member of the Royal Society and recipient of its Rumford and Copley Medals, and served on a number of international committees. He was a fine violinist and painter, and held that art finds its highest expression in science. He died of a cerebral hæmorrhage at Pasadena, California, on May 9, 1931, in his seventy-ninth year.

Antoine Henri Becquerel (1852–1908)

BORN in Paris a century ago, on December 15, 1852, Antoine Henri Becquerel came of a family long distinguished in the world of physical science. Educated at the École Polytechnique, Paris, his early studies were concerned with the magnetic rotation of the polarization plane of light, the influence of earth magnetism on the atmosphere, and the absorption of light by crystals. In 1892 he was appointed professor of physics at the Musée d'Histoire Naturelle—a chair held before him by his father, Alexandre Edmond Becquerel (1878), and by his grandfather, Antoine César Becquerel (1837). Three years later he became professor of physics at the École Polytechnique. His greatest achievement was the result of a lucky accident, but at the same time it was the culmination of a long series of carefully planned experiments. In 1896 he found that photographic plates, protected against ordinary actinic radiations, were fogged by emanations from uranium ores. His paper entitled "Sur les radiations émises par phosphorescence" (*C.R. Acad. Sci. Paris*, 122, 420; 1896) ushered in the new era of radioactivity. Their discoverer in 1903 shared the Nobel Prize for Physics with Pierre and Marie Curie, who in 1898 had isolated radium from pitchblende. Becquerel received the Rumford Medal of the Royal Society in 1900 and was elected president and permanent secretary of the Paris Academy of Sciences in 1908, and in the same year was elected a foreign member of the Royal Society. He died in Brittany on August 25 of that year.

Weights and Measures in Great Britain

A QUESTION regarding the report of the Committee on Weights and Measures Legislation (see *Nature*, July 28, 1951, p. 142) having been asked in the House of Commons, a written reply by Mr. Peter Thorneycroft, President of the Board of Trade, was published on November 11. Mr. Thorneycroft states that the Government is in general agreement with the decisions of Sir Hartley Shawcross announced on May 10 last year, and action has already been started on those recommendations which do not involve legislation. Referring to the metric system, he remarks "The Government are not prepared to proceed with the recommendation for the eventual abandonment of the imperial for the metric system of weights and measures. Consultations with countries of the Commonwealth have, however, shown widespread support for the suggestion that a firm and legally defined relationship between the imperial pound and yard and the international metre and kilogramme should be established. On account of the wide variety of the recommendations and extensive nature of the consultations, the legislation will not be introduced for some time."

Higher Education in Central Africa

IN a written reply to a question in the House of Commons on November 26, the Secretary of State for the Colonies, Mr. Oliver Lyttelton, stated that the commission set up by the Governments of Northern and Southern Rhodesia and Nyasaland, in connexion with the establishment in Central Africa of a college for higher education for Africans, consists of Sir Alexander Carr-Saunders (chairman), Dr. A. Kerr, Dr. A. V. Hill and Prof. F. G. Young, with Mr. Walter Adams as secretary. The commission is now in Central Africa and its terms of reference include a review of the observations regarding the site of the college made by the committee appointed by the Central African Council, the making of recommendations regarding the site, type of courses to be provided and qualifications for admission, as well as on the type of buildings required. The commission is also to draw up a draft constitution for the college and to advise upon the form of 'special relationship with an established university and on the staff required and its recruitment.

Current Literature relating to Scientific Instruments

THE British Scientific Instrument Research Association has issued monthly since 1946 a *Bulletin*, which consists almost entirely of abstracts of any articles, papers, etc., connected with scientific instruments which appear in technical and scientific publications throughout the world. Of course, the abstracting service does not have a fixed and precisely defined subject-field, for the selection of material depends on, among other factors, the interests of the changing membership of the Association, the extent and availability of other sources of information, and the trends of interest revealed by inquiries made by staff who do the abstracting; consequently, a subject may be more fully covered during one period than in another. The *Bulletin* has grown with the years and has now achieved a reputation of filling a very real need and of doing so with considerable adequacy. Its functions are twofold, the first of which is to provide readers each month with a survey of current scientific publications on subjects of interest to them, and in this connexion it is best read like any other periodical review, that is, regularly and as soon after publication as possible. But it may not be realized in some quarters that, by virtue of its annual indexes, the *Bulletin* also serves as a permanent source of reference; indeed, the accumulated copies of the *Bulletin* and its indexes probably provide one of the easiest means of finding information which is related to scientific instruments and has been published within the past six years. All inquiries relating to these abstracts or to scientific instruments in general should be addressed to the Information Department, 'Sira', Southill, Elmstead Woods, Chislehurst, Kent (see also p. 1007 of this issue).

The Air Almanac

THE British "Air Almanac" and the "American Air Almanac" have now become a single publication under the title "The Air Almanac", which will be published three times yearly, each issue containing the requisite data for four months. The first issue of this joint enterprise is for January–April 1953 (Air Publication 1602; pp. 242+56. London: H.M.S.O.; Washington, D.C.: U.S. Naval Observatory. 1952; 10*s*.). It is produced jointly by H.M. Nautical Almanac Office, the Royal Greenwich Observatory, and the Nautical Almanac Office, United States Naval Observatory, but it is printed separately in England and in the United States. Although the unification of the two former publications has necessitated a number of minor changes in both, these will be obvious to those who use "The Air Almanac", and navigators who have been familiar with either almanac will find no difficulty in using the new production. Very full explanations are given, and in order to make the almanac more satisfactory for international use a list defining the symbols and abbreviations that are used is given in English, French and Spanish. The International Civil Aviation Organization accepted the new publication as the basis of an international air almanac, and it seems probable that it will be reproduced, with language changes, in France. It is hoped that it will eventually become international.

Preservation of a Saxon Wooden Bucket

IN the October issue of the *Museums Journal*, Dr. A. A. Moss, of the Research Laboratory of the British Museum, relates with illustrative photographs the remarkable achievement of the preservation of a Saxon bronze-bound wooden bucket with an iron handle. The bucket, when found in Wiltshire, consisted of water-logged staves of yew maintained in position by wet chalk. The four bronze bands were broken. The bucket was immersed in water to prevent shrinking and the chalk removed. The wooden staves were found to be very fragile and the bronze bands corroded. It was deemed necessary to take the bucket to pieces and treat the wood and bronze separately. The corrosion products were removed from the bronze bands and from the supporting strips by electrolytic reduction in a 5 per cent solution of sodium hydroxide. This loosened the rivets, which could then be easily removed. After soaking in water to free from chloride, the fractured edges were joined with soft solder. To preserve the shape of the wood it was decided to replace the water in the cells by alum. Eventually, after drying, the surface of the wood was painted with a dilute solution of cellulose nitrate. In re-assembling the wood and the bronze, a circular bottom for the bucket was made out of 'Perspex'; this fitted into the grooves in the staves. 'Durofix' was used for re-assembling the wooden portions.

The Post-fledging Dispersal of Juvenile Titmice

THE post-fledging dispersal of juvenile titmice was studied by Ivan M. Goodbody in the summer of 1950 in a piece of mixed deciduous woodland near Oxford (*British Birds*, 45, No. 8; August 1952). 248 young bluetits and 191 young great tits were marked with a colour ring on each leg, so that all the birds hatched in the study area could be identified as such, wherever seen. Regular counts of the number of ringed and unringed tits were made in the study area and in a strip of woodland outside it, and showed that an explosive dispersal of young birds takes place within a week or two of leaving the nest; thereafter birds continue to move outwards from their birthplaces. A marked rise in the percentage of unringed juveniles both in the study area and in the outside area in mid-August indicates the possibility that there may be a passage of juveniles at about this time. While no ringed birds were found in a large woodland area one mile away, several were located in low-lying water meadows half a mile away.

Solanaceous Alkaloids in Normal and Grafted Plants

IN normal plants of *Atropa belladonna* the ratio of hyoscine to hyoscyamine is approximately constant at a value of 0·12, irrespective of the total alkaloid present in the plant, the part of the plant analysed, or whether the plant is aged or starved. By contrast, in the normal plants of *Datura innoxia* this ratio is high (average 9·71; tap roots 13·81–17·36; other parts 4·6–9·8). In grafted plants the scion always contains the alkaloids in the proportions characteristic of the plant used as stock, not in those of the scion species. It thus appears that the alkaloids are synthesized in the roots, particularly in the young growing tips, and that they are transported unchanged, probably in the transpiration stream, into the shoot. These results have been obtained using partition chromatography, the extracts tested being of plants into which no foreign alkaloids had been introduced (see G. M. James and B. H. Thewlis. *New Phyt.*, 51, 2, 250; 1952).

A Lower Devonian Charophyte

A NEW species of *Trochiliscus* (Charophyta) from the Downtonian (Lower Devonian) of eastern Europe, described and illustrated by some good photographs by W. N. Croft (*Bull. Brit. Mus. Nat. Hist.* (Geology), 1, No. 7, 1952), probably affords the earliest reliable record of an undoubted Charophyte. It is considered that this species was probably a land plant, growing like the recent and contemporary *Charas* in fresh and brackish water.

Central American Flora

THE very rich floristic region of Central America has long attracted taxonomic botanists. In a recent work ("Flora of Guatemala", by P. C. Standley and J. A. Steyermark. ***Fieldiana:*** Botany, 24, Pt. III. published by Chicago Natural History Museum, April 1952), the authors have dealt with the major monocotyledonous families from Commelinaceæ and Pontederiaceæ to Cannaceæ and Burmanniaceæ, and with dicotyledonous families including Casuarinaceæ and Piperaceæ to Fagaceæ and Urticaceæ. Some excellent line-illustrations accompany the text.

Sunspots during January–April 1952

AN account by Lucy T. Day of the positions, areas and counts of sunspots during the period January–April 1952 is given in United States Naval Observatory Circular No. 36 (June 18, 1952). The results, tabulated in seven pages of the Circular, are based upon measurements made at the Naval Observatory on plates secured there or at the Mt. Wilson Observatory, and are a continuation of those published in the *Monthly Weather Review* from February 1, 1927, to December 31, 1947. An explanation is given of the meaning of the various symbols used in the seven columns, and at the end of each month the mean daily area and the mean relative sunspot number are given.

Colonial Service: Recent Appointments

THE following appointments in the Colonial Service have recently been announced: W. E. M. Logan (assistant conservator of forests, Kenya), regional assistant conservator of forests, Tanganyika; P. S. Hammond (agricultural officer, Gold Coast), assistant director of agriculture (cocoa industry), Gold Coast; J. B. D. Robinson (chemist, Department of Science and Agriculture, Barbados), scientific officer, agricultural chemist, Kenya; J. M. Waterston (senior botanist, Nigeria), principal research officer, Agriculture Department, Nigeria; G. C. Witt (soil survey officer, Trinidad), soil chemist, Trinidad; Dr. S. E. Piercy (senior veterinary research officer, Kenya), chief veterinary research officer, Kenya; J. F. C. Swan (senior veterinary officer, Northern Rhodesia), chief animal husbandry officer, Northern Rhodesia; S. B. Chambers (statistician, Nigeria), government statistician, Nigeria; H. A. Darby, R. E. Osborne and I. H. Tomlinson (agricultural officers, Jamaica), senior agricultural officers, Jamaica; H. C. Poisley (assistant government pharmacist, Fiji), government pharmacist and medical storekeeper, Fiji; G. E. Redshaw (agricultural assistant, Jamaica), agricultural officer, Jamaica; R. O. Williams (agricultural officer, Kenya), chief research officer, Agricultural Department, British Guiana; W. H. Andrews and D. A. L. Brown, agricultural officers, Tanganyika; R. E. H. Atkinson, agricultural officer, Uganda; A. M. Cockburn, agricultural officer, Nigeria; J. R. Dunsmore and M. J. Smith, agricultural officers, Federation of Malaya; J. R. Peberdy, agricultural officer, Kenya; J. W. Reed, agricultural officer, Nyasaland; E. A. Riley, plant pathologist, Northern Rhodesia; G. Fry and J. S. Spears, assistant conservators of forests, Kenya; E. Williams, geologist, Uganda; Miss H. G. T. Maycock, pathologist, Federation of Malaya; J. Riley, scientific officer (entomologist, W.A.P.I.R.U.), Nigeria; J. Smartt, plant breeder/scientific officer, Northern Rhodesia; M. C. Butler, veterinary officer, Kenya; R. H. Johnson, veterinary education officer, Nigeria; A. Beaton, assistant conservator of forests, Uganda; M. J. Berry, assistant conservator of forests, Federation of Malaya; B. M. Brown, meteorologist, West African Meteorological Service, Nigeria; J. A. Channon, meteorologist, East Africa High Commission; P. B. Cornwall, entomologist, West African Cocoa Research Institute, Gold Coast; H. F. Lamprey, biologist, Game Department, Tanganyika; W. McC. Lyall, field geologist, Kenya; P. F. Neal, field officer, Geological Survey Department, Uganda; C. J. Swanson, meteorologist, East Africa Meteorological Department, East Africa High Commission; D. C. Upton, statistician, East Africa High Commission; J. A. Willby, livestock officer, Tanganyika; A. C. Williamson, assistant conservator of forests, British Honduras.

Announcements

PROF. P. M. S. BLACKETT, Langworthy professor of physics in the University of Manchester, has been appointed to the University chair of physics tenable at the Imperial College of Science and Technology, London. The title of reader in organic chemistry in the University has been conferred on Dr. L. N. Owen in respect of the post held by him in the Imperial College.

PROF. JAMES CHESTER BRADLEY, professor emeritus of entomology, Cornell University, one of the United States representatives on the International Commission on Zoological Nomenclature since 1914, has been elected president of the Commission, in succession to the late Dr. James Lee Peters, Museum of Comparative Zoology at Harvard College, Cambridge, Mass.

SIR CHARLES DARWIN has been appointed chairman of the Radioactive Substances Advisory Committee in succession to Sir Henry Dale, who has resigned. Prof. G. R. Cameron (University College Hospital Medical School) and Prof. K. G. Emeléus (Queen's University, Belfast) have been appointed to the Committee.

THE fourth annual conference of the Society for the Study of Fertility will be held in the University of Liverpool during July 7–8, 1953. Further particulars can be obtained from the honorary secretary, Dr. G. I. M. Swyer, at University College Obstetric Hospital, Huntley Street, London, W.C.1.

AT a meeting of former members of the late Scottish Seaweed Research Association, those present determined to form a Society to be known as the Seaweed Utilization Society, to serve as a two-way channel of information and opinion with the Institute of Seaweed Research. The secretary of the Society is Miss M. D. Walker, 49 Rodney Street, Liverpool 1.

THE Oil and Colour Chemists' Association will hold its 1953 conference at Eastbourne during June 2–6. The general theme will be "The Optical Properties of Films of Surface Coating Materials", and there will be three technical sessions, each of three papers, on the mornings of June 3–5. Hotel reservations must be completed before January 1 on the appropriate form, obtainable from the general secretary of the Association at Memorial Hall, Farringdon Street, London, E.C.4.

APPLICATION OF RADAR TO METEOROLOGY

CONFERENCE IN MONTREAL

THE third Radar Weather Conference was held in the Macdonald Physics Laboratory of McGill University, Montreal, during September 15–17. About eighty people actively engaged in research into the application of radar to meteorological problems attended, and some forty papers were read and discussed in seven sessions. A very useful feature of the Conference, which contributed greatly to the value of the discussions that followed each paper, was the provision, before the beginning of the first session, of copies of all the papers scheduled to be read. When it is noted that the time-limit for receipt of authors' manuscripts was only three weeks in advance of the meeting, it is clear that Drs. Marshall, Gunn and Hitschfeld, of the Stormy Weather Research Group, McGill University, who formed the conference committee, accomplished a notable feat of organization.

The subject of Session *A*, under the chairmanship of Mrs. P. M. Austin (Massachusetts Institute of Technology), was "Precipitation Mechanisms". It is now more generally recognized that the Bergeron–Findeisen theory of rain formation—the rapid growth of ice crystals in an atmosphere saturated with respect to water, followed by growth by collision with cloud particles—is not adequate to explain all cases of rain formation, and that growth to raindrop size, without the aid of an ice crystal, by coalescence in the liquid state must also occur. The relative importance of each mechanism in a particular weather situation is, however, still a matter of speculation. That radar may be of great assistance in resolving this problem was shown in papers by Wexler (Massachusetts Institute of Technology), Battan (University of Chicago) and Cunningham (Massachusetts Institute of Technology). From data on the level at which radar echoes from thunderstorms first appear and their subsequent rate of growth, Battan concludes that rain formation in convective clouds, even those extending above the freezing level, may often occur through a process involving only the liquid phase. On the mechanism of this process, East (McGill) suggested that, if by some method—for example, turbulence or steady acceleration of the air—the gravitational field around a cloud droplet is increased, then the rate of growth of that droplet by collision with smaller droplets will also increase. Hence turbulence may play an important part in the generation of rain in cumulus clouds.

Turbulence as it affects aircraft rather than cloud droplets was the subject of a paper by R. F. Jones (Meteorological Office, East Hill). It was shown that the structure of the echo from a cumulus or cumulo-nimbus cloud, as seen on the radar display tubes, particularly in the vertical cross-section, is a useful guide to the severity of the turbulence likely to be encountered by an aircraft traversing the cloud and also indicates the places in the cloud where the turbulence is likely to be the most severe.

Marshall, Langleben and Rigby (McGill), from an examination of the characteristic 'mare's tail' radar echo-pattern (seen in the vertical cross-section) associated with falling snow, suggested that snow is generated continuously in compact generating elements rather than uniformly over a wide area.

Session *B*, under the chairmanship of Prof. H. Byers (University of Chicago), was devoted to "Cloud Observations and Cloud Radar Problems". Whereas radars operating on wave-lengths of 10 cm. and 3 cm.—the only wave-lengths commonly used for weather purposes up to this time—detect only those parts of clouds containing rain or drizzle drops or snowflakes and not the whole clouds, Plank, Atlas and Paulsen (U.S. Air Force Cambridge Research Centre), using a vertically-looking radar of wave-length 1·25 cm., reported that about 47 per cent of all clouds can be detected. Swingle (Signal Corps Engineering Laboratories), with a vertically-looking 0·86-cm. radar, has obtained better results than on 1·25-cm. wave-length on cumulus, cirro-stratus and cirrus clouds, and about the same results on other clouds. The results obtained are in accordance with the Rayleigh scattering theory, so that even these radars of shorter wave-lengths see only the parts of clouds containing the larger elements. Nevertheless, the ability to detect smaller droplets or ice crystals than with wave-lengths of 10 and 3 cm. will add further to the knowledge already gained of precipitation processes.

Session *C* was held in the Council Chamber of the International Aviation Building, with Mr. A. C. Bemis (Massachusetts Institute of Technology) as chairman. The purpose of this session was to bring together the radar meteorologists and those interested in the possibilities of using airborne radar to increase passenger safety and comfort. Carnes (Aeronautical Radio, Inc.) put the airline point of view, and pointed out that economical operation demands that the size and weight of electronic equipment carried must be kept small. He said that 3-cm. airborne radar suffers too much from attenuation in heavy rain, and a wave-length of 6 cm. is being recommended. Tolefson (National Advisory Committee for Aeronautics) showed that the use of radar will enable the pilot of an aircraft significantly to reduce the number of large gusts it encounters with increased passenger comfort, a finding which is supported by the work done in Britain. It is unlikely, however, that radar could assist in reducing the number of small gusts encountered, a factor of importance to structure fatigue.

"Rain Measurements" was the subject of Session *D*, over which Mr. D. Atlas (U.S. Air Force Cambridge Research Centre) presided. 10-cm. or 3-cm. radar has the useful property of indicating over a surrounding area almost instantaneously—in the time taken to sweep the radar beam over the area—the places where precipitation is occurring, and, from the intensity of the received radar signal, an indication of the rainfall intensity can be obtained. In areas where very heavy rainfall over the catchment area of a river leads to dangerous flooding farther down, the warning which radar can give may be of great value in saving lives and property. Research along these lines was reported by Stout and Neill (Illinois State Water Survey), who claimed that rainfall-rates computed from the received signal intensities of a 3-cm. radar were as accurate as those obtained from a rain-gauge network of 1 gauge per 200 square miles.

Similar results using 10-cm. radar, with a pulse integrator device which gives automatically the average signal intensity over an area, were reported by Austin and Richardson (Massachusetts Institute of Technology).

Mr. G. E. Stout (Illinois State Water Survey) presided over Session *E*, which was devoted to "Instruments". As well as the radars of short wave-length already referred to, which it is hoped to use as indicators of cloud base and top, instruments were described which are designed to measure rain-drop sizes and distributions from aircraft and on the ground. A knowledge of liquid water content and drop-size distribution is of importance in assessing quantitatively the radar signal received from a volume of cloud.

Dr. R. A. Smith (Telecommunications Research Establishment, Malvern) was chairman of Session *F*, when "Scattering in the Atmosphere" was discussed. Gunn and East (McGill) and Labrum (Radiophysics Laboratory, Sydney), working independently, have put on a firm quantitative basis the theory of back-scattering of radio energy from ice spheres coated thinly with water and from water spheroids. They have proved (what up to now has been assumed) that a small ice sphere with a thin water coating, as, for example, in the first stage of melting, will scatter nearly as well as a water sphere of the same volume and may absorb better. A water-coated ice spheroid may scatter and absorb very much more strongly than the spherical water drop into which it melts, giving an explanation of the well-known 'bright band' effect of enhanced echo at the freezing-level in conditions of continuous rain.

Gerhardt (University of Texas) said that his refractometer measurements indicated that in subsidence and frontal inversions the refractive index gradient over short distances may be several orders of magnitude greater than the normal, and that isolated patches exist with variations of refractive index adequate to explain 'angel' echoes (radar echoes received from a clear sky). Gordon (Cornell University) explained how scattering from turbulent patches in the atmosphere may increase the field strength beyond the horizon above the theoretical value at frequencies greater than 30 Mc./s., as has often been observed. There was some discussion on 'angel' echoes, which were reported by W. B. Gould (Signal Corps Engineering Laboratory) to have been observed in great numbers using a vertically-looking radar of wave-length 1·25 cm. These echoes are also observed in Britain using wave-lengths of 3 cm. and 10 cm. and are almost certainly associated with inhomogeneities in the atmosphere of the kind described by Gerhardt.

The final session, under the chairmanship of Dr. Gould, discussed "Fluctuating Signals", the object of this topic being to deduce some of the properties of the scattering particles by measurement of the fluctuations from pulse to pulse of a radar signal. In particular, it is hoped that the measurements may yield information on the turbulence within a cloud—for example, the size and duration of turbulent eddies. The subject is clearly complicated by the large distribution of drop sizes within a precipitating cloud and also by the inherent variabilities in the performance of radar sets.

Before finally dispersing, the Conference decided to accept an invitation to hold its fourth meeting during November 1953 in the University of Texas.

R. F. JONES

INTERNATIONAL SCIENTIFIC FILM ASSOCIATION

SIXTH ANNUAL CONGRESS

THE growing strength of the international scientific film movement was well in evidence at the annual congress of the International Scientific Film Association, held in the Maison de la Chimie, Paris, during September 23–October 1. During the congress, the acceptance of three countries as new members was announced—Cuba, East Germany and West Germany—and the reports from all countries showed steady progress and development in the use of the film for scientific education, for research and for popularizing science.

Seventy-two delegates and observers, representing twenty-one countries, the United Nations Educational, Scientific and Cultural Organization, the Fédération Internationale des Archives du Film and the Fédération Internationale des Ciné-Clubs, attended the congress. During the meeting, a hundred and seventeen films were shown to public and specialized audiences and, of these, the largest number from any one country was from Great Britain, no fewer than twenty-seven British films being shown; among them may be particularly mentioned "Atoms at Work", the Crown Film Unit's ten-minute documentary on Harwell, which attracted wide interest and resulted in a unanimous resolution by the congress urging other countries to give it the widest showing and to make similar films depicting their own development of atomic energy for peaceful ends.

Other films shown included a West German film illustrating, by means of infra-red photography, the remarkable fact that mice will fight savagely in the dark but never in the light; a French film showing the film work by the late Bernard Lyot on astronomy; a quite outstandingly beautiful Hungarian colour film of bird and insect life on the great lakes; an Icelandic film made by Mr. Tutte Lemco on the eruption of Mount Hecla, the dramatic shots of which provoked several bursts of spontaneous applause; and an equally striking Italian colour film of the courtship of the praying mantis.

The Research Section of the Association held several sessions, at one of which there was a demonstration of magnetic strip recording by M. André Didier, which was of particular interest to the British members present in view of its introduction at the present time into Britain. There were also two demonstrations of stereoscopic techniques. The first, by Dr. François Savoye (Paris), dispenses with 'Polaroid' glasses and relies on a synchronized rotating 'grill' in front of the screen to alternate the right- and left-eye images. It was effective, but suffered from the fact that the viewer's head has to be held very still in order to avoid a shifting of the images—a drawback that may possibly be due to the fact that both screen and grill were rather small. The other stereoscopic system was demonstrated by H. Dewhurst, of the Telecommunications Research Establishment, Malvern, using 'Polaroid' glasses and a beam-splitting equipment which is within the scope even of the amateur film-maker. The demonstration was mainly with an amateur colour film, and the results were excellent, although again handicapped perhaps by a small screen.

Among matters discussed by the general assembly of the congress was a proposal to establish a Section of the Association to deal with veterinary science, a suggestion which was made by the Netherlands delegation and accepted by the assembly. It was also decided to consider the possibility of holding at the 1953 congress a special session on high-speed cinematography.

The officers of the Association elected unanimously for 1952–53 were as follows: *President*, John Maddison (Great Britain); *Vice-Presidents*, Jan Korngold (Poland) and Prof. Mario Ponzo (Italy); *Honorary Treasurer*, J. W. Varossieau (Holland); and *Honorary Secretary*, Jean Painlevé (France). In addition, Luc Haesaerts (Belgium) was re-elected as curator of the International Film Reference Library and Prof. R. V. Talice (Uruguay) was appointed as delegate for Latin America; Dr. G. Wolf (West Germany) was elected chairman of the Research Section, and Prof. Dekking (Holland) chairman of the Medical Section.

Great Britain was represented at the congress by a strong delegation led by Dr. Malcolm Donaldson, which also included Prof. H. Dryerre, representing the Scottish Scientific Film Association. At the end of the final session of the Assembly, it was unanimously agreed to accept the invitation of the British delegation to hold the seventh congress in London during September 1953. J. STEWART COOK

INSULATION OF ELECTRICAL EQUIPMENT

A VACATION 'school' on the insulation of electrical equipment was held in the Electrical Engineering Department of the Imperial College of Science and Technology, London, during September 15–19. It was attended by some eighty engineers drawn from industry, the British Electricity Authority, research associations, technical colleges and the universities. The purpose of the course was to consider the factors which are limiting insulation design in the main classes of electrical equipment, and the general principles which should govern the approach to the solution of outstanding problems in this field.

An opening address was given by Dr. P. Dunsheath, chairman of convocation of the University of London, in which he commented on the value of postgraduate schools in facilitating and extending the interchange of knowledge and ideas between specialists of long experience and the more junior members of industry and in reducing the time-lag in the use of new information. He then drew on his long experience of cable manufacture in an interesting historical review of early developments in insulating materials and of the difficulties which were encountered and overcome when little was known of the principles underlying their behaviour.

In the first lecture Prof. Willis Jackson, of the Imperial College of Science and Technology, London, discussed the problems facing the insulation engineer, surveyed the historical development of the widely used materials based on natural products and of the more recent synthetic materials, and outlined the progress which has been made towards explaining the electrical, physical and mechanical properties of these materials in terms of their chemical composition and physical structure. He was followed by Dr. L. Hartshorn, of the Electricity Division, National Physical Laboratory, Teddington, who spoke on the phenomena of permittivity and dielectric loss, with particular reference to the effects on them of temperature, humidity and oxidation.

The third lecture, by Dr. S. Whitehead, director of the Electrical Research Association, dealt in a comprehensive manner with existing knowledge of the mechanisms of intrinsic and thermal dielectric breakdown, and of breakdown due to external or internal discharges. Dr. Whitehead also discussed the effect on the electric strength of electrochemical deterioration in service, and the scope for improvement in materials, design and testing. Another member of the Electrical Research Association, Mr. C. G. Garton, then spoke on the structural basis of electrical and mechanical properties, and gave a very illuminating treatment of rate processes in relation to the dependence of these properties on temperature and frequency.

In the fifth lecture Mr. R. Snadow, of the British Thomson-Houston Co., Ltd., reviewed the available insulating materials in terms of the present thermal classification. He emphasized the inadequacy of this classification for some of the new synthetics, and that their application is being retarded by too limited knowledge of their thermal endurance.

The next five lectures were concerned with the applications of insulation in different classes of electrical equipment, and with the design problems involved. In discussing communication components, Mr. I. M. Ross, of the Ministry of Supply, referred to the extremely wide frequency-range with which the communication engineer has to deal, and the severe thermal and mechanical conditions to which military communication equipment, in particular, is subjected. After reviewing the changes in design which the use of new synthetic materials has made possible during recent years, he outlined the directions in which further improvement is required. Dr. L. G. Brazier, of British Insulated Callender's Cables, Ltd., dealt with the development of high-voltage cables and remarked that, in consequence of improvements which have occurred in the qualities of paper and oil and in the methods of cable fabrication, the oil-paper dielectric introduced by Ferranti some fifty years ago remains the only form of dielectric suitable for use at the highest operating voltages. He outlined the outstanding problems and the methods being adopted to resolve them. The design of power capacitors, and the manner in which this might be affected in the near future by the use of the new ceramics based on barium titanate, was then discussed by Dr. R. S. Vincent, of British Dielectrics Research, Ltd.

Mr. E. Jones, of the English Electric Co., Ltd., made a comprehensive review of the insulation problems involved in the design of electrical machines and indicated possible lines of approach to a more efficient use of insulation, and the reasons why, except to meet special requirements, there is no great need for, nor likelihood of, a marked increase in operating temperatures. The subject of transformers was dealt with by Mr. D. McDonald, of the British Thomson-Houston Co., Ltd. After discussing the electrical, mechanical and thermal requirements of transformer insulation design and the problems involved in satisfying them, he illustrated the trends of high-voltage transformer design by consideration of the shielded cylindrical layer-type winding. He brought out the increasing similarities with cable construction and the movement towards the exclusive use at the highest voltages of the oil – paper dielectric. Mr. P. G. Ashley, of the Metropolitan-

Vickers Electrical Co., Ltd., then discussed the insulation of switchgear. He surveyed the main uses of insulation, for supports, fillers and coverings, and the suitability of available materials for these purposes and, after emphasizing the need for fuller information concerning the long-term stability of materials and the difficulties of obtaining it, concluded by remarking that technically, if not economically, 500-kV. switchgear is a feasible proposition.

The final lecture, by Dr. J. S. Forrest, of the Research Laboratories of the British Electricity Authority, was concerned with the testing of insulation in the laboratory, factory and field. He classified the tests in use according to their function and advised on the interpretation of test results; he emphasized the need for constant review of the methods of test directed towards the formulation of a scheme of testing which would reflect the service conditions to be met as faithfully as possible He remarked that such an approach would assist in improving the present inadequate correlation between laboratory, factory and field tests.

The specialized discussions which followed the individual lectures were supplemented by a general discussion during the final session, when attention was devoted to questions such as the availability of new materials; the inadequacies of the present classification; the much more satisfactory understanding of the electrical mechanisms of dielectric behaviour compared with those governing the physical and mechanical properties, and finally, the desirability of increased and more fundamental attention to materials in courses leading to degrees and national certificates in electrical engineering. Visits were made during the course to the laboratories of the Electrical Research Association and the British Insulated Callender's Cables, Ltd.

BRITISH SCIENTIFIC INSTRUMENT RESEARCH ASSOCIATION

OPEN DAYS

WITH whatever feelings one regards the advancing front of science, it is obvious that the operation of new processes and new techniques, which give force to ideas and actions based on them, is maintained and nourished by the development of scientific instruments. These are tools of industry as well as of research. Thus the practice of the art and craft of instrument-making is a key industry, and it is significant that the British Scientific Instrument Research Association was the first of the industrial research associations, being founded in 1918. The laboratories of the Association are situated near Chislehurst in park-like surroundings, and when members and friends were entertained there on the recent open days (November 5 and 6) the weather was mild and clement enough to reinforce the pleasure of the occasion.

For thirty years the work of the Association was carried on in a house in Russell Square, London, and was mainly concerned with the manufacturers of optical instruments. This is not the place to report on the vicissitudes and difficulties of the early years, but in the outcome there has been very considerable development. During and since the Second World War the membership has greatly expanded, as has the scope of the experimental work undertaken, and the facilities provided at Chislehurst are comprehensive and impressive. No great powers of observation are required by the visitor to confirm that the Association is an integral part of the scientific instrument-making industry.

Research associations, though having essential similarities, differ markedly from one another in a variety of ways which reflect the character, scope and state of scientific development of the industries which they serve. Some of them are able to concentrate on the behaviour and manipulation of narrow groups of raw materials or types of processes on which their industries depend. In this sense the field may be relatively narrow, or at least the boundaries may be reasonably well defined. The British Scientific Instrument Research Association must have a broader outlook, for it serves an industry which itself serves a great variety of other industries, and to these must be added the Armed Services, universities and scientific establishments of all kinds. In general, of course, testing and instrumentation are subjects on which a considerable contribution is made to individual industries by their respective research organizations, but there remains an extensive region for activity by the Association.

The original and continuing emphasis on optical work was illustrated during the open days by demonstrations of lens grinding and, judging from the interest displayed by visitors, many people were impressed by the speed and accuracy with which this can be accomplished to precise specifications by precision engineering set-ups. The Association has a small glass-making shop (a palette of colour glasses for artificial eye-making was displayed) and has made considerable contributions to the techniques of chemical analysis of optical glasses, as well as to the examination of such glasses by interferometry, polarimetry and microscopy, including the effects of ageing and attack by humid atmospheres, etc.

The utilization of modern synthetic resins in optical cements has evidently been developed with much satisfaction, and there were striking demonstrations of the preparation of polarizing films from suitable synthetics by molecular orientation, and of metallic mirrors, anti-reflexion films, interference filters for visible light, heat filters, etc., dependent on high-vacuum evaporation techniques.

The development of infra-red transparent materials has made a striking advance through the utilization of the fact (known for some time) that mixed crystals of thallium bromide and iodide are transparent to radiations in the region 0·5–40 μ. The process was demonstrated of growing single crystals in vertical cylindrical crucibles by a progressive freezing of the melt from bottom to top. The material, known as *KRS*-5, can be ground and polished and is chemically stable.

Graticule production may be described as one of the Association's 'specialities'. The methods adopted are mainly photographic in character and were well illustrated, together with the preparation of resolution test-slides for projection lenses.

Relatively recently, with the increasing use of electronic devices, the Association has built up a department well equipped to deal with a variety of electrical problems, exemplified by work on thermionic valves and valve amplifiers, electrometer valves, resistors of low temperature coefficient, magnetic amplifiers, the effects of dust on electrical contacts, etc. By contrast with the apparent complexities of electronic work, there was also displayed in another room the success so far achieved in attempting to answer the simply stated question: How can one ensure free movement of mercury drops in sealed glass tubes such as are used in rocker contacts on electrical relays, etc., so as to avoid faulty make-and-break?

Studies on the gas permeability of thermocouple sheaths, performance specifications for electric ovens, fluid flow of liquids and gases, and the use of pneumatic (air-jet) gauges for observations on the curvature and thickness of lenses, provided further evidence of the wide scope of the Association's activities.

There were many indications of the flexibility of the broad divisional organization of the laboratories, supported by excellent drawing-office and workshop facilities. One learned that all divisions contribute to the information and liaison services, partly by providing background for the Information Department in dealing with technical inquiries, and partly by visits to member firms to study works procedures, to discuss immediate practical problems, and to seek advice about investigations being carried out by the Association. It is noteworthy that heads of divisions and senior staff generally are expected to spend some 20 per cent of their time in such visiting.

It would seem that those member firms which enter into active membership of the British Scientific Instrument Research Association in all its aspects may benefit exceedingly.

ALLEGHENY OBSERVATORY, UNIVERSITY OF PITTSBURG

A SHORT account of the origin and development of the Allegheny Observatory of the University of Pittsburg (pp. 12; from the University) has been compiled by Theodora M. Lauterbach, which makes very interesting reading. The appearance of Donati's Comet in 1859 aroused a new interest in astronomy, and a group of Pittsburg business men soon organized the 'Allegheny Telescope Association' and made plans for the purchase of a large telescope. This 13-in. refractor was made by Fitz, of New York, and was installed in the new building complete with dome, on a hill in the old city of Allegheny which later became part of Pittsburg. In 1867 the Association presented the telescope and building to the Western University of Pennsylvania—now the University of Pittsburg—and in the same year Samuel Pierpont Langley went to Pittsburg as professor of astronomy and director of Allegheny Observatory. Under him, and through financial assistance from William Thaw, a Pittsburg industrial leader, the equipment in the Observatory was greatly improved.

John A. Brashear, a former mill-worker, who had shown a wonderful aptitude for making lenses, and who was encouraged in this work by Langley, played a prominent part in the development of the Observatory. When James E. Keeler, who succeeded Langley in 1891, resigned in 1898 to take up the directorship of Lick Observatory, Brashear became temporary acting director until the following year, when F. L. O. Wadsworth took charge. During the latter's period as director, most of his time was devoted to supervising the construction of the buildings and instruments for the new Observatory, and with Brashear's assistance their efforts were rewarded by the laying of the foundation stone in October 1900. In 1912 the new Allegheny Observatory was dedicated and presented to the University of Pittsburg, and Dr. Frank Schlesinger was appointed director.

The account describes the excellent work of Schlesinger and the succeeding directors—Curtis, Jordan and others—and, as the author says at the end of this interesting brochure, "The Observatory's location serves well for uninterrupted research, and it is through research that Allegheny Observatory has helped to make the University of Pittsburg known throughout the world". The publication contains thirteen photographs of directors, instruments, and portions of the Observatory buildings.

NUFFIELD FOUNDATION

ANNUAL REPORT

THE seventh report of the Nuffield Foundation covers the year ending March 31, 1952*, and is the third in the current period of the present programme, during which allocations totalling £620,311 have been made for fundamental research in the United Kingdom; of this, £189,261 is for biological and £189,950 for sociological studies, and £110,000 is reserved for research overseas in the Commonwealth, of which £40,190 has been allocated in Australia, £12,712 in New Zealand and £18,500 in South Africa. The cost of existing schemes to the end of the quinquennium is estimated at the £498,892 already set aside, while £112,921 has been devoted during the current quinquennium to the continuance and extension of projects in medicine, science and the care of old people begun in the first programme. From the Oliver Bird Fund, £114,000 has been used or reserved for research in rheumatism.

By thus reserving in advance from current income £1,504,849 of £1,596,042 allocated in grants for the quinquennium, the Foundation seeks to assure itself of future freedom in the event of any fluctuations either in income or objectives and opportunities. For the advancement of research in the United Kingdom the Foundation has been concerned chiefly to stimulate studies in biology and sociology and, outside these two fields, any other research of real importance or promise which lacks the funds required for its full development. For financing projects of this latter type, the Foundation has set aside a sum which is termed the 'free fund', the use of which is essentially unplanned, and from this fund grants totalling £241,000 have been allocated during the past year. The greater part of this is to meet the Foundation's commitment to share with the Department of Scientific and Industrial Research the cost of the steerable radio telescope at the Jodrell Bank Experimental Station of the University of Manchester. This grant will avert the postponement of the project because sufficient public funds could not be made available. Grants from the same fund have been made to the University of Cambridge towards the cost of sinking and lining a borehole at or near the geophysical laboratories for experiments and measurements deep into the earth's crust, and towards the construction, during the next five years, of a new and improved high-speed electronic calculating machine. A three-year grant has also been made to Prof. J. Rotblat, of the Physics Department, St. Bartholomew's Hospital Medical College, to enable him to retain two technicians specially trained in the photographic emulsion technique he uses in his study of nuclear energy states, and a grant of £14,000 has been made to the Royal Anthropological Institute for the establishment for five years of the Nuffield blood-group research and reference centre, which came into operation on January 1, 1952.

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* Nuffield Foundation. Report for the Year ending 31 March 1952. Pp. 162. (London: Nuffield Foundation, 1952.)

Grants totalling £95,492 promised during the year for biological studies include those to the University of Cambridge for theoretical investigations at the Chemical Laboratory on molecular structure with the view of their application to biological problems and the study of animal behaviour, particularly studies of imprinting, habituation, insight and homing orientation at the Madingley ornithological field station; to the University of Leeds for studies on the molecular structure of collagen and infra-red techniques in the Department of Biomolecular Structure; and to the Lister Institute of Preventive Medicine to enable investigations on the isolation and characterization of antigens to be resumed and for the continuance of the work on co-enzyme A and related substances. Grants have been made to the University of London to increase the biological balance of the team working in the Wheatstone Physical Laboratory at King's College, under Prof. J. T. Randall, on the structure and function of nucleic acids in cells and the structure and fibrogenesis of the collagen of connective tissues; for the work on the embryonic brain at the Department of Anatomy and Embryology, at University College; and for the work on proliferation and morphology in the adult in the same Department, in association with the Department of Physiology; while grants have also been made to the Department of Clinical Pathology of University College Hospital Medical School for work on the red cells of human blood and to the Department of Morbid Anatomy for work on the responses to injury, and subsequent repair and regeneration, in liver and other tissues; the Obstetric Unit of the same School has received a grant for assisting the application of the sensitive electronic recording apparatus required for the further development of the work on the normal pattern of uterine contractions in child-birth and the effects of drugs on the contractions.

A grant of up to £4,000 has been made to the University of Manchester to enable Dr. H. C. B. Slack to investigate the metabolism of the extracellular substances of the body at the Rheumatism Research Centre. The University of Oxford has accepted grants for the continuance of work at the Physical Chemistry Laboratory on the mechanism by which resistance to various drugs and antibodies of a bacterial population is increased; for a graduate assistant to Dr. W. Holmes, of the Department of Zoology and Comparative Anatomy, to extend, along histological, histochemical and biochemical lines, his work on the adrenal cortex in lungfish; and for building up in the same Department a research unit in animal behaviour. A grant has also been made to enable the Strangeways Research Laboratory, Cambridge, to provide a worker trained in tissue culture and histology to collaborate with the Sir William Dunn Department of Biochemistry, University of Cambridge, in work on the effect of insulin and other hormones on the rudimentary long bones and animal tissues grown in tissue-culture.

The Foundation's grants for sociological studies are aimed primarily at aiding non-economic subjects, but two recent grants have been made for applied economic research: one of £6,500 to the Department of Applied Economics, University of Cambridge, is to collect and construct the social accounts of Cambridgeshire; the other, of £11,500, is to the Institute of Statistics, University of Oxford, for a national sample-survey of personal savings, to be carried out in two succeeding years. Both these projects have strong social implications and will make use of sample-interview techniques, thus contributing to the further development of this essential tool of social research. Grants totalling £3,200 have been made to the Department of Social Anthropology, University of Edinburgh, to finance work under Dr. Kenneth Little on the organization of Colonial students in London, their educational activities, etc., the social organization of coloured people in Manchester, and, in West Africa, on the complex social and economic factors which give rise to emigration and direct it to Britain. A grant has been made of £3,500 for the creation, for five years, of a research fellowship at Bedford College, University of London, to be held by Mrs. Barbara Wootton to review the whole field of social research. A grant of £4,000 has gone to the Department of Town Planning, University College, London, for a two-year study of the contribution of the social sciences to the principles and techniques of town and country planning and a survey of the processes of planning.

From the Oliver Bird Fund a further grant of £4,000 will enable the team under Prof. M. Stacey, in the Department of Chemistry, University of Birmingham, to continue for two or three years its studies of the organic chemical structure and enzymatic behaviour of the tissue components and joint fluids. The grant of £1,100 for the examination of the steroids of ox-bile, the original source of cortisone, under Prof. F. S. Spring at the School of Chemistry, Royal Technical College, Glasgow, has been renewed for a further two years. Renewed grants totalling £7,041, for the two years ending 1954, have been made to the Rheumatic Unit, Northern General Hospital, Edinburgh, for continued clinical work with cortisone, studies of cortisone as an adjuvant to the treatment of anaemia in rheumatoid arthritis and other fundamental work. Renewed grants have also been made to the Orthopaedic and Accident Department, London Hospital, to enable Mr. A. Law to continue his studies of surgical treatment in rheumatic disease of the hip, spine and knee, to the Postgraduate Medical School, University of London, for the retrospective follow-up of patients, and to the South-west and Oxford Regional Research Unit, Bath, for completing therapeutic trials of X-ray therapy in osteoarthritis, rheumatoid arthritis, and spondylitis, and of intra-articular injections in osteoarthritis.

New grants for research overseas within the Commonwealth include those to the Waite Agricultural Research Institute, University of Adelaide, to enable Dr. H. L. Penman, of Rothamsted Experimental Station, to visit Australia in connexion with work on evaporation; for Dr. D. F. Thomson, of the Department of Anthropology, University of Melbourne, to visit social anthropologists in the United Kingdom and later to revisit Arnhem Land; to the Department of Chemistry, University of Western Australia, for equipment and infra-red spectroscopical research on Australian natural products; to the University of Otago, for studies in the Department of Botany of morphology and chromosome numbers in *Ranunculus* and transplantation experiments and population analyses, at the Portobello Marine Biological Station, of the physiological mechanisms of animal behaviour and the interpretation of their structure in these terms, and, in the Department of Zoology, of the processes of bird-life. Grants have also been made to the University of Pretoria for work at the Plant Physiological Research Institute on nitrogen assimilation and metabolism in leguminous plants; to the Research Department of Ichthyology, Rhodes University, for research on freshwater fishes of southern Africa; to the Transvaal Museum, Pretoria, for completing the excavations at Swartkrans; and to the Bernard Price Institute of Geophysical Research, University of the Witwatersrand, for the establishment of a Nuffield Geochemical Unit.

For the second year's selection, applications for biological scholarships and bursaries have been stronger in number and quality, and out of thirty eligible applicants, two were awarded scholarships and one a bursary; two sociological scholarships and one bursary were also awarded to the twenty-two applicants under that scheme. The Foundation has reviewed the scheme of travelling scholarships for farmers of the United Kingdom, and reports from the National Farmers' Union suggest that the objects of the scheme are being achieved: ten awards, among sixty-four applicants, were made in 1951. Two travelling fellowships for Home Civil Servants, one in the administrative and one in the professional grade, were made in the year. Only six applications were made for dental fellowships, and three awards were made. Three medical fellowships were awarded among sixteen applicants.

Among new grants for miscellaneous projects may be mentioned one of £3,000 for the compilation of an archive of the Smuts papers and £15,000 towards the inter-congress meetings of the Association of Universities of the British Commonwealth; £650 to the British Committee for Flame Radiation Research to enable a British physicist to work at the Stockholm Technical College's water-cooled plant with heat-absorbing walls; to the British Sociological Association for its first three years, and to Dr. H. Lehmann, of the Department of Pathology, St. Bartholomew's Hospital, for investigations of the blood of south Indian aboriginal tribes, which seem to show that the sickle-cell trait connects the Veddians with Africa although their *Rhesus* blood-groups point to connexion with Australia. A grant of £1,580 to the University of Reading will enable Miss M. D. Vernon, of the Department of Psychology, to direct a three-year study of visual methods in teaching. New grants in continuation of past programmes include a final grant of £4,500 to the Joint Committee of the Royal College of Obstetricians and Gynaecologists, the Population Investigation Committee and the Institute of Child Health, for completing and publishing a report on the study of growth, health and environment of a sample of children from birth to the first year of school life; of £18,000 to the University of Cambridge for the work at the Psychological Laboratory on the problems of ageing, and of £600 for three years to Mr. F. Le Gros Clark for investigations on the social influences that determine retirement, and the employment of ageing persons, and on the capacity of industry, to absorb the labour of ageing persons.

SEISMIC REFRACTION EXPERIMENTS IN THE PACIFIC

By DR. T. F. GASKELL and J. C. SWALLOW
H.M.S. *Challenger*

THIS communication summarizes the results of seismic refraction experiments carried out in H.M.S. *Challenger* in the Pacific during the period October 1950–April 1952. Sixteen stations have been occupied in this area; their positions, and those of the Atlantic stations already described[1], are shown on the accompanying chart. The observed structures fit into five groups, described below.

(1) *Deep ocean types.* Four stations showed a sea bed consisting of a comparatively thin layer of sediment overlying material with a high velocity for compressional sound waves (20,500 ft./sec.). The velocity of sound in the sediment layer was not observed at these stations, but from other measurements is taken to be between 6,000 and 8,000 ft./sec. (Table *A*).

Reverse shots at stations 8, 10 and 11 showed that there was no appreciable slope under the hydrophones. There was no reverse shot at station 17, but the results from successive shots suggest that there may be a small slope, which would give a true velocity of 21,000 ft./sec., and a few hundred feet increase in sediment thickness.

(2) *Deep ocean near islands.* Two stations, one near the Hawaiian islands, the other twenty miles from Funafuti, showed a thin layer of sediment, followed by several thousand feet of material with a sound-velocity of 11,000–15,000 ft./sec. overlying the high-velocity layer (Table *B*).

At station 9, a reverse shot confirmed the 13,500 ft./sec. velocity, but at neither station were reverse points obtained from the high-velocity layer.

Allowing for the remaining possibility of a dip in this layer, the observed velocities are not incompatible with the previous value of 20,500 ft./sec. Adopting this velocity would change the thickness of covering material by only a few hundred feet.

(3) *Western Pacific.* Two stations in deep water, south-west of Formosa, showed a lower sound-velocity for the main layer, with about 2,000 ft. of sediment cover (Table *C*).

The depth of the sea bed was variable; but several reverse shots were made and corrections applied for dip under the hydrophones.

(4) *'Continental' types.* The results at stations 6 and 7, off the North American coast, were not checked by reverse shots, and were obtained over an irregular sea bed. However, two distinct layers are indicated at each station, and the velocity of sound in the deeper layer is substantially less than the 20,500 ft./sec. of the deep Pacific stations. Stations 14 and 15 show a velocity of about 17,000 ft./sec., confirmed by reverse shots (Table *D*).

At station 15, an increase of velocity with depth in the sediment layer was observed, from about 5,000 ft./sec. to 8,300 ft./sec., the latter layer probably being consolidated sediment.

(5) *Near deep trenches.* Stations 13 and 18 were in the deep trench south-west of Guam, at 11½ N., 142¼ E. Some indication of a layer with very high velocity (27,000 ft./sec.) was obtained, but the results were rendered uncertain by drift of the hydrophones over a very irregular sea bed, and by the weakness of the ground waves obtained in these great depths

Table *A*

Station	Position	Depth (fm.)	Velocity in main layer (ft./sec.)	Sediment thickness (ft.)
8	35 N., 143 W.	2,880–2,940	20,900 ± 400	700–1,000
10	26 N., 164½ W.	2,560–2,610	20,300 ± 250	1,100–1,500
11	43½ N., 153 E.	2,770–2,860	20,800 ± 230	2,400–3,400
17	4 N., 146 E.	2,390–2,410	20,100 ± 400	2,100–2,900

Table *C*

Station	Position	Depth (fm.)	Velocity (ft./sec.)	Sediment thickness (ft.)
20	21 N., 127 E.	2,850–3,090	19,100 ± 1,400	1,500–2,100
21	20½ N., 124½ E.	3,030–3,170	18,800 ± 500	2,000–2,800

Table *B*

Station	Position	Depth (fm.)	Velocity in upper layer (ft./sec.)	Velocity in deep layer (ft./sec.)	Sediment thickness (ft.)	Cover material thickness (ft.)
9	22½ N., 160 W.	2,500–2,560	13,500 ± 200	23,000 ± 200	*c.* 100	9,300
16	9 S., 179 E.	2,660–2,690	11,000–15,000	22,200 ± 700	700–1,000	4,500–6,000

Table *D*

Station	Position	Depth (fm.)	Velocity in upper layer (ft./sec.)	Velocity in deep layer (ft./sec.)	Sediment thickness (ft.)	Upper layer thickness (ft.)
6	27½ N., 117 W.	1,830–2,290	10,800	17,200 ± 900	—	0–1,500
7	31 N., 117½ W.	970–1,120	> 9,000	19,400 ± 2,000	700–1,000	*c.* 5,000
14	8½ N., 143 E.	1,230–1,450	—	16,600 ± 200	1,700–2,300	—
15	18 S., 161½ E.	1,540–1,610	8,300	17,700 ± 300	1,100	7,900

Table *E*

Station	Position	Depth (fm.)	Velocity in upper layer (ft./sec.)	Velocity in deep layer (ft./sec.)	Sediment thickness (ft.)	Upper layer thickness (ft.)
12	14½ N., 141 E.	2,650–2,675	19,800 ± 1,100	28,000 ± 900	4,000–5,000	10,000
19	14¾ N., 141 E.	2,630–2,680	20,000 ± 2,300	27,600 ± 800	1,200–1,600	10,000

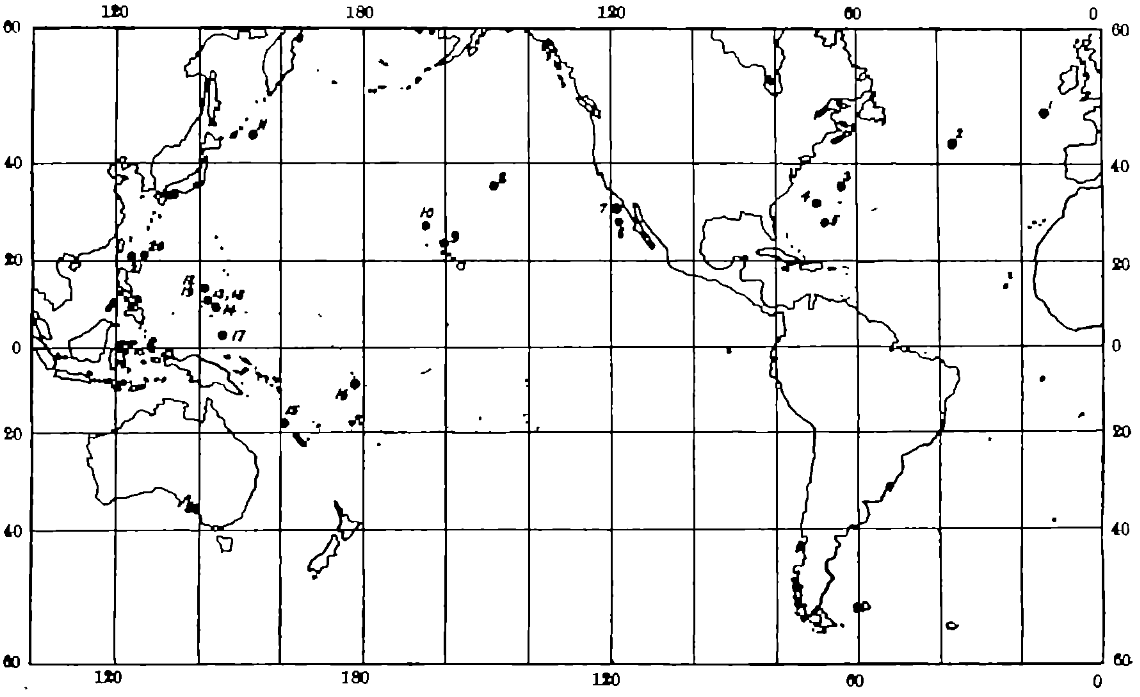
from the small explosive charges available. Station 12, and a repeat station in the same area (19), on the north side of the trench, were interesting in showing a very high velocity, comparatively near the surface (Table *E*).

At station 12, the very high velocity was not checked by a reverse shot, but is supported by the absence of any indication of dip along the direct line. The high velocity of station 19 is derived from shots between 12 and 16 miles from the hydrophones, in both directions.

The main part of the North Pacific basin may well consist of material showing a velocity of sound of 20,500 ft./sec. (probably gabbro or basalt) at least 8,000 ft. thick, covered by one or two thousand feet of sediment. Elevations of the ocean bed are characterized by a lower sound velocity, in the neighbourhood of 13,000 ft./sec., and such material was also observed in experiments on atolls (to be published separately). This probably corresponds to erupted volcanic rock, though it is possible for limestone to show such a velocity. There is evidence at both stations 9 and 16 that subsidence of the deep layer has occurred, due perhaps to the weight of volcanic material resting upon it.

An experiment in shallow water at Ominato in northern Japan showed material with a velocity of sound of 21,600 ft./sec. overlaid by about 6,000 ft. of sediment in which the velocity of sound was 6,400 ft./sec. The high velocity observed is in agreement with recent seismological observations in the same area, showing little, if any, thickness of granite.

The velocity of sound observed for the main layers at stations 20 and 21 is appreciably lower than that



found in the main Pacific basin, and may indicate the presence of a 'granitic layer' in this area, though 19,000 ft./sec. is a rather high velocity for granite. Its thickness would be at least 12,000 ft. assuming 25,000 ft./sec. for the next layer.

The very high velocity observed at stations 12 and 19 is similar to that assigned by seismologists to the layer below the Mohorovičić discontinuity. In the present case, this layer is only 11,000–15,000 ft. below the sea bed.

Station 15 was very similar to the Atlantic stations described by Hill and Swallow[2]. The increase of velocity with depth in the sediment observed at this station may have been present at others, though obscured by irregular topography and the greater depth of water. On the other hand, it may be a property of areas where large thicknesses of sediment have been laid down. The velocity of 17,700 ft./sec. obtained here is probably from a granite layer, and its thickness would be at least 7,500 ft.

These experiments could not have been made without the continuing assistance and co-operation of all on board H.M.S. *Challenger*, or without the support of the Hydrographer of the Navy, and of the Ministry of Supply. [June 19.

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[2] Hill, M. N., and Swallow, J. C., *Nature*, 166, 193 (1950).

CYTOCHEMICAL LOCALIZATION OF ESTERASES USING INDOXYL DERIVATIVES

By DR. S. J. HOLT and R. F. J. WITHERS

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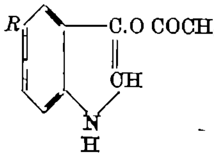
IN response to many requests for further details of a new method for the localization of hydrolytic enzymes in tissues using indoxyl derivatives[1], it is felt that a further brief report is desirable before publication of a more extensive critical account. With derivatives of indoxyl itself, for example, (I, R = H), as enzyme substrates, a major drawback is that the indigo deposit formed by aerial oxidation of enzymically liberated indoxyl is granular or crystalline[1,2], with a particle size comparable to that of various cell structures. Accurate localization of enzymic activity is therefore difficult to determine, since one cannot readily distinguish between dye granules and dyed cell components, apart from other possible sources of error, such as diffusion of dye, chemical precursors of dye, or of enzyme. The factors controlling the size of the indigo crystals have been investigated and undesirable features eliminated as a result of systematic synthetic modifications of the indoxyl molecules as suggested earlier[1]. For this development, the chemically more accessible O-acetyl derivatives of indoxyl, having different substituents in the benzene moiety of the molecule, were studied. Like the parent compound (R = H), these were also found to be rapidly hydrolysed by the common carboxylic acid esterases.

Since the oxidative dye-producing reaction occurs after enzymic hydrolysis, the same indoxyl would be liberated from appropriate derived substrates by different enzymes[1]. The subsequent dye-forming reaction would therefore be the same for each enzyme.



(I)

The different indoxyl acetates thus served not only as simple models on which to study the general effects of chemical substitution on the nature of enzymically produced indigoid dyes, but also to investigate the localization of esterases in tissues. Of a large number of such compounds synthesized for this study[3], 5-bromoindoxyl acetate (I, R = Br) was found to be a satisfactory compromise between ease of preparation, tinctorial power and size of particles of the derived dye (5 : 5′-dibromoindigo). This rich blue, extremely insoluble dye was found to form a deposit so free from granularity that no particles could be detected in suitably homogeneous tissue sites (for example, contents of pancreatic duct) under the highest powers of the optical microscope plus photographic enlargement. In most other sites, granules, when produced, were far smaller than the common cell organelles (excluding microsomes). Only in the presence of gross lipoid (for example, fat cells) having esterase activity[4] did recognizable crystals appear, but even here these were much smaller than with the unsubstituted compound. Such sites could easily be distinguished, however, by carrying out control experiments with fat dyes such as Sudan IV.

The possibility of developing a method for the intracellular localization of esterases thus appeared to be possible, provided that the substrate penetrated to all cytological levels (see below), that the dye produced stained the cell organelles possessing esterase activity and that diffusion effects could be controlled. This was not immediately feasible, however, for several reasons. First, the indoxyl acetates failed to indicate, or only very inadequately so, the presence of esterases in certain sites of known high activity, for example, the motor end-plates of striated muscle. Here, a very diffuse staining reaction took place in both fresh and formalin-fixed frozen sections. This was traced to the rapid diffusion of the enzymically liberated indoxyl away from the site of generation into the surrounding tissue and substrate solution before complete oxidation to the corresponding indigo could take place. Such diffusion was intrinsically much less with the 5-bromo-derivative and with other similarly less soluble, high-molecular weight compounds. In all cases, diffusion was greatly reduced and localization improved by traces (10^{-4} M) of cupric salts, as mentioned previously[1]. This improvement has now been traced to the catalytic effect of the cupric ion in speeding up the oxidation of the enzymically liberated indoxyl.

The process thus seemed open to very much greater control than other histochemical localization procedures, by the use of oxidation catalysts or oxidizing reagents of graded strength, which obviously had to be selected to have as little effect on enzyme activity as possible. It appeared logical to assume that the more rapidly the free indoxyl could be oxidized to the corresponding indigo, the nearer the site of the enzyme would the dye be deposited. This hypothesis was fully borne out by experiment. Of the many oxidizing agents and catalysts tested for inclusion in the substrate solution, potassium ferricyanide appeared to be the most satisfactory, agreeing with similar observations made during a parallel series of investigations by Burgen[6] at McGill University. A tendency for the indigo formed to be bleached by further oxidation to dehydroindigo could be prevented by also adding an equimolar proportion of potassium ferrocyanide. As test objects, in view of their fine and complex structure, the motor end-plates of mouse intercostal muscle and rat diaphragm were used. As the quantity of oxidizing agent was increased from zero to the optimum, the result produced in the muscle tissue, using 5-bromoindoxyl acetate as substrate, changed from the non-localized staining mentioned above, through diffuse circular patches on each muscle fibre, to a sharply delineated structure (Fig. 1) comparable with the results obtained by Couteaux[5] using his Janus green technique.

No further effect could be obtained by increasing the concentration of the oxidizing agent above 5×10^{-3} *M* of each component salt. With formalin-fixed tissues (see below) the motor end-plates already showed staining in as little as 10 sec. Even after 48 hr. incubation, the stained structures were merely very much darker than with the short period, which is a good indication of the specificity of the reaction, absence of autohydrolytic deposition of dye and negligible diffusion effects. With long incubation times, the only difference found was that the nerve supply to the end-plates became lightly stained.

Under optimum conditions, acetylindoxyl still produced a granular diffuse deposit, and we now consider that unsubstituted indoxyl is a poor basis for derived substrates for accurate histochemical localization of esterases.

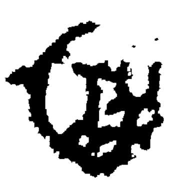
Direct application of the optimum substrates to many other tissues produced, for the first time, consistent, easily reproducible intracellular localization of esterases. In particular, the results produced with rat kidney and liver were interesting. In the kidney, the sites of esterase activity in the tubular epithelium consisted of intracellular spherical bodies, diameter approximately 1–3 µ (Fig. 2), which, when stained less intensely than illustrated, often showed a concentric spherical structure, only the inner component being stained. In the liver, esterase activity was seen to be mainly associated with particles resembling liver mitochondria in appearance, clustered around the intercellular bile canaliculi (Fig. 3).

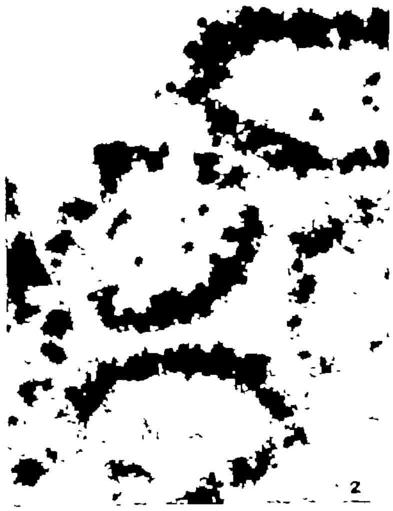
Results illustrated were obtained with tissues fixed for 16 hr. in cold (4°) neutral formalin (5 per cent formaldehyde) containing sodium chloride (0·9 per cent). Frozen sections were cut at a thickness of 5 µ and incubated in a substrate solution containing the following concentrations of components: 5-bromoindoxyl acetate ($2 \cdot 5 \times 10^{-4}$ *M*), potassium ferricyanide and potassium ferrocyanide (5×10^{-3} *M* of each), calcium chloride (10^{-2} *M*), 0·1 *M* tris-hydroxymethylaminomethane maleate[7] buffer *p*H 8·0 (2 ml. in 10 ml. of substrate solution). Sections were examined periodically and removed when the stain, which appears spontaneously, was sufficiently intense.

Control experiments showed that none of the blue staining obtained in tissues was due to the presence of iron, which would give a Prussian blue deposit with the ferro-ferricyanide reagent. On the other hand, the use of steel needles to manipulate the tissues often resulted in contamination of this type, although it has not been observed after using steel microtome knives.

The use of fresh-frozen sections is unsatisfactory, for common reducing substances in such tissue quickly destroy the ferricyanide, apart from effects due to diffusion of enzyme.

With the degree of intracellular localization obtained, it soon became obvious that tissues fixed and cut as described above were inadequate for critical cytochemical studies. Apart from the well-known translocation of substances occurring during chemical fixation of fresh tissues[8], the relatively slow freezing at the microtome invariably produced some ice crystal artefacts. At present, frozen-dried tissues are being examined, as these appear to be more suitable for cytological studies[9]. Until results with frozen-dried material are fully evaluated, no claims are made for the accuracy of the cytological localization achieved with formalin-fixed material. The nature of the cell organelles staining by this process is also being studied by a number of complementary staining and optical techniques.





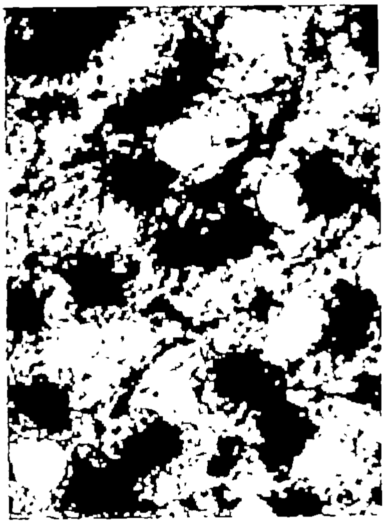


Fig. 1. Motor end-plate (mouse intercostal muscle): part was lost at upper right in cutting section. × 650

Fig. 2. Rat kidney. Esterase-positive spherical bodies in cells of tubular epithelium. × 850

Fig. 3. Rat liver. Esterase activity mainly associated with particles clustered around bile canaliculi. × 650

Non-critical methods for localization of enzymic activity usually show somewhat diffuse activity in tissues, particularly from the cytological point of view. Such methods may also indicate activity at sites known to contain no enzyme or vice versa. Observations of this kind have formed the basis for considerable doubts to be thrown upon the validity of histochemical staining techniques. In our experience, for precise localization, it seems essential that different types of tissue should be studied independently, to arrive at the optimum conditions for each. With the 5-bromoindoxyl acetate method described briefly above, good results are obtained with most tissues, except those of the central nervous system, where very little activity is demonstrable with the substrate solution described. This appears to be associated with the high phospholipin content of such tissues; but the difficulty can be overcome by modifying the ratio of the components of the substrate solution. We are studying this type of problem, but a full investigation of the use of 5-bromoindoxyl acetate with tissues of the central nervous system is being carried out by Burgen.

Apparently, different effects of the type mentioned above, in the action of tissues on enzyme-indicating substrates, are not by any means restricted to the indoxyl method. A typical case is that which arises with more familiar methods for the localization of esterases, such as the myristoylcholine method[10], the naphthyl acetate[11] and thiocholine[12] techniques. In each of these methods, in spite of claims to give good localization of esterase activity, none demonstrates such activity in one of the most important and least to be doubted sites of esterase, namely, the erythrocytes of, say, the rat. This does not even appear to have been specifically mentioned before, and should at once cast doubt on the validity of these methods, unless their scope and limitations have been previously thoroughly investigated, which does not appear to be the case. With the indoxyl method, in the absence of cupric ions or the ferro-ferricyanide mixture, the erythrocyte is one of the major staining sites. In the presence of the oxidizing catalyst or agent, however, the staining reaction is inhibited; this has been traced to the effect of these reagents on the special permeability properties of the erythrocyte membrane. The effect of copper in this connexion is well known[13]. In a subsequent publication it will be shown the failure to stain erythrocytes by the choline fatty acid ester technique is due to the failure of the quaternary ammonium salt substrate to penetrate the red cell envelope. In the naphthyl acetate method, the diazonium ions from the coupling reagent will also be shown not to penetrate the red cell membrane, and in the thiocholine techniques, sufficient copper is present in the substrate solution to destroy the permeability of this membrane. In addition, staining artefacts may well arise from a temporary or permanent fixation of the quaternary cations by acidic components of the tissue. The nuclear staining extensively found when using the thiocholine technique is probably due to such an effect and is being investigated. With substrates derived from indoxyl, chemically and electrically neutral molecules are involved, with which such artefacts should be minimal, and rates of penetration high, and possibly may become still higher as a result of further modifications of the molecular structure at present being developed.

We thank Mr. Peter Runnicles, of the Anatomy Department of this Medical School, for the photomicrographs, and the University of London for a grant to one of us (R. F. J. W.) from the Central Research Fund of the University. [November 6.

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PURIFICATION OF CYTOCHROME *C*

By Dr. E. MARGOLIASH*
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THE first preparations of mammalian heart cytochrome *c* had an iron content of 0·34 per cent[1,2]. Theorell and Åkesson[3], however, showed that very prolonged electrophoresis in the large-scale Tiselius apparatus resulted in the separation of a fraction having 0·43 per cent iron. Less cumbersome techniques have been developed since for the production of the 0·43 per cent iron type of preparation[4,5], but they are not very reliable and have involved the use of conditions that cause a considerable reduction in the yield of cytochrome *c*. Paléus and Neilands[6] have used the synthetic polycarboxylic resin 'Amberlite *IRC*-50' for the chromatography of cytochrome *c* at *p*H 9, obtaining several fractions containing up to 0·466 per cent iron. The eluates obtained were very dilute and were concentrated by precipitation with trichloroacetic acid in the cold. My experience has been, however, that this last step causes, in the absence of saturated ammonium sulphate, a very great reduction of the enzymic activity.

Preparation of 0·43 per cent iron cytochrome c. With any suitable cation exchanger, the chromatographic separation of several distinct fractions could be effected from cytochrome *c* containing 0·34 per cent iron, using as eluant any monovalent cation at neutral *p*H and a concentration of 0·25 *M*. The first or colourless non-cytochrome fraction was entirely unadsorbed by the cation exchanger, so that the use of a chromatographic column was unnecessary.

The method finally adopted for the preparation of 0·43 per cent iron horse heart cytochrome *c* was as follows: 'Amberlite *IRC*-50' (The Rohm and Haas Co., Philadelphia, U.S.A.) is ground and the fraction settling in water between 15 sec. and 3 min. collected. It is converted into the ammonium salt using an excess of 2 *N* ammonium hydroxide, and then dried in air between two layers of filter paper until there is no detectable smell of ammonia. 100 ml. of a 1 per cent solution of 0·34 per cent iron cytochrome *c*, prepared from horse hearts by the method of Keilin and Hartree[4], and well dialysed against water, are gently shaken with 15 gm. of the resin until adsorption is complete. The resin is collected on a coarse sintered glass funnel and thoroughly washed with glass-distilled water.

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* On leave from the Hebrew University, Jerusalem.

The cytochrome *c* is then eluted with several washings of 15 ml. of 0·25 *M* ammonium hydroxide, keeping only the coloured portion of the eluate. The eluate is at once dialysed against running tap-water followed by three to four changes of distilled water, and finally filtered through a retentive filter paper.

The product has an iron content of 0·43 per cent, does not contain any denatured or modified cytochrome *c*, and with careful elution may be obtained in concentrations 1·5–2 times that of the original solution. It was found to be as fully active enzymically as the usual preparations, per mole of iron, in the succinic oxidase and cytochrome oxidase systems, these assays being carried out in Barcroft differential manometers at 37° C. and a *p*H of 7·3 (phosphate buffer), using varying amounts of added cytochrome *c* with cytochrome *c*-deficient enzyme preparations (kidney preparations, according to Slater[7], and heart muscle preparations, according to Tsou[8]) in the test systems given by Slater[7,9].

Repetition of the procedure three times on the same sample did not cause an increase of the iron content above 0·43 per cent. It is possible, however, that chromatography would give a higher iron content. The overall yield was 85–97 per cent.

The advantages of such a method over those previously used are its simplicity and rapidity, its reliability and the fact that the product is obtained directly in a concentrated form with full enzymic activity, the yield being practically quantitative. Moreover, the colourless fraction of the 0·34 per cent iron preparation is separated at its original concentration, giving an excellent starting material for its isolation and identification.

The success of this type of procedure depends on the fact that the isoelectric point of cytochrome *c* is at a *p*H of 10·6, thus making it act as a cation at lower *p*H values, whereas the associated protein substance or substances react as anions. Moreover, the cation exchangers effectively distinguish between native and modified cytochrome *c* in solution, only the native form being adsorbed; indeed, the products of the type of procedure described above show the same degree of reduction enzymically with succinic dehydrogenase as with an excess of sodium hydrosulphite, whereas the usual preparations commonly show a slightly greater degree of reduction chemically than when reduced enzymically.

The ease with which the colourless fraction of the 0·34 per cent iron preparations is separated by cation exchangers makes it reasonable to suppose that the bond between it and the rest of the molecule is a simple ionic one, confirming the electrophoretic observations of Theorell and Åkesson[3].

It should be noted that 'Amberlite *IRC*-50' is by no means the only cation exchanger which can be used, identical results having been obtained, for example, with 'Decalso *F*' (The Permutit Co., Ltd., London), which is an aluminium silicate.

Preparation of reduced or oxidized cytochrome c in a stable form. The simplicity of the procedure for adsorbing and eluting cytochrome *c* from a suitable cation exchanger makes it a very satisfactory method for the preparation of reduced or oxidized cytochrome *c*, free from any extraneous substance.

The techniques which have usually been employed are bubbling hydrogen gas in the presence of platinum black for reduction, which is effective only in rather dilute solution, or the use of chemical agents such as sodium hydrosulphite or ascorbic acid for reduction, and potassium ferricyanide for oxidation, leaving an excess of the reagent and its reaction products in solution.

The procedure using cation exchangers is as follows: 100 ml. of a solution containing 80–120 µmol. of 0·43 per cent iron horse heart cytochrome *c* prepared by the cation exchange method, is reduced with ascorbic acid or fully oxidized with potassium ferricyanide. Freshly prepared solutions are used, adding no more than twice the calculated stoichiometric amounts, the ascorbic acid being neutralized and containing versene (ethylene diamine tetra acetic acid) to stop its auto-oxidation.

The solution is then shaken with 20 gm. of the ammonium or potassium salt of 'Amberlite *IRC*-50, depending on the subsequent elution, per 100 µmol. of cytochrome *c*, until adsorption is complete; the resin is prepared as given above for the ammonium salt.

The cation exchanger carrying the reduced or oxidized cytochrome *c* is quickly collected on a coarse sintered glass funnel, thoroughly washed with glass-distilled water and sucked dry.

When oxidized cytochrome *c* is desired, the protein can be eluted as described above with 0·25 *M* ammonium hydroxide, filtered and immediately freeze-dried over sulphuric acid and sodium hydroxide.

When reduced cytochrome *c* is being prepared, it is necessary to avoid the alkaline *p*H's at which cytochrome *c* begins to be auto-oxidizable, and the elution is carried out with four to six washings of 20 ml. of 0·25 *M* potassium chloride. The eluate is dialysed for 5–6 hr. in the cold, with shaking, against running distilled water, filtered and freeze-dried.

The products are powdered and kept in ampoules sealed *in vacuo*. After storage at 0° C., the powders dissolve to give clear solutions having substantially the same percentage reduced or oxidized cytochrome *c* as when prepared, and showing full enzymic activity.

The advantages of this method over those hitherto used are the stability of the dried product in the reduced or oxidized form, the possibility of obtaining reduced or oxidized cytochrome *c* in a solution of any desired strength, and the complete freedom from the chemical agents used for reduction or oxidation and the reaction products. Such a product is particularly useful when it is necessary in enzymic studies to use cytochrome *c* in stoichiometric rather than catalytic quantities.

A detailed report of these techniques and their results will be published elsewhere. I wish to express my gratitude to Prof. D. Keilin for his constant advice and encouragement during this work. Thanks are also due to Dr. E. C. Slater for his advice in enzymatic matters, and to Mr. N. K. Boardman and Dr. S. M. Partridge for their help in the use of ion-exchangers. [Aug. 6.

Note added in proof. Neilands[10] now uses saturated ammonium acetate for elution from a column of 'Amberlite *IRC*-50', and obtains an enzymically active cytochrome *c*.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Resistance to the Potato Root Eelworm, *Heterodera rostochiensis* Wollenweber

I have already reported some of the results of my search for resistance to the potato root eelworm among the South American tuber-forming *Solanum* species in the Commonwealth Potato Collection[1,2]. This work, begun in 1941, is now practically complete, and more than 1,200 lines, belonging to more than sixty species, have been tested in duplicate on at least one occasion. Very few have been found to be resistant; one such line, *Solanum ballsii*, has certain disadvantages for breeding work as it is a diploid, whereas the domestic potato, *S. tuberosum*, is a tetraploid. In 1948, however, I was fortunate in finding a further five apparently resistant lines (C.P.S. numbers, 1673. 1685, 1692, 1595 and 1647), four of which belong to *S. tuberosum* sub-species *andigenum*, a group of tetraploids very close to the domestic potato and readily crossed with it; the other (1647) is a sterile triploid. Tests in later years have confirmed the early promise of these lines.

The routine tests to which all lines are subjected is of a very simple sort. The plants are grown in duplicate in pots of infested soil sunk in the soil of an infested allotment. At the end of the season, the plants are lifted and their roots examined for cysts. Promising lines are selected for further test if they have few cysts on their roots; but as this may be the case for a variety of reasons, factors such as the vigour of the plant and the extent and type of root system, etc., are also taken into account. Such an assessment, clearly, is of a subjective nature, and even though the evidence of repeat tests on a larger scale may reinforce a first impression, there is no evidence, as I have already pointed out[2,3], that the assessment is sound and the apparent resistance not the result, from the present point of view, of secondary factors. However, this possibility can be tested, for, by appropriate sexual and vegetative propagation, it is possible to compare a series of genetically different clones of common parentage and of very similar general habit; the results of such experiments are now available.

In 1951, Dr. K. S. Dodds, of the Potato Genetics Station, Cambridge, which houses the potato collection, supplied Dr. H. J. Toxopeus, of Wageningen, with selfed seed of three of the lines of *andigenum* first found by me in 1948 to be probably resistant. Some of his results are reported in the accompanying communication, and it is gratifying to find that they provide strong evidence that resistance to the potato root eelworm is probably inherited. The resistance of the four *andigenum* lines likely to be useful in potato breeding is now being examined on a much larger scale, both in Holland and in England.

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Sept. 29.

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Genotypical Background of Resistance to *Heterodera rostochiensis* in *Solanum tuberosum*, var. *andigenum*

In January 1951, we received from the Potato Genetics Station at Cambridge some selfed seed of three clones of *S. tuberosum* subspecies *andigenum* which, according to the experiments of Dr. C. Ellenby, seemed as if they might serve as a basis for breeding for resistance to potato root eelworm, *Heterodera rostochiensis*.

The seeds were sown immediately, and in April five to ten cuttings were made from each of the seedlings. These cuttings were transplanted into 7-in. pots filled with sandy soil heavily infested with potato root eelworm. The pots were embedded at random in the field and several rows of pots containing the domestic variety Eigenheimer were used as controls.

Six weeks after transplanting, yellow cysts could easily be seen on the roots of susceptible plants when they were removed from the pots. It appeared that all plants of a clone were either free or nearly free from cysts, or as heavily infected as the domestic controls. The results of the inspection are given in Table 1.

Table 1. Infection of *andigenum* Seedlings with Potato Root Eelworm

Parent	Number of clones Without cysts	With many cysts
C.P.C. 1673	16	4
C.P.C. 1685	7	3
C.P.C. 1692	2	0

When the plants had finished growing, 20-c.c. samples of soil were taken from some of the pots and the number of cysts in each of these samples was determined. The results are given in Table 2.

Table 2. Counts of Cysts and Larvae in 20-c.c. Samples of Soil

Material	Cysts	Viable cysts	Larvae	Number of Pots	Clones
S. tuberosum	58 ± 6·5	47 ± 5·4	4,300 ± 635	10	–
S. andigenum susceptible	55 ± 5·2	43 ± 4·9	3,600 ± 475	18	4
S. andigenum resistant	11 ± 1·0	2	30	21	8
Initial potting soil	18 ± 3·0	5 ± 1	250 ± 75		

It will be seen that twenty-five seedlings were apparently resistant to infection and that seven were susceptible. In the pots containing the domestic variety and the susceptible seedlings of *andigenum*, the number of viable cysts increased nearly ninefold, whereas, in the pots containing the resistant seedlings of *andigenum*, the population of cysts did not increase. These results suggest that resistance to potato root eelworm is inherited; but the progenies used were too small to permit an interpretation of the genetic mechanism involved.

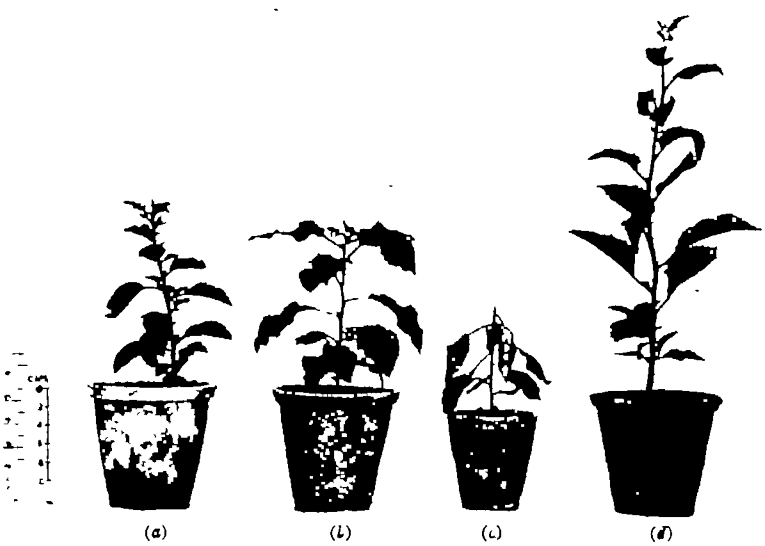
S. tuberosum subspecies *andigenum* is cultivated in the Andean regions from Venezuela to northern Argentina, and apparently is closely related to domestic varieties, which represent only a small part of this very variable species. For this reason resistant *andigenum* varieties would seem to offer a very good basis for a practical breeding programme, and their possibilities are now being examined on a much wider scale.

H. J. Toxopeus
C. A. Huijsman

Institute of Agricultural Plant Breeding,
Foundation for Agricultural Plant Breeding,
Wageningen. Sept. 29.

Pear-Apple Hybrids

At the John Innes Horticultural Institution we have recently raised hybrids between pears and apples; they were obtained in the following way. The occurrence of apomixis in the Pomoideæ[1], and the high frequency of diploid seedlings, 23 out of 39, in a family of pears we raised from crossing the diploid variety Fertility with the triploid variety Beurre Diel, suggested that they may have been apomictically, or in part apomictically, reproduced. To test this possibility one of us (E. M.) isolated a tree of Fertility, emasculated sixteen flowers and brushed the ovaries over with a 40 p.p.m. solution of β-naphthoxy-acetic acid. Four flowers were pollinated with the pollen of an unnamed tetraploid variety of apple and twelve with the pollen of the diploid apple Crawley Beauty. Twenty-four hours later the ovaries were again treated with β-naphthoxy-acetic acid. Three fruits developed from pollination with the tetraploid apple and twelve from pollination with the diploid. Seed content and germination are shown in the following table.



(a) Pear, (b) surviving pear–apple hybrid, (c) dying pear–apple hybrid, (d) apple

Pear	Fertility 2x	Flowers	Fruit	Seeds	Seeds sown	Germinated	Survived
×	Apple 4x	4	3	18	18	13	1
×	Apple 2x	12	12	100	79	56	10

During the early stages of growth the seedlings were very uniform, and at first we thought they were pears of apomictic origin. Later their development was unusual, and it became clear that the plants were not pear seedlings but pear–apple hybrids. They developed intermediate characters, and after three months showed slightly greater resemblance to the male apple parent, though distinct from normal apple. Furthermore, all the seedlings had a somewhat defective root development and appeared to lack ability to take up sufficient of some of the essential mineral nutrients. In consequence, many of the seedlings died, but eleven have survived (see table and photograph). From preliminary grafting of some of the hybrids on to apple seedlings, it appears that difficulty in growth may be overcome.

One seedling in each family has been examined cytologically by Mr. R. D. Brock: the one in which the tetraploid apple was the male parent was triploid and the one with the diploid apple parent was diploid. This supports their hybridity.

In the past we have made pollinations between apples and pears but never obtained seeds. They were made without any hormone treatment, and it therefore seems that, when distant crosses with plants are being attempted, the use of β-naphthoxy-acetic acid may be of value.

It appears that this is the first time sexual hybrids between pears and apples have been produced. In *Plant Breeding Extracts*[2], an apple pear hybrid is referred to in Sweden, at the Balsgård Fruit Breeding Institute; but Dr. I. Granhall, director of the Institute, has recently informed us that this is wrong and that no such hybrid is known in Sweden. According to Dr. Granhall, this false report originally appeared in a newspaper article. The alleged apple pear vegetative hybrid Renette-Bergamotte, referred to so much in recent years by Soviet scientific men, is figured, and an account of it given, in Michurin's "Selected Works". From the illustrations and the descriptive account of Renette–Bergamotte, it appears to us to be entirely apple.

M. B. Crane
E. Marks

John Innes Horticultural Institution,
Bayfordbury, Hertford.
Oct. 24.

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Rate of Photosynthesis and Concentration of Carbon Dioxide in *Chlorella*

Previous investigations of the relationship in *Chlorella* between rate of photosynthesis at high light intensities and concentration of carbon dioxide have been made using cells suspended in alkaline solutions[1]. In such solutions cells grown in 4 per cent carbon dioxide show an unusually long induction phase ($t_{1/2}$, 40–50 min.) at low concentrations of carbon dioxide; but when allowance is made for this and the rate of photosynthesis in the steady state alone considered, half the maximum rate is attained with a concentration of carbon dioxide[2] of 0·9 × 10^{-6} *M* at 25° C. The possibility has been suggested that in alkaline solution the relatively high concentration of bicarbonate ion affects the rate of photosynthesis[3].

Experiments have now been made with *Chlorella pyrenoidosa* in acid phosphate solution (*M*/30 potassium dihydrogen phosphate, *p*H 4·6). The cell suspension was placed in a tube containing a sintered glass bubbler which was connected in a closed circuit with appropriate drying tubes and with one absorption tube of the infra-red gas analyser manufactured by Grubb Parsons. The control tube contained carbon dioxide-free air. Within the closed circuit a hermetically sealed pump continuously circulated the gas so that a complete cycle was achieved every 10–15 sec. The apparatus was calibrated by adding standard carbonate from a burette to acid contained in the bubbling tube, thus giving an absolute calibration as well as a measure of the response time of the system.

When *Chlorella* is placed in the bubbler tube and illuminated, the concentration of carbon dioxide progressively falls, and from the time-course the relationship between the rate of removal of carbon dioxide from the gas phase and the concentration in the gas phase can be determined. It can be shown that the actual rate of photosynthesis is greater than the measured rate, and that the concentration of carbon dioxide in the gas phase is greater than that in equilibrium with the aqueous phase in the cells. Thus any estimate of the concentration of carbon dioxide for half maximal rate of photosynthesis made from such observations must be maximal. Results are shown in the accompanying table. From the linear portion of a graph of the reciprocal of the rate against the reciprocal concentration, an estimate of the minimum concentration to give half the maximal extrapolated rate is $1\cdot20 \times 10^{-6}$ *M* (that is, allowing for solubility of the gas, $0\cdot95 \times 10^{-6}$ *M* in solution) at 25° C. This is in good agreement with our earlier measurements in alkaline solution; further, aliquots of cells from the same culture gave the same value using either method. Similar experiments with *Chlorella vulgaris* have been described by Egle (a report of which was not seen, however, until after the completion of this work), and his results are consistent with our own[4]. In the present measurements any possible role of bicarbonate ion is excluded since the concentration in solution at *p*H 4·6 is negligible.

RELATIONSHIP BETWEEN RATE OF PHOTOSYNTHESIS AND CONCENTRATION OF CARBON DIOXIDE IN *Chlorella pyrenoidosa*

Concentration of carbon dioxide (%)	0·0300	0·0108	0·0089	0·0070	0·0052	0·0033	0·0017	0·0013
Rate of real photosynthesis	18·0	16·8	16·3	14·6	12·9	11·5	8·5	6·8

The rate was determined after 40 min. illumination, that is, after the induction phase was ended. It is expressed as µl./µl. cells/hr. Concentration is in volume per cent at 760 mm. pressure. Temperature 25° C.; light intensity, 20,000 lux.; *p*H 4·6.

Both at *p*H 4·6 and 6·8 a long induction phase was observed at a concentration of carbon dioxide maintained between 0·01 and 0·02 per cent; but it was shorter the more acid the solution ($t_{\frac{1}{2}}$, 13 min. at *p*H 4·6; 18 min. at *p*H 6·8). At *p*H 6·8 and 8·2, preliminary experiments indicate that higher concentrations of carbon dioxide are necessary for half saturation.

A fuller discussion of these observations will appear in a joint paper with Prof. G. E. Briggs, to whom I am grateful for helpful advice. I also wish to thank the Agricultural Research Council for financial assistance.

C. P. WHITTINGHAM

Botany School,
Cambridge.
Sept. 10.

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Chemical Differentiation of the Genera *Podocarpus* and *Dacrydium*

THERE are numerous instances where a genus or other group of plants is characterized by particular chemical constituents. In the Eucalypts, for example, chemical evidence has been of value in some instances in determining specific differences, while in *Pinus*, Erdtman and co-workers[1] have recently shown the presence of a characteristic pattern of heartwood constituents.

From the results of a study of rimu (*Dacrydium cupressinum*) we have been led to consider the data available in the Podocarpaceae. A clear distinction between the genera *Podocarpus* and *Dacrydium* is apparent, with the interesting exception of *D. cupressinum*.

In various species of *Podocarpus* and *Dacrydium*, the heart-shake resin, the oleo-resin and the resin extracted with solvents from the wood have been investigated and found to consist principally of oxygenated diterpenoids. They fall into the following two distinct groups:

(*a*) Phenolic tricyclic diterpenes, namely, ferruginol from the oleo-resin of *P. ferrugineus*, totarol and a small amount of what is probably a hydroxy totarol[3] from the wood resin of *P. totara*, ferruginol 9-keto-ferruginol and totarol from the wood resin of *D. cupressinum*[2]. This wood also contains as the heart-shake resin podocarpic acid. The same heart-shake resin occurs in *P. dacrydioides* and in the Javanese species *P. cupressinus*.

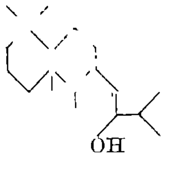
(*b*) Non-phenolic diterpenoids with two carbocyclic rings, namely, manool from *D. biforme*, *D. bidwillii*[4] and *D. kirkii*, manoyl oxide, 3-ketomanoyl oxide and a trihydroxyditerpene oxide from *D. colensoi*. These substances are all obtained by solvent extraction of the wood.

It should be pointed out that in *Podocarpus* the solvent-extractable resin has only been investigated in *P. totara* and *P. dacrydioides*[5]. The latter wood contains relatively little resin and the manool type of diterpenoid appears to be absent. *P. spicatus* gives a heart-shake resin containing the structurally unrelated matairesinol and conidendrin, but the solvent extract has not been studied. A summary of the diterpenoids of the resins of the *Podocarpus* and *Dacrydium* genera is set out in the accompanying table.

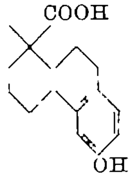
On the chemical evidence available, it appears that *D. cupressinum* shows much less affinity with

CONSTITUENTS OF THE WOODS OF *Podocarpus* AND *Dacrydium*

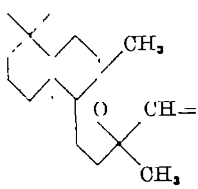
Wood	Constituents	Chemical type
Podocarpus ferrugineus	Ferruginol	Tricyclic phenolic diterpenes or related thereto
P. totara	Totarol, hydroxytotarol (?)	
P. dacrydioides	Podocarpic acid	
P. cupressinus	Podocarpic acid	
Dacrydium cupressinum	Podocarpic acid, totarol, ferruginol, and 9-keto-ferruginol	
D. biforme	Manool	Bicyclic oxygenated diterpenes (non-phenolic)
D. kirkii	Manool	
D. bidwillii	Manool	
D. colensoi	Manoyl oxide, 3-ketomanoyl oxide, a trihydroxy-diterpene oxide	



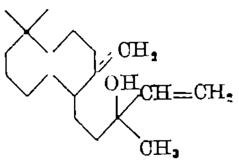
Ferruginol



Podocarpic acid



Manoyl oxide



Manool

Dacrydium, but a close relationship to, and should perhaps be placed with, *Podocarpus*. This conclusion is in agreement with the view that the anatomical features of the wood resemble those of *Podocarpus*[6].

(the late) C. W. BRANDT

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B. R. THOMAS

Birkbeck College,
London, W.C.1.
April 30.

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Early Effects of Growth Substances

ISOLATED cambium-phloem strips from *Bryophyllum calycinum* Salisb. show a curvature with the cambium at the concave surface, and this curvature is increased when the strips are placed in water. Plasmolysis causes the complete relaxation of the strip. Partial relaxation can be obtained in solutions of indolylacetic acid and 2,4-dichlorophenoxyacetic acid (2,4-D) in concentrations of 1-50 parts per million, the action of indolylacetic acid being in some cases reversible. It can be shown that the average width of the cambium cells decreases immediately after placing the strip in the hormone solution. The reaction is strongly influenced by temperature; it occurs between 15° and 30° C., with an optimum near 30° C. At 29° C. a maximal curvature of the strip (or shrinkage of the cambium cells) is obtained within five minutes. In indolylacetic acid, 1 20 p.p.m., a reversal of this shrinkage occurs which may lead to an increase beyond the original size of the cell; this might properly be considered as growth. At 29° C. the reversal appears twenty minutes after the beginning of the experiment.

Similar almost instantaneous effects of growth substances were demonstrated on the nyctinastic movements of various *Oxalis* spp., in which 2,4-dichlorophenoxyacetic acid, 1-100 p.p.m., and also indolylacetic acid cause a suppression, or even reversal, of the normal movement of the leaflets. This effect, too, may be accounted for by a sudden change of turgor, in this case in the pulvinar cells.

With *Bryophyllum* and carrot tissue, preliminary experiments have shown that 2,4-dichlorophenoxyacetic acid (1-50 p.p.m.) does not increase permeability to neutral red or ammonium ions. Plasmolysis in hypertonic glucose, as well as in glycerol, is materially accelerated in 2,4-dichlorophenoxyacetic acid, even in concentrations as low as one part in ten million.

We have also observed the disappearance of air from the intercellularies after treatment with 2,4-dichlorophenoxyacetic acid. This phenomenon, caused by an extrusion of water or cell sap, had been observed already in 1930 by Miss Nicolai[1] using cress roots mechanically stimulated at certain spots; at these spots the roots developed nodules. It is possible that the production of swellings by 2,4-dichlorophenoxyacetic acid, as well as the internal wilt which appears after its application, may yet be traced to the same cause, namely, an initial loss of water or sap from the cell.

The experimental work will be published in the near future. This research has been made possible by a grant from Timbrol Pty., Ltd., Australia.

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Corchsularin, a New Bitter Principle from Jute Seeds (*Corchorus capsularis*, Linn.)

SEN isolated corchorin[1], a crystalline bitter principle of melting point 174° C. and molecular composition $C_{22}H_{36}O_8$ and corchoritin[2], having melting point 218–222° C. and molecular formula $C_{15}H_{18}O_5$ from the alcoholic extract of jute seeds (*Corchorus capsularis*, Linn.). Karrer and Banerjee[3] obtained corchortoxin, having melting point 247° C. and molecular composition $C_{23}H_{32}O_6$. Soliman and Saleh[4] identified corchorin as strophanthidin.

We are also engaged upon a study of the bitter principles of jute seeds. Simply by extracting jute seeds with rectified spirit and digesting the alcohol-free extract with boiling water, a better yield of corchorin has been obtained. Corchorin extracted in this manner agrees largely as regards properties with those described by Sen and fails to show its identity with strophanthidin. It has also been found that a new bitter accompanies corchorin. This has been isolated and crystallized. It has a melting point of 157° C. and molecular composition $C_{29}H_{47}O_9$. Since this is neither corchorin, corchoritin nor corchortoxin, we propose a new name, 'corchsularin', for the substance. Corchsularin yields, on acid-hydrolysis, a new deoxy sugar, for which we also propose the name 'corchsularose'. Corchsularose has been found to be a deoxy methyl pentose.

A fuller account of this work will be published elsewhere.

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Identity of *Polystictus* (= *Polyporus* = *Trametes*) *cinnabarinus* (Jacq.) Fr. with *Polystictus sanguineus* (L.) Fr.

Externally, sporophores of the two species, *Polystictus cinnabarinus* and *P. sanguineus*, differ in the tint of red coloration and in the nature of the porous areas, though they are regarded by many as identical. Miss Wakefield holds (personal communication, 1948) *Polystictus sanguineus* as the tropical country-analogue of *Polystictus* (*Trametes*) *cinnabarinus* of the temperate climate. Cunningham[1], in his recent revision of Australian Polyporaceae in herbaria of the Royal Botanic Gardens, Kew, and of the British Museum (Natural History), holds *Polyporus* (*Coriolus*) *sanguineus* Fr. to be identical with *Polyporus cinnabarinus* Fr., with the remark that "there is no constant feature upon which two species may be maintained". Cleland[2] is also of the same opinion, as he noticed fruit bodies of *Polystictus sanguineus* and *Polyporus cinnabarinus* growing in the same area of Sydney, almost at any time of the year after sufficient rain, on fallen logs. Lloyd[3] holds *Polystictus cinnabarinus* as the temperate region-analogue of the tropical *Polystictus sanguineus*.

Cultural characters of the two species in malt extract–agar slants, however, show important and constant differences between the two. The hyphæ of *P. sanguineus* usually soon develop red pigments[4] on their walls, and the whole slant looks mainly grenadine red, and scarlet red, scarlet or Brazil red afterwards[5], while the vegetative hyphæ of *P. cinnabarinus* remain perfectly uncoloured; only the porous areas, when eventually formed with development of basidia-initials, take on the characteristic Morocco red, scarlet, scarlet red, and Brazil red colour[5].

On pairing cultures of the two species on malt–agar-coated slides no hyphal fusion between the two could be observed; the hyphæ of the two colonies passed along each other without any fusion and there were abundant coilings (anti-clockwise under the microscope) of some hyphal branches of both, showing distinct inhibition as remarked by Brian *et al.*[6]. If there were thicker coatings of malt agar on slides, there appeared a distinct line of aversion between the two. Malt extract–agar plates were inoculated on the same day by the disk method with cultures of *P. sanguineus* and *P. cinnabarinus* on two sides of the plate at a distance of 3 cm. from each other. In the course of three days *P. sanguineus*, being a faster grower, surrounded the colony of *P. cinnabarinus*, leaving a visible distinct zone of aversion all round (see accompanying illustration). Microscopical examination of both aerial and submerged mycelium at the zone of aversion showed hyphæ of both species crossing each other with no hyphal fusion anywhere and with very pronounced anti-clockwise coiling of some hyphal branches of both.

From these characters it is concluded that the two species are distinct and are not identical, as held by previous workers.

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Enhancement of Streptococcal Bacteriophage Lysis by Hyaluronidase

It is well known that most Group A streptococci synthesize hyaluronic acid, which forms the streptococcal capsule, during the early stages of growth, and that mucoid colonies on blood agar are formed by strains that produce considerable amounts of hyaluronic acid. During attempts to propagate bacteriophages active against Group A streptococci, it was found that the organisms which survived and gave secondary growth were invariably mucoid. This observation suggested that the hyaluronic acid capsule might form a barrier between the organism and the bacteriophage and prevent attack. If this were so, then the inclusion of hyaluronidase in the medium might be expected to prevent the formation of a capsule and leave the organism vulnerable to attack by the bacteriophage.

Tests were made to find the smallest amount of purified hyaluronidase (Bengers) which prevented capsule formation in serum broth. In the subsequent tests with phages, five times this concentration was used.

Two phages, which ordinarily gave only partial clearing in broth, were added, together with their respective propagating strains, to plain serum broth containing hyaluronidase. The tubes were incubated for 15 hr. Those tubes containing hyaluronidase showed complete clearing, none of the others showed any evidence of lysis.

Dilutions of phage were then spotted on their respective propagating strains spread over the surface of glucose serum agar plates with and without hyaluronidase; in both cases the titre was higher on the hyaluronidase plates than on the controls (see table).

The effect of the hyaluronic acid capsule on phage action can also be illustrated by using mucoid and non-mucoid variants of one strain. On a 'glossy' non-mucoid variant of type 6, phage *A6* had a titre

TITRATION OF PHAGE ON SOLID MEDIA WITH AND WITHOUT HYALURONIDASE

Strain	Serum glucose agar	Reciprocal of phage dilution				
		10	100	1,000	10,000	100,000
594	Control	CL	+	±	–	–
	„ + hyaluronidase	CL	CL	++	+	±
Type 12	Control	CL	±	–	–	–
	„ + hyaluronidase	CL	CL	CL	++	+

–, No plaques, ±, fewer than 10 plaques, +, 10–50 plaques; ++, 50 per cent lysis; CL, confluent lysis

of 1/1,000 with or without the addition of hyaluronidase. On a 'mat' mucoid variant of the same strain, the titre was only 1/10 without hyaluronidase; but using plates containing hyaluronidase the titre was approximately the same as on the non-mucoid strain.

Streptococci always appear more mucoid in media containing serum, and consequently the effect with hyaluronidase is more striking. Evans[1] has reported the inhibition of phage action by a variety of body fluids. The observations reported here suggest that this inhibition may be due in part to the promotion of capsule formation rather than to phage neutralization. Phage 594 used in this work is that used by Evans[2]. The other phages employed in these tests were given to us by Prof. N. A. Boulgakov, who isolated them from Paris sewage.

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An After-effect in Butter-fat irradiated with High-energy Electrons

IN a previous communication[1], a number of the oxidative effects produced in butter-fat by irradiation with high-energy electrons were reported as increasing with decrease of temperature during irradiation. Further examination has now shown that the changes which occur during irradiation are in some circumstances followed by extensive changes after irradiation. and that both are markedly affected by temperature. The main influence of temperature is, in fact, on the after-effect, which shows a surprising maximum reaction-rate in the region of – 20° C.

The effects during and after irradiation are clearly seen in the accompanying table. 1·2-MeV. electrons were used at a superficial dose-rate of 4 × 10[illegible] r.e.p./min. as described previously, and the butter-fat was a fresh sample saturated with air and water at + 37° C. Completely filled polythene dishes with sealed-on polythene-film lids were used to eliminate heating effects associated with the walls of glass vessels and the possibility of gross differences of oxygen content at different temperatures. Each line of the table is the average of duplicate experiments, in each of which a sample was irradiated at a given temperature and distributed in equal portions between a series of glass tubes pre-equilibrated to a range of storage temperatures. All manipulation, which was complete within two minutes of the end of irradiation, was in subdued artificial light and storage was in the dark.

EFFECT OF TEMPERATURE OF IRRADIATION AND STORAGE ON THE PEROXIDE VALUE OF BUTTER-FAT IRRADIATED WITH A DOSE OF 2 MILLION R.E.P. OF 1·2-MEV. ELECTRONS. (THE UNIRRADIATED BUTTER-FAT HAD NO MEASURABLE PEROXIDE VALUE)

Temp. during irradiation (° C.)	Temp. during storage (° C.)	Peroxide (μmol. oxygen/gm.) after storage for		
		0 days	2 days	8 days
–70	–70	3·0	4·2	4·5
	–20		17·0	15·7
	0		5·1	7·3
	+20		4·3	5·1
0	–70	3·0	3·0	5·0
	–20		18·5	17·3
	0		7·1	7·4
	+20		3·1	6·0
+20	–70	1·5	1·6	1·6
	–20		1·5	1·6
	0		1·1	1·0
	+20		1·6	2·3
+37	–70	0·2	0·0	0·6
	–20		0·1	0·7
	0		0·1	0·0
	+20		0·8	1·2

It can be seen that fats irradiated at 0° C. or – 70° C. (on solid carbon dioxide) showed a striking increase in peroxide value[2] during the first two days of storage at – 20° C., compared with increases which were much smaller at 0° C. and barely significant at + 20° C. or – 70° C. Further investigations have shown that the reaction at – 20° C. follows a smooth reaction curve which in some cases does not attain its maximum value until four or five days after irradiation. Irradiation at higher temperatures gave a somewhat different picture. No after-effect was observed after irradiation at + 20° C., while the molten fat at + 37° C. failed to show even peroxide formation during irradiation. The same series of interrelationships was also given with an independent method of following the damage to the fat, namely, the Schibsted method[3], which is normally regarded as measuring aldehydes of high molecular weight. Since the butter-fat is molten above 35° C., semi-plastic at + 20° C. and virtually solid by about – 20° C., it appears possible that the changes are related to the physical state of the fat.

Some indication of the possible mechanism has been given by the demonstration that the typical reaction at – 20° C. occurred in samples which had been held for as long as 24 hr. at – 70° C. after irradiation, but not after three hours at + 20° C. Even 15 min. at + 20° C. (barely time for equilibration to temperature) eliminated three-quarters of the after-effect. These observations indicate the formation, by the radiation, of a reactive intermediary compound which is stable at very low temperatures and rapidly deactivated at room temperature or higher. At temperatures in the region of – 20° C. an intermediate state may exist in which the destructive mechanisms are suppressed, possibly by the decreased mobility, but the temperature is still sufficiently high for some localized reactions to occur.

A partial destruction of the small amounts of antioxidants (mainly tocopherols) present in the fat also occurs during and after irradiation. This can be demonstrated as a reduction of storage-life before typical rancidity develops, and has proved to be parallel to the peroxide value with all samples so far examined. In the present experiments, least destruction occurred with samples melted before, during or immediately after irradiation (storage life two to three days), while samples in which the peroxide had risen to high values at – 20° C. had no residual storage life. It is not certain, however, that the antioxidant disappears at the same stage of the reaction at all temperatures, and further investigation is required before the part it plays in the whole series of changes can be suggested.

The relationship between these effects and those of normal autoxidation, or the after-effect observed spectroscopically by Mead[4] with X-irradiated linoleic acid, is still obscure. Qualitatively similar effects have also been shown with 40-kV. X-rays.

This work has been carried out with the co-operation of the Medical Research Council as part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research. We are grateful to Mr. J. W. Boag and Mr. D. Moore, of the Radiotherapeutic Research Unit of the Medical Research Council, Hammersmith Hospital, for carrying out the necessary irradiations.

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Differences in the Biological Activity of 2 : 3 : 5 : 6-Tetrachloronitrobenzene and its Isomers

IN a recent paper[1], differences in the metabolism of 2 : 3 : 5 : 6-tetrachloronitrobenzene and the 2 : 3 : 4 : 5 compound in the rabbit have been described. Preliminary investigations in these laboratories have shown other differences between these compounds.

The 2 : 3 : 5 : 6 symmetrical isomer, formulated as a dust, has been used successfully to control *Botrytis* disease of lettuce[2] and dry rot of seed potatoes[3], and it has been shown to inhibit the sprouting of potatoes[4,5].

In our experiments, against normal strains of *Fusarium caeruleum* (Lib.) Sacc. in culture, 2 : 3 : 4 : 5 tetrachloronitrobenzene has inhibited radial growth more than the 2 : 3 : 5 : 6 isomer. Two of the mutant strains produced by McKee, and shown by him to be resistant to the 2 : 3 : 5 : 6 isomer[6], have been tested, and found to be less resistant to the 2 : 3 : 4 : 5 isomer. Both retained resistance to 2 : 3 : 5 : 6-tetrachloronitrobenzene after five months growth in its absence. In the accompanying table are results from an experiment in which subcultures were grown under the influence of the vapour from 0·01 gm. of the pure isomers deposited centrally in the lids of the Petri dishes.

MEAN INCREASE OF COLONY DIAMETER (MM. PER DAY). MCKEE STRAIN *B*

Strain	Tetrachloronitrobenzene isomers None	2 : 3 : 5 : 6	2 : 3 : 4 : 5
Normal	7·0	4·5	3·7
Mutant, resistant	5·8	5·1	3·7

When 1-lb. batches of Craig's Defiance potatoes were each dressed with 2 gm. of a 2 per cent dust of each isomer, and stored in closed tins until untreated controls were sprouting profusely, the following mean sprout weights were obtained :

Tetrachloronitrobenzene isomers None	2 : 3 : 5 : 6	2 : 3 : 4 : 5
26·8 gm.	10·4 gm.	27·9 gm.

With treated potatoes in small clamps, some inhibition of sprouting occurred with seed treated with the 2 : 3 : 4 : 5 isomer, but less than that in clamps treated with the 2 : 3 : 5 : 6 isomer. It is concluded that 2 : 3 : 4 : 5-tetrachloronitrobenzene is a less powerful inhibitor of potato sprouting than is the 2 : 3 : 5 : 6 isomer.

Application of the isomers as 5 per cent dusts to lettuce in boxes resulted in a visible check to growth, which was quickly overcome in the case of the 2 : 3 : 5 : 6 isomer but which persisted in plants treated with the 2 : 3 : 4 : 5 isomer and produced a significant reduction in dry weight of the final crop ($P = 0.001$). It is concluded that both isomers can inhibit the growth of lettuce, but the 2 : 3 : 4 : 5 isomer is a more powerful inhibitor. Preliminary field-tests have shown the 2 : 3 : 4 : 5 isomer to be less effective than the 2 : 3 : 5 : 6 in controlling *Botrytis* disease of lettuce.

The limited examination yet made of 2 : 3 : 4 : 6-tetrachloronitrobenzene suggests it is more active than the other two isomers in inhibiting the growth of both *Fusarium caeruleum* and *Botrytis cinerea* in culture, and the sprouting of potatoes, but may be less inhibitory towards the growth of lettuce.

The investigations are continuing.

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Mode of Action of Agents giving Protection from Radiation

A CONSIDERABLE number of compounds is now known to be capable of protecting animals against X-rays and other radiations. Among the most effective of these are sodium cyanide and sodium azide[1], and thiourea[2]; alcohols[3] and amines[4] are active at higher concentrations. X-rays degrade polymethacrylic acid in aerated aqueous solutions, and the extent of the reaction could readily be followed by changes in viscosity with a high molecular weight sample of the polymer[5]. Table 1 shows that the degradation is reduced in the presence of substances which are protective agents in biological experiments. Since the compounds were placed in the same order of effectiveness in both tests, it is suggested that similar chemical reactions are involved. Allyl thiourea, which does not appear to have been examined biologically, was found in our work to be a highly effective protective agent.

Since polymethacrylic acid is not degraded by comparable doses of X-rays in the absence of air (see

Table 1. FALL IN VISCOSITY OF POLYMETHACRYLIC ACID (0·025 PER CENT NEUTRALIZED TO pH 7) ON IRRADIATION WITH 1,000 r. (200-KV X-RAYS) IN THE PRESENCE OF COMPOUNDS GIVING PROTECTION AGAINST RADIATION

Protective agent	% fall in viscosity*
None	52
Solution saturated with nitrogen	2·0
4×10^{-4} *M* potassium cyanide	7·9
1×10^{-4} *M* allyl thiourea	0·0
8×10^{-4} *M* thiourea	14·0
8×10^{-4} *M* sodium azide	16·9
8×10^{-4} *M* methylamine	49
8×10^{-4} *M* methanol	40
250×10^{-4} *M* n ethanol	20

* Determined at a shear rate of 50 sec.$^{-1}$

Table 1) the primary products of the radiolysis of water, that is, hydrogen atoms and hydroxyl radicals, cannot be responsible for the breaking of carbon–carbon bonds in this system. The perhydroxyl radical, HO_2, is known to be formed by X-rays in the presence of oxygen and seems to be the most probable agent responsible for the degradation observed. Hydrogen peroxide, another product of irradiation, does not by itself react with the polymer even in high concentrations. These results indicate that the compounds examined here giving protection against radiation may react with perhydroxyl radicals possibly by adding an oxygen atom, for example, cyanide to cyanate, amine to amine oxide, sulphur compounds to sulphones or sulphoxides. The possibility that these compounds also react with hydroxyl radicals was tested in the following experiment.

Table 2. POLYMERIZATION OF AN AQUEOUS SOLUTION OF METHACRYLIC ACID (20 PER CENT) BY IRRADIATING WITH 10,000 r. (200-KV X-RAYS)

Solution	% Monomer polymerized
Saturated with nitrogen	51·5
Saturated with nitrogen + 0·1 *M* thiourea	72·5
Saturated with nitrogen + 0·1 *M* allyl thiourea	51·0
Saturated with nitrogen + 0·1 *M* ferrous sulphate	20·0
Aerated	2·4
Aerated + 0·8 *M* thiourea	22·5

Hydroxyl radicals are catalysts in the polymerization of vinyl compounds, and in deoxygenated solutions methacrylic acid is readily polymerized by X-rays. Table 2 shows that this reaction is not inhibited by thiourea or allyl thiourea at a concentration sixty and one thousand times respectively of that needed to protect polymethacrylic acid against X-ray degradation; in fact, the polymerization in the presence of oxygen is promoted by thiourea. On the other hand, ferrous sulphate, which is well known to react with hydroxyl radicals, prevents the polymerization. Some at least of the compounds giving protection against radiation therefore do not react with hydroxyl radicals, whereas they all react with the radical responsible for the degradation. These experiments lead us to suggest that these substances protect against radiations *in vivo* by competitively removing perhydroxyl radicals formed in the presence of oxygen, and that it is the reaction of these radicals with vital cell constituents which brings about those of the biological effects (for example, radiation sickness) which can be counteracted by these chemicals. The protection afforded to animals by reduced oxygen tension[6] is in agreement with this hypothesis.

We wish to thank Prof. A. Haddow for his interest and encouragement, and Mr. C. A. Greatorex (Physics Department, Royal Cancer Hospital) for carrying out the X-ray irradiation. This investigation has been assisted by a special grant from the Anna Fuller Fund and by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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The Stauromedusan *Craterolophus tethys* Clark in British Waters

THE stauromedusan genus *Craterolophus*, although bipolar, has appeared nevertheless to have a curiously restricted distribution[1]. The type species, *C. tethys* Clark 1863 [2], seems never to have been recognized outside the type locality Heligoland, though frequently reported in that region. The southern form, *C. macrocystis* von Lendenfeld[3], the specific status of which is in some doubt[1], occurs only on the New Zealand coast. Recent observations indicate that the northern form at least is more widespread than has been supposed.

Stauromedusæ make sporadic and infrequent appearances on the Yorkshire coast. *Haliclystus octoradiatus* and a supposed *Lucernaria campanulata* were first recorded from the Scarborough area in 1913 [4], but neither was seen again for nearly ten years[5,6]. Since the second appearance there have been no further records or reports of their occurrence; but in 1950 a chance find by Dr. W. S. Bullough at Robin Hood's Bay, Yorkshire, led to the discovery, after protracted search, of several specimens of what was thought to be a species of *Lucernaria*. This now proves after detailed examination to be, in fact, *C. tethys* Clark. The same species was again present, now in some numbers, in the summer of 1951, though in the intervening spring its absence was made the more conspicuous by the sudden appearance of *Haliclystus octoradiatus* (Lamarck).

It is quite certain that these appearances of *C. tethys* are not invasions by a species new to Britain, for by a fortunate chance a solitary specimen from one of the Scarborough collections mentioned above[4,5] is in the possession of this Department. Though allegedly *L. campanulata*, it is identical with the recent material. There is evidence, too, that the species has appeared in other localities. Johnston[7] described a *Lucernaria convolvulus* from Berwick Bay which is almost certainly not *L. campanulata* Lmx. to which he afterwards equated it[8], but on the other hand agrees more closely with *C. tethys*[1]. Johnston further considered that his specimens belonged to the same species as others found on the Devon coast. This is of some interest, as a recent photograph of a specimen from this same region[9] seems more likely to be of *C. tethys* than of *L. campanulata*, to which it, too, is ascribed.

It seems very probable that *C. tethys* has appeared at intervals over a considerable stretch of the east and south coasts of Britain. It remains to be discovered, whether it is established there, or whether it is a case of sterile distribution with periodical recruitment occurring from an outside source as a result of favourable circumstances at the time of reproduction. The latter alternative seems the less likely, since so far as is known the planula stage in the development of Stauromedusæ is of short duration, and therefore unlikely to be transported over any great distance.

I wish to thank Mr. P. G. Corbin both for the loan of specimens of *Lucernaria* and for much helpful discussion and assistance with the literature.

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Uricotelism in the Common Indian Apple-Snail, *Pila globosa* (Swainson)

NITROGEN catabolism in animals has been assessed partly by analysis of the excretory products and partly by the identification of the enzymes in the liver or hepatopancreas. Since Strohl reviewed the excretory mechanism in the Mollusca, work on a few European marine, freshwater and terrestrial gastropods has been extended[1-4]. Since no data are available for an amphibious snail and no parallel record for an Indian form, so far as we know, a study was undertaken on the common Indian apple-snail *Pila globosa* (Swainson). This particular form, besides being amphibious, develops through a cleidoic egg. The most active period of this snail's life is during the rainy season, when it lives in fresh water and feeds and also breeds on the banks. With the approach of the winter it becomes less active and burrows in the mud to æstivate for the rest of the year until the onset of the next rainy season.

During the course of the investigations, it was noticed that the uric acid content of the nephridium, which in this snail consists of an anterior and a posterior renal chamber, was rather low in the snails collected from their natural environment during the rainy season—being only 7·68 mgm. per gm. dry weight of the tissue in the anterior chamber and almost nil in the posterior renal chamber. After these snails have been maintained in the laboratory in wet jars in the shade for about a month, the quantity of uric acid increased to about 60 mgm. per gm. dry weight of the tissue in the anterior, and 14 mgm. in the posterior, renal chamber. When some of these snails were allowed to æstivate in the mud in the laboratory for a couple of months or more, the uric acid content of the nephridium gradually increased still further, as was shown by periodic estimations of the uric acid in their nephridia. It attained a maximum of about 102 mgm. per gm. dry weight of the tissue in the anterior, and 42 mgm. in the posterior, renal chamber, in the snails which had æstivated for more than six months.

A few of these æstivating animals with high uric acid content of the nephridium were selected and kept in water in small glass bowls, in which they were left for a number of days and periodically exposed to bright sunlight. They were examined one by one after regular intervals and the uric acid content of their nephridia determined. It was found that the quantity of the uric acid decreased with the length of time the snails were kept in the water (see accompanying table).

Period in water	Uric acid* Anterior chamber	Uric acid* Posterior chamber	Total
Nil	102·38	42·58	144·95
15 days	78·3	50·88	109·18
21 days	79·04	10·23	80·27
27 days	29·88	Nil	29·88

* Uric acid content in mgm. per gm. dry weight of the tissue. Two or three snails were selected for each estimation.

Attempts were also made to see if this uricogenesis in *Pila globosa* could be correlated with certain enzymes present in the hepatopancreas and the nephridium of the snail. Following the technique of Baldwin[1] and Sumner and Somers[5] for arginase and xanthine oxidase respectively, it was possible to demonstrate the occurrence of both these enzymes in the hepatopancreas of *Pila globosa* in appreciable quantities. However, neither of these enzymes could be detected in the nephridium of *Pila globosa*. Whether these enzymes could be directly related to the æstivation of *Pila* is difficult to say[6,1], and so far it has not been possible to find any appreciable difference in the arginase content of the æstivating *Pila* and those living in an aquarium. The work is, however, being extended by one of us (B. B. S.).

All our experiments were carried out at room temperature with controls and blanks simultaneously.

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June 6.

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Ultra-Violet Papyrography: an Automatic Analytical Apparatus using Filter Paper without a Colour Reagent

A NEW analytical technique using filter paper and termed 'ultra-violet papyrography'[1] has been developed in these laboratories (Fig. 1).

The apparatus uses light from the ultra-violet (2537 A.) to visible region for the four methods.

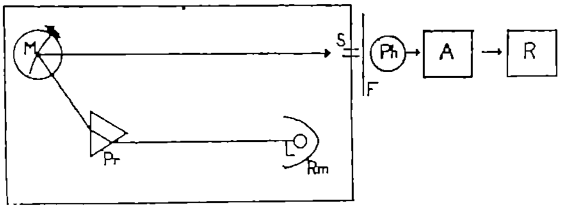

Fig. 1. *Rm*, Parabolic reflector for ultra-violet radiation; *L*, high-power mercury lamp; *Pr*, quartz prism for ultra-violet, *M*, concave reflector for ultra-violet; *S*, adjustable slit; *F*, filter paper; *Ph*, photomultiplier for ultra-violet; *A*, amplifier, *R*, recorder

(1) densitometry of finished filter papers prepared by paper chromatography or electromigration; (2) automatic paper chromatography; (3) automatic paper electromigration; (4) automatic paper electrochromatography.

Substances absorbing in the ultra-violet region may readily have their R_F values determined by use of ultra-violet light in method 1. In this case the finished filter paper is moved from the starting line to the solvent front. With methods 2, 3 and 4, a beam from a monochromator is projected on the fixed paper, and a sample is run by use of a developing solvent or an electric current. By these latter methods a quick automatic analysis of colourless substances is realized.

The apparatus can be used for both qualitative and quantitative analyses. By the methods of paper chromatography described, there have been obtained ultra-violet papyrograms for flavonoids[2], alcohol xanthates[3], and some organic bases[4]. Thus the accompanying papyrogram (Fig. 2) was obtained by ultra-violet densitometry (2537 A.) applied to the finished paper chromatogram of the hydrolysate of deoxyribonucleic acid.

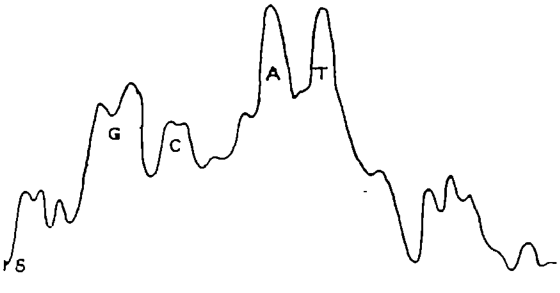

Fig. 2 *S*, Starting line; *G*, guanine, *C*, cytosine, *A*, adenine, *T*, thymine

This work was described at the annual meeting of the Pharmaceutical Society of Japan, at Osaka University, April 1, 1952, and a symposium of microchemistry of plant components held at Kyoto University, February 27, 1952. We are indebted to Prof. T. Kariyone, of Kyoto University, and Dean F. Seto, of this College, for guidance.

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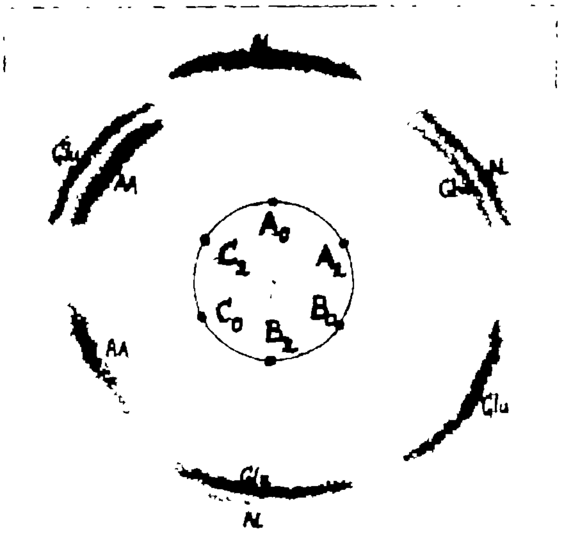
A Simple Paper Chromatographic Method for the Study of Transamination Reactions

Recently, the application of paper chromatography to the study of transamination reactions has been reported by several workers. The method adopted by Fincham[1] is based on the visual comparison of the spots and as such it is only roughly quantitative. Tulpule and Patwardhan[2] reported a method based on conversion of α-ketoglutaric acid and pyruvic acid to the respective dinitrophenylhydrazones and estimating them colorimetrically after paper chromatographic separation. This method, even though claimed to be accurate, is obviously time-consuming and tedious. While our work on transaminating systems in Indian pulses was in progress, Awapara's paper[3] appeared in which the distribution of transaminases in rat organs was followed by using unidimensional paper chromatography.

In this communication is presented a simple method for the detection and quantitative determination of transaminase activity in plant tissues using the circular paper chromatographic technique[4–6], which is now being continuously used in this laboratory.

The following reactions have been studied by us (*a*) alanine + α-ketoglutarate → glutamic acid + pyruvate; (*b*) glutamic acid + pyruvate → alanine + α-ketoglutarate; (*c*) aspartic acid + α-ketoglutarate → glutamic acid + oxalacetate.

The enzyme was prepared by extracting the powder of resting seeds (*Phaseolus radiatus*) with water (1 : 4, w/v) and dialysing the centrifuged extract against distilled water for 24–48 hr. at 0–5° C. The dialysed extract was centrifuged and the cloudy supernatant used in these experiments. The reaction mixture containing 0·1 c.c. of $M/15$ amino-acid, 0·1 c.c. of $M/15$ α-ketoglutaric or pyruvic acid (neutralized with sodium hydroxide), 1 c.c. of $M/15$ phosphate buffer (*p*H 7·4) and 0·8 c.c. of enzyme solution, was incubated at 35° C. for 2 hr. and the



Circular paper chromatogram showing presence of transaminating systems in green gram (*Phaseolus radiatus*) The reaction mixtures were spotted at positions marked on the circumference of the circle. A_0, B_0, C_0, refer to the reaction mixtures at 0 hr for the systems mentioned in the text; A_2, B_2, C_2, to the same after 2 hr. incubation reaction stopped by the addition of an equal volume of absolute ethanol. The protein precipitated was centrifuged off and 20 µl. of the clear supernatant were spotted on the paper and developed as described in earlier publications[5,6].

The accompanying photograph is of a typical chromatogram showing the presence of the above systems in green gram (*Phaseolus radiatus*).

The progress of the reaction was followed quantitatively by estimating the amino-acids by the following method[7]. The colour on the chromatogram was developed by spraying with 0·5 per cent ninhydrin in 95 per cent acetone, heating at 65° C. for 30 min., cutting off the individual amino-acid bands, extracting the colour with 4 c.c. of 75 per cent ethanol containing 0·2 mgm. of $CuSO_4,5H_2O$, and measuring the colour intensity with a Klett–Summerson photoelectric colorimeter using a green filter (540 mµ). An interesting feature is the effect of added cupric ions, which increases the tone and colour intensity considerably. The method is highly sensitive, simple and can be easily carried out in a short time.

Full details of this investigation will be published in the *Journal of the Indian Institute of Science*.

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Self-branching of Vinyl Polymers

The physical properties of a substance consisting of long-chain molecules are modified considerably if branches are introduced into the molecules, and a method for estimating the number and length of the branches in a synthetic addition polymer would be of very great value. That some types of vinyl polymers are, in fact, branched has been demonstrated in this laboratory by an examination of the molecular weight (M) and length (d) of polyvinyl acetate in suitable solvents[1]. According to light-scattering theory, the value of M/d^2 should be independent of M. In fact, M/d^2 increases in value as the temperature of synthesis is increased, showing that the polymer becomes more compact in structure, that is, branching becomes more pronounced.

During the polymerization of a vinyl monomer, branching occurs owing to a growing radical attacking a dead polymer molecule, abstracting a hydrogen atom and forming a free valency in the polymer chain; growth of a side-chain can begin at this point. It has been demonstrated that if a monomer is polymerized in the presence of the polymer of a second monomer, it is possible to isolate material containing both types of monomer unit[2]; during the polymerization, side-chains must have been grafted on the dead polymer. A new method has now been developed for studying the branching reaction using a single monomer, and preliminary results obtained using styrene and vinyl acetate are presented here.

Monomeric styrene labelled with carbon-14 was polymerized in the presence of inactive polystyrene of average molecular weight about 500,000, the conditions being adjusted so that the active monomer yielded polymer of fairly low molecular weight (about 50,000). A small fraction of the material of highest molecular weight was isolated and it was found to possess an appreciable amount of activity. In order to calculate the amount of activity which was chemically combined with the high polymer, it was necessary to perform a blank experiment and to make allowance for incomplete separation of active low polymer and inactive high polymer.

Comparison of the activity grafted on the high polymer with the activity of polymer formed directly from the active monomer would have permitted calculation of the number of branches in the system if the average length of the branches had been known. It was assumed that the average length of the branches was equal to half the average chain-length of the linear polymer formed at the same time. The rate of formation of branch-points, which is equal to the rate of transfer to polymer, is $k_x n(M.U.)$, where n is the number of growing centres in the system and $(M.U.)$ is the concentration of monomer units incorporated in the polymer. The value of n can be calculated from the observed rate of polymerization, the concentration of monomer and the velocity constant for chain-growth. Provisional values in litre mole^{-1} sec.$^{-1}$ for the constant k_x are 0·35 at 130° C. and 0·56 at 154° C., giving approximately 7 kcal. as the energy of activation. At 154° there is one branch of 115 monomer units for about 7,920 monomer units in the linear polymer. If the polymerization of styrene is carried to high conversion at elevated temperatures, an appreciable number of branches may be formed; but at temperatures below about 100° C. in reactions allowed to proceed only to small conversions, branching must be negligible.

The experimental procedure was altered slightly for studying the branching of vinyl acetate. Unlabelled monomeric vinyl acetate was polymerized in the presence of labelled polyvinyl acetate of high molecular weight (about 660,000), the conditions being such that a polymer of average molecular weight about 100,000 was produced. A value of 8·1 litres mole^{-1} sec.$^{-1}$ was obtained for the velocity constant k_x at 40° C. At this temperature there was one side-chain of 582 monomer units on the average for 2,760 monomer units combined in the form of linear polymer. Clearly, transfer to polymer and branching are of more significance in the polymerization of vinyl acetate than in that of styrene, owing to the much higher reactivity of the vinyl acetate radical.

The results indicate that the value of the velocity constant k_x is similar to those for the velocity constants for transfer to monomer (k_f) and for transfer to small molecules (k_f'), which can be taken as models for the monomer unit in the polymer[3]. For styrene at 130°, k_x was found to be 0·35 litre mole^{-1} sec.$^{-1}$, while k_f and k_f' for ethyl benzene are calculated as 0·34 and 0·45 litre mole^{-1} sec.$^{-1}$ respectively. In the case of vinyl acetate, k_x at 40° is 8·1 litres mole^{-1} sec.$^{-1}$, while a value of about 5 litres mole^{-1} sec.$^{-1}$ has been quoted for k_f at 50° C.

It can be predicted that branching is most likely to be important for monomers which yield reactive radicals, for example, vinyl chloride; branching might be particularly pronounced with this monomer, as the abstraction of a chlorine atom by a free radical should occur more easily than the abstraction of a hydrogen atom.

The results of experiments with further monomers, and full details of the experimental procedure, will be published elsewhere.

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Anomalous Specific Heat of Chromium Oxide (Cr_2O_3) at the Antiferromagnetic Curie Temperature

RECENTLY, some observations have been published of phenomena related to the second-order transition of chromium oxide (Cr_2O_3) at the antiferromagnetic Curie temperature; for example, the change of lattice constants[1] and the anomalous absorption of high-frequency electromagnetic energy[2]. However, so far as I am aware, no measurements of an anomalous specific heat have been published. In the present communication, measurements are presented of C_p between 100° and 350° K. and of the magnetic susceptibility χ between 77° and 550° K., which were made on samples of the same preparation of chromium oxide.

The compound was prepared by firing ammonium dichromate in air at 1,000° C. The susceptibility was measured on a sample of 280 mgm. of the resulting oxide by the Faraday' method (force on the specimen in an inhomogeneous magnetic field). The torsion spring balance used was an improved design of that described elsewhere[3]. The results are plotted in Fig. 1. It is remarkable that the values of χ at low temperatures are lower than those found by Foex and Graff[4], whereas the high-temperature values of χ seem to be somewhat higher than was found by these investigators. The dip of the curve which is believed to indicate the antiferromagnetic Curie temperature is found at 45° C.

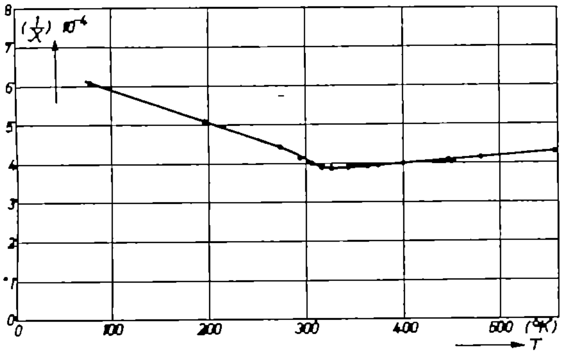

Fig 1 Reciprocal susceptibility per gram of chromium oxide as a function of temperature

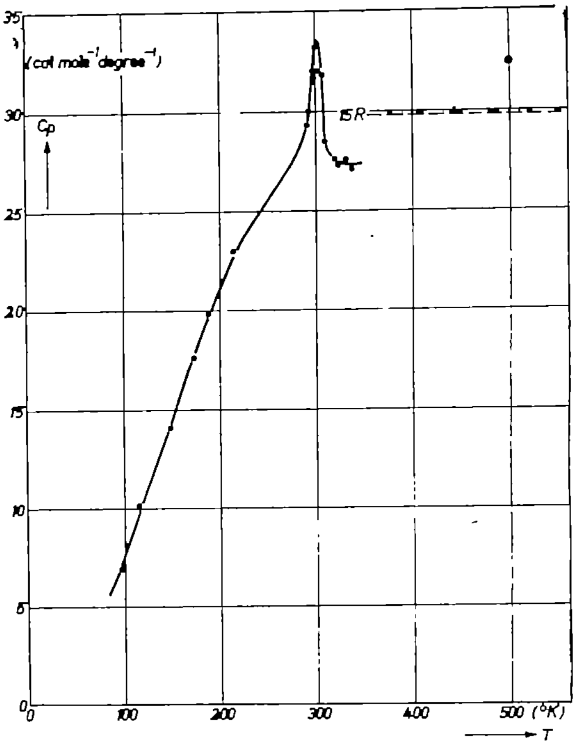

Fig. 2. Molecular specific heat of chromium oxide as a function of temperature

The specific heat was investigated on a sample of 29·6 gm. The substance was well enough sintered to form one solid piece, so that no container had to be used for the calorific measurements. The apparatus and method were the same as described by Volger[3]. The results are given in Fig. 2. Obviously, the anomaly of C_p at about 35° C. is due to the final disappearance of the antiferromagnetic ordering. The very steep drop of C_p was confirmed by the continuous heating method (analysis of the drift of temperature caused by a very small supply of heat[5]). Similar anomalies of the specific heat have been observed with oxides of other transition elements exhibiting antiferromagnetism; for example, manganese oxide (MnO) and dioxide (MnO_2), and iron oxide (FeO) and also with copper oxide (CuO)[6,7].

In a recent paper, Foex[8] states that his unpublished measurements of the thermal expansion or the specific heat of chromium oxide indicate a Curie point of this oxide at 40° C.

I am much indebted to Mr. F. C. Romeyn for preparing the compound, and to Mr. J. H. Aalberts for help during the measurements.

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Thermodynamics of Irreversible Electrochemical Processes

In a recent paper, DeGroot and Tolhoek[1] have attempted, by means of an application of the thermodynamics of irreversible processes, to extend Guggenheim's[2] ideas concerning the activities of ions and the electrical potential difference between two phases. To this end they have considered a medium showing a bulk motion and in which chemical reactions and flows of energy, matter and electricity are occurring; two different mathematical treatments of this system are given.

As a result of their second treatment, these authors deduce that electrical potential differences are (in principle) measurable apart from differences in ionic chemical potentials, provided that an electrical space charge is present, that is, in nearly insulating media but not in media showing any appreciable degree of electrical conductivity. This conclusion is obtained from the fact that the thermodynamic equations of this method of treatment, provided that there is no space charge, contain the chemical potential μ_i of the ith ionic species and the electrical term $e_i\varphi$ (where φ is the electrical potential of the medium and e_i the ionic charge) only in the combination $\bar{\mu}_i = \mu_i + e_i\varphi$, that is, as the electrochemical potential of i; if a space charge exists, however, the equations contain additional terms involving φ but not μ_i.

Now both the second and first methods of treatment involve the use of the following thermostatic equation for the change in intrinsic energy of a system:

$$\mathrm{dU} = Td S - p d V + \sum_i \mu_i d n_i, \qquad (1)$$

where the symbols have their usual thermodynamic meaning. Since the change in U is quite independent of the path followed, it is quite correct to apply this equation to any process whatever occurring in the system, reversible or irreversible. However, it is subject to the restriction that the system does no specialized work, that is, no work which cannot be included in the second and third terms on the right of (1). It is therefore quite erroneous to apply it to a system containing electrical charges and potentials, which can perform electrical work.

It is readily ascertained from thermostatic first principles that, when a system can perform specialized work, a term representing the maximum specialized work that it is capable of performing under reversible conditions must be added to (1). The equation is then still applicable to an irreversible change, for the same reason as before; but it must be noted that the specialized work term is then not equal to the specialized work which has actually been performed in the process. In the case of electrical work, the correct form of the equation is obtained by replacing the chemical potentials μ_i in (1) by the electrochemical potentials $\bar{\mu}_i$ as defined above:

$$\mathrm{dU} = Td S - p d V + \sum_i \bar{\mu}_i d n_i. \qquad (2)$$

It is this expression, not (1), which must be taken as the basis of the thermodynamic treatment of an irreversible electrochemical process, although the erroneous use of (1) has apparently been in vogue for a number of years[3].

If now the first method of DeGroot and Tolhoek is carried through using (2) in place of (1) as the only modification, it will be found that the equations finally obtained do indeed contain μ_i and φ only in the combination $\bar{\mu}_i$; in particular, the thermodynamic force acting on the ith ion is given by:

$$X_i = F_i - T \operatorname{grad}(\bar{\mu}_i/T), \qquad (3)$$

where F_i is the non-electrical external force acting on the ion (the effect of external electrical forces is already included in the φ term of $\bar{\mu}_i$). Equation (3) leads to the usual and well-known results when applied in any particular problem. Thus from this first treatment alone it is seen that no thermodynamic measurement can ever determine separately either the electrical or non-electrical part of $\bar{\mu}_i$, no matter whether or not a space charge exists in the system.

The second method of DeGroot and Tolhoek can also be carried through with the same modification, but then some rather peculiar equations result. In this method, instead of the intrinsic energy U, used in the first case, a quantity $\overline{\mathrm{U}}$ is employed; this is said to be the "intrinsic energy, including electrical energy", and is defined as:

$$\overline{\mathrm{U}} = \mathrm{U} + e\varphi, \qquad (4)$$

where e is the total electric charge in the system. However, the intrinsic energy U does, by definition, include the totality of the energy contained in the system, so the addition of the term $e\varphi$ is tantamount to including the electrical energy twice over. Thus $\overline{\mathrm{U}}$ as defined by (4) is a new thermodynamic function which might conceivably have some particular applications, but which certainly cannot be used in place of U in equations (1) and (2).

The whole of this second method of treatment must therefore be considered invalid. This leaves us with the conclusion, drawn from the revised first treatment, that thermodynamic measurements on any system will never give us anything other than the electrochemical potentials $\bar{\mu}_i$ of the ionic species concerned. This is in complete agreement with Guggenheim's original conclusions. The question of whether or not the electrical and non-electrical parts into which the $\bar{\mu}_i$ may be formally split have any real physical significance is, however, quite another matter and cannot be discussed here.

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Thermal Decomposition of Normal Paraffins

During the past two years, four papers dealing with the thermal decomposition of normal paraffin hydrocarbons by Sir Cyril Hinshelwood and his collaborators have been published in the *Proceedings of the Royal Society*. The work described in them is based upon the following assumptions: (1) that primary decomposition, in the simplest case, involves the formation of methane, and the corresponding olefine; (2) that reaction is inhibited by the addition of nitric oxide to the paraffin, and may therefore be assumed to be initiated by free radicals, and carried forward by a chain mechanism; (3) that the rate of the process mentioned under (1) can be measured by observing the rate of change of pressure at constant volume and temperature.

Before the War, one of us with various collaborators had shown that, in the case of ethane: (1) primary hermal decomposition of the hydrocarbon results n hydrogen and ethylene only; this process is nhibited by the addition of nitric oxide to the ethane; (2) the formation of methane, and under certain conditions of methane and polymer together, s secondary to the formation of hydrogen and ethylene. The formation of methane, or of methane and polymer together, which is a measure of the rate of disappearance of C_2-hydrocarbon, is the result of a single time-determining process, the rate of which s not diminished but slightly accelerated by the presence of nitric oxide.

The behaviour of ethane might be supposed to be unique, and we assume that for this reason this work has not been referred to in the papers we have mentioned. We have now proved, however, that the thermal decomposition of propane follows exactly the same course. This fact, and others of which we give details in a paper which has been communicated to the Royal Society, appear to us to justify the claim that the manner in which normal paraffin hydrocarbons decompose when heated is that which we have described. The locus of the rupture of the carbon chain is that of the ethylene bond in the product of the primary olefine. In the case of ethane and propane there can, of course, be only one olefine. In the case of butane one would expect that the primary olefine would be 1-butylene, from which the secondary products would be methane, possibly with some polymer, and propylene. But in the region of our experiments a shift in the position of the double bond would give rise, in the first instance to some dimethyl-ethylene, the secondary products from which would be ethane and ethylene. This is what is actually observed.

We believe that the results which we have obtained places our knowledge of this very important set of reactions on a firm experimental foundation.

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Sept. 29.

It is not correct to say that the work from this laboratory referred to is based upon the 'assumptions' (1), (2) and (3) of the communication from Mr. C. G. Silcocks and Prof. M. W. Travers. That the reactions are partly chain reactions, and that in many cases pressure change is quantitatively proportional to decrease in amount of original paraffin, represent considered conclusions from detailed experiment. 1) has never been stated: the formation of methane and olefine has been given as one of several simultaneous modes of decomposition of the higher paraffins.

The writers appear to think that the primary and predominant formation of ethylene and hydrogen from ethane is incompatible with a chain reaction nvolving alkyl radicals. Reference to almost any text-book on chemical kinetics shows that this would be an error. (According to a generally accepted scheme—not devised by us—the ethylene is formed by breakdown of ethyl radicals.)

The implication of (3), that work in this laboratory has uncritically used change of pressure as a measure of reaction-rate, is wholly unfounded. Detailed analyses at different stages of various reactions of paraffins have been made repeatedly, and indirect tests that the kinetic conclusions are independent of possible errors from this source have also been applied. One of the latest published sets of analyses is in *Proc. Roy. Soc.*, A, 214, 20 (1952), and here it is again specifically shown that change of pressure gives a good measure of initial rate. The results also contradict decisively Prof. Travers's contention that the higher paraffins would give primarily olefine and hydrogen only. With normal butane at 530° C. and 1,400 mm. initial pressure, when the increase of pressure is 145 mm. the percentages of hydrogen, butene, methane and ethane in the products are, respectively, 2·14, 4·1, 31·4 and 13·4; when the increase of pressure is 357 mm. these percentages are, respectively, 2·14, 3·9, 32·9 and 14·5 (the analyses are by mass spectrometer). The other constituents are also consistent with primary formation of lower paraffin and olefine.

Ethane itself could not, of course, give methane and olefine in one step; that it gives methane by some process is already known. Propane does the same; but this cannot have much bearing on the primary behaviour of higher hydrocarbons, nor upon the question whether and to what extent the reactions involve chain processes. Steacie and Puddington[1] have shown that the primary decomposition of propane gives approximately equal amounts on one hand of propylene and hydrogen and on the other of methane and ethylene.

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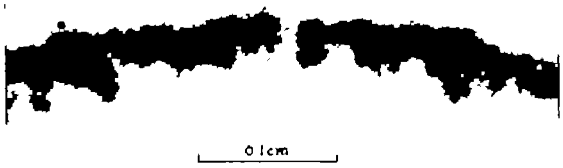
Autoradiography of Metal Surfaces using a Radiochemical Method

A number of methods have been suggested for the autoradiographic study of metal surfaces. Variations of surface composition have been detected using differences in nuclear reactions occurring during irradiation[1], differences in radioactivity produced as a result of irradiation[2,3], and differences in contact potential leading to differences in adsorption of charged radioactive material[4]. The method described in this communication uses the different chemical reactivities of the various metal components towards some radioactive substance that forms a localized radioactive reaction product on the metal surface.

Experiments were carried out with amyl iodide containing some of the iodine-131 isotope, which has a half-life of eight days and emits both β- and γ-rays. The liquid as obtained had a specific activity of 1·5 mC./gm. It had an amber colour and probably contained free iodine, and it seems likely that this iodine, rather than the amyl iodide itself, was responsible for the chemical reactions observed.

When the liquid was placed on a clean copper surface, allowed to remain for fifteen seconds and wiped off with filter paper, a considerable amount of radioactivity remained on the copper surface. Autoradiographs of the copper surface were taken and measurements showed that the equivalent of 150 atomic layers of iodine was present on the copper surface, almost certainly in a chemically combined form. On a mild steel surface under the same conditions, the amount of activity was much less, equivalent to ten atomic layers only. Washing with cold



Autoradiograph of steel surface showing location of copper fragments transferred during sliding

water did not affect the activity on the copper; but it removed all but $2\frac{1}{2}$ iodine layers from the steel surface. It is possible that this residual iodine layer was of monolayer thickness only, the factor of $2\frac{1}{2}$ being the ratio of real to apparent surface area for the lapped steel specimen[5].

The accompanying illustration shows an autoradiograph of the friction track produced by a clean, hemispherically ended copper specimen sliding on steel under a load of 1 kgm., after which the iodine solution was applied for fifteen seconds, the surface washed with cold water and a two-day exposure given on 'No-Screen X-Ray' film. The copper wear fragments transferred to the steel are shown as black circular patches along the (curved) sliding track, while the background due to the steel is nearly invisible. The general appearance of the friction track is very similar to one shown by Rabinowicz and Tabor[6], who obtained their autoradiograph by an entirely different method using a radioactive copper specimen.

Of a number of metals and alloys examined, silver, chromium, lead and copper react most strongly with the iodine (~ 200 atomic layers); indium, tungsten carbide and brass react less vigorously (~ 50 layers); aluminium, bismuth, nickel, antimony, tin, cadmium and mild steel produce still thinner films (~ 15 layers); while zinc and titanium take up only three atomic layers.

The radiochemical method would appear to have considerable potentialities in surface autoradiography. Since only the surface itself is activated, good resolution can be achieved, while flexibility is ensured by the large number of radioactive chemicals and solvents that can be used to achieve a difference in the radioactive intensity at various regions on the surface.

E. RABINOWICZ

Lubrication Laboratory,
Department of Mechanical Engineering,
Massachusetts Institute of Technology,
Cambridge, Mass. May 23.

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[2] Rabinowicz, E., *Proc. Phys. Soc.*, A, 64, 939 (1951).
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Gravitational Instability of a Turbulent Medium

CHANDRASEKHAR has derived in a very elegant manner[1], from his theory of density fluctuations in an isotropic homogeneous turbulence field[2], the generalization to a turbulent medium of Jeans's criterion for the stability against inhomogeneity of an infinite quiescent homogeneous medium. The expression which he obtains may be written:

$$\lambda^2 = \frac{\pi}{G\rho}\left(c^2 + \tfrac{1}{3}\overline{u^2}\right)$$

$$= \frac{\pi}{G\rho}\left(\gamma\frac{k\theta}{m} + \tfrac{1}{3}\overline{u^2}\right), \tag{1}$$

where λ is the critical length for stability, c is the speed of sound in the medium, θ the temperature, m the mass of a gas molecule, and $\overline{u^2}$ the mean square velocity of the turbulence field.

First, we should like to point out that because of the slow change in density in this process, the temperature will not vary adiabatically, as in the case of the relatively high frequencies involved in most acoustic radiation, but rather will approximately obey a polytrope law of the form

$$\theta = \theta_0\left(\frac{\rho}{\rho_0}\right)^{\alpha-1}, \tag{2}$$

where α is adjusted to give the best fit to the theoretical equilibrium temperatures[3]. One finds approximately $0{\cdot}4 < \alpha < 1{\cdot}00$ in H_{I} regions and $1{\cdot}00 < \alpha < 1{\cdot}04$ in H_{II} regions. Thus γ should be replaced by α in equation (1).

Secondly, we should like to point out that expression (1) may be derived by some simple physical arguments. From the virial theorem one sees that it is the internal translational velocities of the molecules which oppose the gravitational forces. The kinetic temperature is defined as a direct measure of these motions. Thus, we define a 'turbulence temperature' Θ by

$$3k\Theta = m\overline{u^2}. \tag{3}$$

We also assume that

$$\Theta = \Theta_0\left(\frac{\rho}{\rho_0}\right)^{A-1}. \tag{4}$$

Now, without turbulence,

$$\lambda^2 = \frac{\pi k}{G\rho m}\,\alpha\theta,$$

so that $\alpha\theta$ is the quantity characteristic of the internal stability of the medium. To include the turbulence, therefore, we simply replace $\alpha\theta$ by $\alpha\theta + A\Theta$. We obtain

$$\lambda^2 = \frac{\pi k}{G\rho m}\,(\alpha\theta + A\Theta). \tag{5}$$

If we assume, after Chandrasekhar, that $\overline{u^2}$ is independent of time, while ρ is varying, then $A = 1$ and we have:

$$\lambda^2 = \frac{\pi k}{G\bar{\rho} m}\,(\alpha\theta + \Theta).$$

If $$c^2 \equiv \alpha\frac{k\theta}{m},$$

and is the velocity of sound with period less than the thermal relaxation time of the gas, then we may write

$$\lambda^2 = \frac{\pi}{G\bar{\rho}}\left(c^2 + \tfrac{1}{3}\overline{u^2}\right).$$

E. N. PARKER

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Salt Lake City.
Utah.
May 27.

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[2] Chandrasekhar, S., *Proc. Roy. Soc.*, A, 210, 26 (1951)
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FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, December 15

School of Pharmacy, University of London (in the Chemistry Lecture Theatre, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.30 p.m.—Dr. C. D. Darlington, F.R.S. "Genetics and Medicine".*

Society of Chemical Industry, Crop Protection Panel of the Agriculture Group (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5 30 p.m.—Mr. H. E Harbour: "The Chemical Control of Animal Parasites".*

Tuesday, December 16

Society of Chemical Industry, Agriculture Group (in the Chemistry Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S.W.7), at 2.15 p.m.—Dr. J. H. Hamence, Dr. N. H. Pizer and Dr G. W. Cooke: Papers on "The Determination of Phosphorus and Potassium in Acid Extracts of Soils".*

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 30 p.m.—Prof. Roger Russell "Experimental Studies of Hereditary Influences on Animal Behaviour".*

Oil and Colour Chemists' Association, London Section (at the Royal Society of Tropical Medicine and Hygiene, Manson House, 26 Portland Place, London, W.1), at 7 p.m.—Dr. D. F. Rushman: "Radio-chemistry in Paint Research"

Tuesday, December 16—Wednesday, December 17

Association of University Teachers (at Trinity College, Cambridge).—Meeting of the Central Council.

Wednesday, December 17

Royal Society of Arts (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Rt. Hon. Lord Merthyr: "A Reformed Calendar".

Geological Society of London (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

Royal Meteorological Society (at 49 Cromwell Road, London, S W.7), at 5 p.m.—Scientific Papers.

Royal Microscopical Society (at Tavistock House South, Tavistock Square, London, W.C.1), at 5.30 p.m.—Dr. Jean Hanson: "The Sub-Microscopic Structure of Muscles".

Institute of Fuel (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C 2), at 6 p.m.—Papers on "The Sulphur Content of the Flue Gases discharged from Power-Station Chimneys".

Thursday, December 18

Institution of Mining and Metallurgy (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers

London Mathematical Society (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr N. S. Hawley: "Functions of Several Complex Variables".

Society of Chemical Industry, Microbiology Group (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 6.15 p.m.—Dr. Arthur Hughes: "Aspects of Cell Life—Behaviour of Embryonic Cells in Tissue Culture".

Chemical Society (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Scientific Papers.

Society for Visiting Scientists (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Prof. S. Sambursky: "Science in Israel".

Thursday, December 18—Friday, December 19

Physical Society (in the Physical Laboratories, The University, Manchester).—Autumn Provincial Meeting on "Ionization Loss by Relativistic Particles".*

Friday, December 19

Biochemical Society (in the Department of Biochemistry and Chemistry, St Bartholomew's Hospital Medical College, Charterhouse Square, London, E.C.1), at 2 p.m.—Scientific Papers.

Institute of Navigation (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Brigadier R. A. Bagnold, F.R S: "Navigation on Land".

Saturday, December 20

Nutrition Society (in the Department of Biochemistry, The University, Sheffield), at 10 15 a.m.—Conference on "The Role of Vitamins in Metabolic Processes".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Botanist (male) (Pass degree in botany is essential) in the Field Investigation Department, to work on the determination of damage to grain and other seeds by mechanical harvesting—The Secretary, National Institute of Agricultural Engineering, Wrest Park, Silsoe, Beds (December 19).

Assistant Chemist at the Sewage Treatment Works, East Hyde—The Town Clerk, Town Hall, Luton (December 20).

Assistant Lecturer in Anatomy—The Secretary, University College, Gower Street, London, W.C.1 (December 20).

Principal Scientific Officer at the Propulsion Research Laboratory, Salisbury, South Australia, to be responsible for initiation and general supervision of research and development in the fields of general physics and instrumentation related to rocket propulsion research—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (December 20).

Lecturer and a Senior Lecturer in Anatomy—The Dean of the Medical College, St Bartholomew's Hospital, West Smithfield, London, E C.1 (December 31).

Principal Agricultural Economist and Head of the Agricultural Economics Department with the status of Reader—The Registrar, The University, Manchester 13 (January 13)

Science Studentships at the Military College of Science, Shrivenham—The Secretary, Ministry of Supply (Est 3 c), Room 510, Carlton Hotel, Haymarket, London, S.W.1 (January 14).

Agronomist (Ph.D. in agronomy, with specialization in soil fertility, is the minimum requirement)—The Secretary, Tobacco Research Board, P.O. Box 1909, Salisbury, Southern Rhodesia (January 15).

Chair of Physical Chemistry at the Institute of Cancer Research (Royal Cancer Hospital)—The Academic Registrar, University of London, Senate House, London, W.C 1 (January 15).

Senior Lecturer, a Lecturer, and a Fellowship (temporary), in the Department of Chemistry and Chemical Technology, University of Natal, Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 15)

Readership in Statistics at the London School of Economics and Political Science—The Academic Registrar, University of London, Senate House, London, W C 1 (January 20)

Chair of Electrical Engineering in Auckland University College (University of New Zealand)—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31)

Graduate Assistant (physiologist with knowledge of modern physical techniques, who would be interested in cardiovascular system)—Dr. G. S Dawes, Nuffield Institute for Medical Research, Oxford (January 31).

Lecturer in Civil Engineering at the University of Melbourne—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 31).

Assistant Director of the Commonwealth Institute of Entomology—The Secretary, Commonwealth Agricultural Bureaux, Farnham Royal, Bucks (February 28).

Assistant Lecturer (with an honours degree and interested in the physical aspects of biochemistry) to teach Chemistry and Physics, and to co-operate in the research work of the Scottish School of Bakery—The Secretary, Royal Technical College, Glasgow.

Assistant Lecturer (Grade A) to teach Physical Chemistry to B.Sc. and A R I.C. standard—The Principal. School of Technology, Tower Ramparts, Ipswich

Biochemistry Graduate (Ph D.) with experience in the enzyme field, to collaborate on research on the enzymes of developing red blood cells—The Regional Director, Blood Transfusion Service, Royal Infirmary, Edinburgh 1.

Botanist to assist in the preparation of Flora of Tropical East Africa at Royal Botanic Gardens, Kew—The Under-Secretary of State, Research Department (S 610), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1

Demonstrator in Botany—The Registrar, The University, Nottingham

Mechanical and Electrical Engineers for design, operation and maintenance of ground mechanical and electrical works services on R.A.F. and Civil Aviation stations, home and overseas—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.290/52A

Mechanical or Electrical Engineer (with a first- or second-class honours degree in mechanical or electrical engineering) at a Ministry of Supply Design Establishment at Chertsey, to investigate vehicle ride performance, including experimental determination of component stresses as found in fast cross-country vehicles, and vibration and noise characteristics as obtained during road and rig tests—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W 1, quoting C.690/52A

Meteorologists in the East African Meteorological Department—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting CDE.57/88/01.

Physical Chemist or Engineer (with a first- or second-class honours degree, or equivalent, in chemistry or engineering) at the Royal Aircraft Establishment, Farnborough, to take charge of small section engaged on research and development work on manufacture and properties of reinforced plastics, with special reference to nature, production and properties of reinforced fibres such as glass and asbestos—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S W.1, quoting F.756/52A.

Plant Pathologist (with a degree in natural science with training in plant pathology) to investigate diseases of coffee at the Coffee Research Station, Ruiru, Kenya—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/197.

Regional Trials Officer (with a degree in agricultural or natural sciences, with practical experience in crop production) in charge of the Institute's trials in mid-Wales, a Senior Technical Officer (with a degree in agriculture or natural sciences, with suitable practical experience or postgraduate training in research) in the Seed Production Branch, to work mainly on root and vegetable crops, and a Technical Officer (with a degree in natural sciences or agriculture and, preferably with some practical or postgraduate experience) in the Crop Improvement Branch, mainly in connexion with the testing of plant-breeders' material at the Seale-Hayne Trial Station—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge.

Senior Scientific Officer (with first- or second-class honours degree, and experience in organic chemistry or biochemistry) at the D.S.I.R. Food Investigation's Torry Research Station, Aberdeen, for work on the chemistry and biochemistry of extractives and volatile components in fish muscle that are responsible for flavour and odour in fresh, spoiling and cured fish—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.760/52A

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scottish Plant Breeding Station. Report (abridged) to the Annual General Meeting by the Board of Directors. Pp. 40. (Edinburgh: Scottish Plant Breeding Station, 1952.) [259

Reports of the Commonwealth Economic Committee. Thirty-sixth Report: A Survey of the Trade in Agricultural Machinery. Pp. vi+174. (London: H.M. Stationery Office, 1952.) 7s. 6d. net. [259

International Council of Scientific Unions. Report of the Executive Committee, 1951. Edited by F. J. M. Stratton. Pp. viii+108. (Cambridge: International Council of Scientific Unions, Gonville and Caius College, 1952.) [259

Philosophical Transactions of the Royal Society of London. Series A. Mathematical and Physical Sciences. No. 896, Vol. 245. A Table of $\sqrt{(\frac{1}{2}\pi)}e^{\frac{1}{2}\pi\rho^2}\int_{\rho}^{\infty}e^{-\frac{1}{2}\pi\lambda^2}d\lambda$ for Complex Values of ρ. By P. C. Clemmow and Cara M. Mumford. Pp. 189–211. (London: Cambridge. At the University Press, 1952.) 5s. 6d. [259

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Commonwealth Bureau of Animal Health. Review Series No. 3. Photo-sensitization in Diseases of Domestic Animals; a Review. By N. T. Clarke. Pp. vi+58+8 plates. (Farnham Royal: Commonwealth Agricultural Bureaux, 1952.) 7s. 6d. [259

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines under the Coal Mines Act, 1911, for the Year 1951. East Midland Division. Report by W. B. Brown. Pp. ii+30+6 plates. 1s. 6d. net. North-Western Division. Report by G. Hoyle. Pp. iii+28+6 plates. 1s. 6d. net. (London: H.M. Stationery Office, 1952.) [259

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Brompton Hospital Reports: a Collection of Papers recently published from the Hospital. Vol. 20, 1951. Pp. vii+196. (London: Brompton Hospital, 1952.) 12s. 6d. net. [710

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Journal of the Mechanics and Physics of Solids. (Quarterly, 4 issues a volume.) Vol. 1, No. 1, October. Pp. 76. (London: Pergamon Press, Ltd., 1952.) 90s. per vol. [710

Saqqara and the Dynastic Race: an Inaugural Lecture delivered at University College, London, 28 February 1952. By Prof. W. B. Emery. Pp. 12. (London: H. K. Lewis and Co., Ltd., 1952.) 3s. net. [710

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Bulletin of the American Museum of Natural History. Vol. 99, Article 7: Mating Behavior within the Genus *Drosophila* (Diptera). By Herman T. Spieth. Pp. 395–474. (New York: American Museum of Natural History, 1952.) 1 dollar. [259

Bulletin of the Bingham Oceanographic Collection. Vol. 13, Article 3: Hydrographic and Biological Studies of Block Island Sound. By Gordon A. Riley, Georgiana B. Deevey, Daniel Merriman, Ruth Sclar and Howard L. Sanders. Pp. 237. (New Haven, Conn.: Yale University, 1952.) 3.60 dollars. [259

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INTERNATIONAL SCIENTIFIC RELATIONS AND NATIONAL SECURITY

AN important chapter in the Berkner report, "Science and Foreign Relations", issued in 1950 by the International Science Policy Survey Group of the United States Department of State*, considered the controls over the international flow of scientific information, from the point of view both of persons and of material. Earlier in this report, stress was laid on the positive contribution to the advancement of science, as well as to the security of the United States, which resulted from the full and free interchange of scientists and technologists and of information, as had been earlier emphasized in the Steelman report, independent of its reminder that national security depends far more upon the total scientific potential than upon anything else. Considering, however, the negative aspect, that of the types of control over such interchange which might be desirable from the point of view of security, the Survey concluded that there was ample evidence that unnecessary restrictions existed on the flow of unclassified scientific and technological information, and that these restrictions were dangerous to the progress of science in the United States, affected adversely the conduct of foreign relations in science, and were therefore damaging to national security.

This Berkner report pointed out that visa regulations and their restrictive effect on proposed visits to the United States by foreign scientific men involved for any particular case a balance, within the limits of the immigration statutes, between considerations of security and other national interests, including considerations of international scientific relations. Unless, however, foreign scientists were permitted access to their American colleagues, either at international meetings or through individual visits, science in the United States lost the benefit of the potential contribution of foreign research and technical advances to its own. The Berkner report made no specific recommendations for change in practice: it was content to point to the dangers of the situation, particularly that of the creation of a furtive atmosphere in which the flow of information necessary to progressive science was halted. It did, however, also stress that the relation between internal security and exchange of technical information represents a balance of interest similar to that required in the visa situation. The conclusion was reached that no definite and positive controls of unclassified technical information are possible under the American system of government, and that it would be inimicable to the American way of life to attempt to control the use of information that is freely available to everyone. From this point of view it is asserted that the Department of State has a special responsibility for bringing to the attention of the Interdepartmental Committee on Internal Security the implications of security situations which adversely affect international scientific relations.

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* United States Department of State Publication 3860: Science and Foreign Relations. (General Foreign Policy Series 30.) Pp. viii+170. (Washington, D.C.: Division of Publications, Office of Public Affairs, 1950.)

Since this report was issued, several books have been published in which the whole question of secrecy and security regulations as it affects the progress of science has been discussed. The misgivings freely expressed by American scientific men regarding the procedures and practices current in the United States have frequently been framed in general terms which could be emphatically endorsed by their colleagues everywhere in the free world. It has been made abundantly plain that in their protests against the absurdities and excesses to which security regulations and procedures have been carried in the United States, American scientific men and other scholars have stood firmly and responsibly on those principles of intellectual freedom of investigation, of utterance and communication, which were written into the constitution of their country and are the fundamental condition of scientific advance.

Something less than justice has been done, on the whole, to the stand against the threat to intellectual freedom which has been made by men of science in the United States, both within and without the universities. That is one reason for welcoming the special issue of the *Bulletin of the Atomic Scientists* (8, 209; Oct. 1952), which is devoted to American visa policy in its relation to foreign scientific workers. Ultimately that policy, whatever its effects, is a matter for American scientific men and their fellow citizens, and there are details on which comment from outside would rightly be resented. The experiences of British, French and other European scientific men narrated by the individuals directly concerned are indeed purely factual, and in their range they show clearly the extent to which the policy is of international concern and is handicapping scientific work and communication generally. The survey includes the text of the relevant passages of the Internal Security Act of 1950, generally known as the McCarran Act. American comments are often critical but also constructive, recognizing as clearly as Prof. A. V. Hill, in his presidential address to the British Association, that complete abandonment of secrecy is out of the question and that some measures of control in the interest of security are inevitable. But this indictment by American scientific men and other scholars of their Government's policy and its execution cannot be read outside the United States without recognizing the courage and honesty required, in present circumstances, of those who framed it.

Any foreign comment on this issue must start by way of tribute to that courage and sincerity. That alone should dispose of any fear expressed by Prof. E. A. Shils in his editorial, "America's Paper Curtain", that this exposure will do more harm than good. Attempts to use such material against the United States are out of the question while it remains manifestly impossible for any corresponding protest against government restrictions or policy to be voiced behind the Iron Curtain. Against such risks the issue seems admirably designed to promote that formation of enlightened American public opinion which is the essential preliminary, either to the wiser execution of the present policy or to its modification in the direction they indicate.

Prof. Shils, in this editorial, points out that the survey has been confined almost entirely to scientific workers, with three illustrative instances from other fields of learning. It includes an account from Prof. L. Pauling of the Department of State's refusal of his request for a passport last February and its ultimate issue in July more than two months after the Royal Society discussion which he had originally proposed to attend. Prof. Shils comments that Prof Pauling's statement shows that the fundamental errors of the present policy are not due to legitimate concern with security, but are the manifestations of an underlying xenophobia and of an undue sensitivity to criticism. He is concerned that the refusal to allow foreigners to discuss unclassified scientific matters freely with American scientific men, and efforts to prevent American scientific men with no classified information from going abroad to meet European men of science, falsify the United States' claim to leadership in the defence of the free society of the West. Prof. Shils touches briefly but adequately on the more personal consequences of delay or refusal to issue a visa, against which it was necessary some years ago to protest in Great Britain also (cf. *Nature*, 156, 215; 1945). Any strain which he fears the present American policy is likely to place on the faith of overseas men of science in the soundness of a common cause with the United States should, however, be more than eased by the dignified protests made by Prof. Shils himself and by his fellow citizens such as Dr. A. Einstein, Prof. H. A. Bethe, Prof. H. C. Urey, Prof. J. Franck, Dr. A. H. Compton, Dr. W. P. Murphy and others. Incidentally, this number should remove any misgivings as to the attitude of American men of science that may have been read into Dr. D. W. Bronk's address to the British Association in Belfast last September.

Prof. Shils's argument is, however, mainly that the McCarran Act impedes American efforts to block the Communist attempt to dominate the mind of Europe and to break the North Atlantic Treaty Organization, and that it also weakens the security of the United States itself. International scientific organizations, he points out, are already beginning to avoid arranging meetings in the United States with a loss to science in the United States which no expenditure or apparatus can replace. Free informal contact, the exchange of impressions and interpretations, and the comparison of results and procedures in face-to-face conversations retain all their advantages and are indispensable.

These points are reiterated in a report prepared by a Committee of the Federation of American Scientists of which Prof. V. F. Weisskopf was chairman. The report, however, merely makes the points that the present visa policy is contrary to the fundamental principles of American political philosophy, that it is harmful both to science in the United States and to scientific life in Western Europe and that it is seriously weakening the position of the United State abroad: no concrete proposals are advanced, however, for the revision of the Internal Security Act and the Immigration and Nationality Act, both of which, it may be recalled, were vetoed by President Truman and sustained by Congress over his veto. Prof. Shils, after remarking on the need for consular officers responsible for decisions about visas to be more realistic and better informed, makes several definite suggestions, which in essence amount to a plea for a return to common sense and to common humanity which might be noted and heeded in other countries besides the United States. In particular, Prof. Shils suggests that the law should be changed so that those who have not been members of Communist groups for the past five years should be able to enter the United States for scientific purposes; and he protests against the absurdity of applying the same rigorous criteria to a visitor for a few weeks or months as to a prospective permanent resident or citizen, as is done by the present law. Equally he argues for a more particularized defence against alien subversives and less diffuse fear of foreigners and of scientific men. Both the law and legislators should permit administrators to free their minds from the constant and obsessive pre-occupation with Communist subversion whenever they deal with a foreigner or a scientific worker. Consuls should be given discretionary powers to grant, as well as to refuse, visas, and be expected to use them.

The most encouraging feature of this review is the emphasis on positive measures. It is recognized that full provision must be made for counter-intelligence and security services. No countenance is given to the doctrine, which was condemned forthright by Prof. A. V. Hill, that the freedom of conscience, which is the first condition of freedom, for the scientist as for any other citizen, extends to the giving away of other people's property, whether of goods or knowledge. Implicit in the survey is the belief that scientific men are loyal and can be trusted, and the whole issue may be taken as a considered attempt to dispel the distrust of the educated and the suspicion of the scientist which are clearly preventing the reasonable working of even existing regulations and policy.

The existence of certain anti-scientific trends, which are partly responsible for the present timidity of consular officials in granting visas, is as manifest in this survey as in the address on that specific subject which Prof. Kirtley F. Mather delivered at the annual meeting of the American Association for the Advancement of Science in December 1951 (see *Science*, 115, 533; 1952), and is indeed one reason why this issue of the *Bulletin of the Atomic Scientists* is of general interest. These trends are not confined to the United States. They are to be found in Britain also and are of increasing importance as the dependence of scientific research upon public funds for support rather than upon independent or private endowments continues to grow. They are responsible, too, for the misunderstandings and uninformed judgments which sometimes hinder the furtherance of scientific work in Great Britain.

Prof. Mather, like Prof. Hill, sees that in the practical world of to-day complete abandonment of secrecy, in government and in industry, is out of the question. The limits of such secrecy have to be determined as a matter of practical policy by honest and courageous effort, and the first steps in that direction for American scientists have been indicated by Prof. Mather and now by Prof. Shils and others.

These measures have their implications for scientific men elsewhere. It is not sufficient to acknowledge the courage displayed in these protests against illiberal practice and policy. The convictions on which they are based are shared by men of science everywhere, and the Jefferson dictum quoted by Prof. Mather, "We are not afraid to follow truth wherever it may lead, nor tolerate error as long as reason is left free to combat it", echoes the earlier words of Milton: "who ever knew Truth put to the worse in a free and open encounter?" And men of science in Great Britain too must realize, as Prof. Hill reminded them, that the prestige of science is not their personal property, but a trust which they have an obligation to pass on uncompromised to their successors.

This issue of the *Bulletin of the Atomic Scientists* represents, in fact, a step in a campaign of public education directed specifically, as Prof. Mather suggested, against what appears to be a well-organized attempt to paralyse all independent thought, discussion, dissent and protest in the United States. The extent to which in recent Parliaments in Britain independent opinion has been excluded is sufficient reminder that a like danger exists here also, and that British scientific workers must take their share in the task of educating public opinion as to what is required if a free society is to continue. Neither science itself nor a free society can long flourish in the climate of fear and negation against which this American protest is directed.

To place confidence in scientific security is, as Mr. H. A. Wallace told President Roosevelt's Cabinet, to rely on the imagined security of a Maginot Line. Only such a dynamic and positive policy as the Steelman Committee visualized can provide an adequate basis for security; but to achieve such a policy demands both public understanding of the nature of scientific and technological advance and confidence in the scientist and technologist. With the work of education involved in this first task must go an attempt to repair whatever shocks public confidence has undoubtedly received from recent episodes. This question of professional loyalty seems to be worth a little closer attention by professional bodies, as indeed seems to be implied by Prof. Hill's remark in his presidential address to the British Association; and while it may be of some interest and profit to discover the real causes of the exceptional failures in loyalty, whether to a professional tradition or scientific discipline or to a community, it is imperative to satisfy the community of the basic loyalty of the overwhelming majority of scientists and technologists.

That is one step towards establishing the full understanding and confidence which can deprive present anti-scientific trends of their real power. Clearly it is one which could well be taken even more effectively by joint action between British and American men of science, as was indeed suggested by Dr. J. B. Conant in his Stevenson Memorial Lecture last March. It is perhaps curious that this issue of the *Bulletin of the Atomic Scientists* is so preoccupied with the exclusively American aspects of visa policy that no attention is given to the wider aspect of the secrecy question and the suggestion for Anglo-American co-operation made by Dr. Conant. It may be hoped, however, that this indication of the extent to which scientific opinion in the United States and in Britain is in line on the issue of the interchange of knowledge and the problem of secrecy in relation to security will give a fresh impulse to a co-operative attempt to find a satisfactory solution to problems as yet unresolved in either country, which in essence are a particular aspect of the general one of power and responsibility. As Dr. J. Bronowski insisted at the Present Question Conference in 1951, it is a responsibility of the scientist to-day to become a teacher to the whole community, so that society learns to understand the implication of his work. Only when that task is discharged with imagination can society wisely exercise its own responsibility, directing its policy towards ends which turn to good, and entrusting the execution of its policy to those who will do so with courage and with wisdom.

LINNÆUS REDIVIVUS

Carl Linnæus

By Knut Hagberg. Translated from the Swedish by Alan Blair. Pp. 264+4 plates. (London: Jonathan Cape, Ltd., 1952.) 18*s*. net.

Svenska Linné-Sällskapets Årsskrift

Arg. 33–34, 1950–51. Pp. iii+188. (Uppsala: Almquist and Wiksell, 1951.)

ACCORDING to the publisher, inspired doubtless by the author himself, this work has not been written for the specialist, nor does it aspire to be a normal biography following traditional lines. Rather is it an analysis of the outstanding personality of the "greatest rational and consistent scientific genius that Swedish cultural history has known". It is claimed that Linnæus was not only a great botanist, but also that he excelled as a philosopher and a master of his own language, whose purpose it was to standardize a system of botany consistent with a designed and orderly creation by the Deity. This, says Linnæus, was possible by a study of Nature herself, but was not deducible from books.

Knut Hagberg's restrictions of the scope of his work are not always conducive to a just understanding of Linnæus's contributions to biology. Thus, in the section on "Floral Nuptials", the lay reader will not be able fully to assess Linnæus's attitude towards this very important matter, nor will he gather what was his contribution to the discovery of the facts and the part he played in accepting and exploiting them in his schemes of classification. It is to be noted that Sachs, a great and not always a just and fully informed critic, while asserting that Linnæus added nothing new to the sex theory of plants, allows that he contributed essentially to its recognition, and thus acquires an overwhelming importance for the skilful way in which he gathered up all that had been done before him and fused together the scattered acquisitions of the past. This, Sachs concludes, is the great and characteristic merit of Linnæus. It is unfortunate, as Hagberg regretfully admits, that "Linnæus would never have admitted his debt to a predecessor. Such was his disposition and we must bear with him".

Linnæus's study of Nature exposed some startling and distressing anomalies, which he accepted without attempting to explain, or even realizing that some explanation was expected of the philosophic naturalist. For example, in his paper on the 'gadfly' (= warble fly, *Oedemagena tarandi*), which attacks the reindeer, he is full of admiration for the skill exhibited by the Creator in adapting the insect to a complex life-history of merciless parasitism, but has no thought or pity for the miseries endured by the tormented reindeer, which, none the less, he describes in detail. Such examples of the ruthless struggle for existence, in which he believes that some species have been specifically created for the torment and destruction of others, appeal to him only as glorious spectacles of the wisdom of God, and he views with reverent but unsympathetic enthusiasm the existence of poisonous snakes as masterpieces of the wonderful power of the Creator. He had evidently no conception of the possibility that inflexible natural laws, acting mechanically on plastic material, would produce a fortuitous medley of living organisms.

The views of Linnæus on evolution begin in 1751 with the statement of 'fact' that the number of species now existing is the same as that created at the beginning of the world. Later, however, he came to accept that species and genera were the products of time, but continued to hold that the natural orders were the works of the Creator. This does not mean that he had hit upon the idea of evolution, since he maintained that the emergence of new forms would of necessity result from the incidence of cross-breeding. However, albeit with some reluctance, he no longer denies that new species have, in fact, arisen in time. This marks the complete abandonment of his original conception of species. What he considered he had discovered was the *plan* of the creation. To quote his own words: "God has suffered him to peep into his secret cabinet. God has suffered him to see more of his created work than any mortal before him. God has endowed him with the greatest insight into natural knowledge, greater than any has ever gained. The Lord has been with him, whithersoever he has gone, and has exterminated all his enemies for him, and has made of him a great name, as one of the great ones of the earth". Hagberg's comment on such naive and frank manifestations of our egocentric is: "Linnæus was not one of those who doubt themselves or the significance of their achievements. It would be hard to find more unstinted admiration of his importance than that he himself expresses in many places . . . the thought is always there that God's blessings towards him have indeed been justified".

There are many passages in this original and deeply interesting study which would call for notice if space were available, but a few others need revision or correction. Among the latter is the statement that Thomas Bewick owes something to the literary style of Linnæus. The text of Bewick's works was written by Ralph Beilby, except that, when Beilby broke away from the partnership, Bewick had to write the text of Part 2 of the "Birds" himself. He did this of necessity and with many misgivings, and it is difficult to discover in the result any traces of the influence of Linnæus. Again, Hagberg's description of Clerck's work on Swedish spiders as a "lovely book whose pictures are an abiding source of joy" makes one wonder whether he is acquainted with those classic illustrated texts of zoological literature to which alone such an encomium can reasonably be applied.

The lack of an index is to be regretted.

F. J. COLE

THE IRIS IN THE SOUTHERN HEMISPHERE

The Iris and Its Culture

By Jean Stevens. Pp. 168+20 plates. (Melbourne and Sydney: Lothian Publishing Co. Pty., Ltd., n.d.) 45*s*.

IN Britain lovers of the iris are generously provided with works of reference. Apart from W. R. Dykes's large monographic study of the genus, still the standard work and long likely to remain so, there are his shorter works and numerous papers on the culture and breeding of these plants, and, as recently as 1950, Mr. N. Leslie Cave's very informative and practical handbook. The needs of American iris growers in large measure have been met by the American Iris Society's publication in 1947 of a comprehensive treatise, "The Iris, an Ideal Hardy Perennial", and by the late Prof. Sydney Mitchell's "Irises for Every Garden".

No such works have been available for growers of the iris in the southern hemisphere, where, because seasons and conditions, and consequently horticultural practice are so different, growers cannot use profitably much of the information contained in books concerned with culture in the northern hemisphere. Thus an authoritative statement, especially a cultural statement, on this genus as it is grown in New Zealand and Australia has long been desirable and at last has been made by Mrs. Jean Stevens, the federal president of the Australian and New Zealand Iris Society and the first president of the New Zealand Iris Society, and who for more than twenty years has been a successful cultivator of the numerous species of this genus, and a noted breeder with an international reputation of the more numerous garden hybrids, especially the tall bearded irises.

"The Iris and its Culture", therefore, is the first handbook on irises to be written for gardeners in New Zealand and Australia, and as such it is eminently suited to its purpose. One half of the book is devoted to a classification of the genus and to a description of the various species from a horticultural point of view. In a country such as New Zealand where, apart from privately owned copies, Dykes's monograph apparently is available only in the County Library Service in the South Island, specific descriptions of some kind obviously are essential. These descriptions, however, are no mere rehashes of those of Dykes, but are written from personal observation and experience, for the author has grown and flowered almost all the species discussed. As a result of the information of intense practical value which is woven into this enumeration of the species in their various groups, readers will not be tired and irritated (so often the reaction of the practical gardener to species descriptions) by this section of the book.

The rest of the book—the first seventy-five pages—in the main is concerned with the history, breeding and cultivation of the hybrid bearded irises which have been bred for more than a century, have been popular with many growers for some twenty to twenty-five years and which, due to their vast improvement in colour, form and substance, during the past ten years or so have rushed meteorically to the forefront of gardening in both hemispheres. Because most of the emphasis on iris growing to-day is on the bearded irises, and because Mrs. Stevens can speak authoritatively (she is recognized as one of the foremost breeders of bearded irises in the world, and with her irises Pinnacle and Summit has raised the first white and yellow bicolours – white standards and yellow falls), one does not feel that to devote one half of the book to this group of plants is to give them much greater prominence than their position in the genus merits. The reviewer does feel, however, that the author could have elaborated her two chapters on the breeding of the bearded irises to the extent of introducing and explaining such terms as diploid, tetraploid and polyploid. By so doing, the true significance of the year 1900 in the evolution of the tall bearded iris could have been made plain. All hybrid bearded irises raised up to 1900 were diploids, and their parents were the tall-stemmed blue-violet flowered *Iris pallida* from Dalmatia and the short-stemmed yellow flowered *I. variegata* of the Balkans, and some of their natural hybrids such as *I. squalens*, *I. neglecta*, *I. plicata*, *I. amœna*, etc. In 1900, the Asiatic species *I. cypriana*, *I. trojana* and *I. mesopotamica*, all large-flowered and tall-growing, and all of them tetraploids, were introduced into Britain and were used more and more in breeding. As a result, by 1915, 33 per cent of the hybrids in Britain were tetraploids; by 1920, 45 per cent were tetraploids; by 1930, 75 per cent were tetraploids, and by 1940 there was scarcely a diploid tall bearded iris.

As for the illustrations of Mrs. Stevens's book, only some of the sixteen monochrome plates are good, and even though the best of them give some indication of the colour patterns of the flowers, none gives any idea of the actual colours or of the flower texture. More colour plates of the calibre of the frontispiece illustrating many of the colour forms of *I. innominata* or of *I. gracilipes* would have enhanced the book greatly—though perhaps at the same time have increased considerably the published price, which even at 45*s*. those in Britain who are interested in the genus are likely to regard as somewhat prohibitive.

H. R. FLETCHER

ANTHROPOLOGY DURING THE PAST CENTURY

A Hundred Years of Anthropology

By T. K. Penniman; with Contributions by Beatrice Blackwood and Dr. J. S. Weiner. (The Hundred Years Series.) Second edition, revised. Pp. 512. (London: Gerald Duckworth and Co., Ltd., 1952.) 30*s*. net.

THIS work is up to p. 344 a reproduction of an earlier work which was first published in 1935. The publisher's claim printed on the dust-cover that it reappears revised is not confirmed by the author, who speaks of photographic reproduction with minor emendations. There remain to review here its final pages, which discuss the subject of anthropology since 1935.

The section on prehistory and technology in the Old World, pp. 345–375, records considerable progress in Near-Eastern archæology since 1935, gives an account of the titles of the main works concerned and sometimes adds a few sentences indicating the general nature of their contents. There are interesting accounts of methods employed in dating archæological discoveries. The author only lapses into speculation, however, when he suggests that, if all modern inventions were lost, those made in the Near East about the fifth millennium would still make the good life possible, and when he asserts that prehistoric art was done partly for art's sake and partly to aid the artists to control the incalculable in life.

There follows a survey of physical anthropology since 1935 written by J. S. Weiner (pp. 376–412). Weiner mentions, among other matters, that it still remains for the physical anthropologist to demonstrate in the field how the biological properties of a community and its social organization are interrelated. He tends to over-emphasize the comparative importance of the study of discontinuous variation, on the grounds that the gene systems underlying blood groups are known, whereas the study of continuous variation by 'traditional' anthropometric measures uses phenotypic criteria the genetic bases of which are unknown.

Miss Beatrice Blackwood gives an account of Americanist studies (pp. 412–40), which is adequate except that it omits sociological and psychological studies of the American Indian from review, and refers the reader to a bibliographical paper published elsewhere for titles of such studies.

The final fifteen pages of text on general ethnology and social anthropology list some titles of books, and lay disproportionate stress upon such purely occasional papers as a bibliographical Americanist paper by Betty Meggers and a chapter in "The Development of Scientific Thought in the Twentieth Century", edited by A. E. Heath, by Meyer Fortes. The works of Margaret Mead, which are internationally known for their value, are not mentioned. Otherwise these pages are mainly concerned with a difference of opinion of small importance between Radcliffe-Brown and Evans-Pritchard. Radcliffe-Brown considers that sociology will yet become a natural science; Evans-Pritchard points to an absence of laws of social organization discovered to date, represents himself as a "functionalist seeking a new orientation", and in common with Radcliffe-Brown ignores the possibility of knowledge of social psychology. There is a long résumé of a single lecture by Evans-Pritchard, but the works of Peristiany, Nadel, Gluckman, Hunter, Kuper, Godfrey Wilson, Hallowell, Embree, Oliver and many others are completely overlooked. Since there is no evidence of similar loss of proportion or failure of good judgment in the preceding three sections of the book reviewed, the author's more than ordinary concern here that the works of a few persons now or recently at Oxford should be given such prominence is all the more remarkable. The result is not a judicious appraisal.

About psychological studies, it has been said that anthropologists who discuss topics of the nature of motivations and attitudes attempt to explain social phenomena in terms of individual psychology; but the social anthropologist and the psychologist study different kinds of phenomena—the former social systems, and the latter psychical systems—and what one studies cannot be understood in terms of conclusions reached by the other. It has also been said that those who study topics of the nature of motives and attitudes avoid the real work of ethnology as drastically as those who study nothing but social organization, and explain what they study in terms of the functional efficiency of organization in maintaining itself. These criticisms are actually not substantial, since knowledge of any still-existing society depends absolutely upon knowledge of individuals who are in that society or who share that culture. The ethnological or social anthropologist critic owes his own knowledge of still-existing peoples to the study of individuals in disregard of antitheses between individual and society, organism and environment, personality and social structure, at least until the last minute when he begins to write down what knowledge he possesses. R. F. FORTUNE

EXPERIMENTAL METHODS IN ARABLE HUSBANDRY

The Practice of Arable Crop Experimentation

By P. N. Harvey. Pp. vii+79. (Norwich: Norfolk Agricultural Station, Sprowston, 1952.) 6s.

IN the literature of agricultural experimentation the statisticians are much more in evidence than the field workers; but no matter how ingenious and adequate statistical methods may be, their practical value in dealing with agricultural problems largely depends on the common sense and skill of those who handle the experimental operations on the farm. As soon as crop trials became something more than rough yield comparisons between treated and untreated halves of the same field, some sort of technique became necessary, and this has been developed during the past thirty years both to meet the needs of the newer experimental designs and to reduce working errors. The people responsible for this have been the field supervisors and farm managers of experimental farms, with the statistician available to advise on matters of principle. The methods developed, although recorded in scattered memoranda and papers, have not been widely published, and it is here that Mr. P. N. Harvey's book makes a useful addition to the literature.

The Norfolk Agricultural Station at Sprowston was well established when the new experimental designs began to be introduced in the early 'twenties, and it was quick to adopt them in its studies of crop husbandry. Mr. Harvey puts on record the field methods that have been gradually built up and developed at the Station for experiments on arable crops. The operations are described in detail with the drawings that are necessary to make the procedure intelligible. The subject-matter covers the choosing of land, the marking out and sowing of plots, and the harvesting and sampling of cereals and roots. The procedure adopted for harvesting plots by combine, a recent development of great promise, is dealt with at length. There are also sections dealing with the application of fertilizers and the calibration of seed and manure drills

There is no finality in these methods, and field experimenters, now an increasing company, are recommended to read this book, for it will provide a basis on which to review and, in many instances, to improve their own procedure. For students it is an excellent introduction to the subject.

ACCURACY AND SENSITIVITY OF THE HUMAN EYE

By Dr. M. H. PIRENNE and Dr. E. J. DENTON

Physiology Department, Marischal College, University of Aberdeen

It is well known that the sensitivity of the human retina is so high that a few quanta absorbed by the retinal photoreceptors can initiate a visual response[1–4]. We wish to show here that this finding, obtained in special laboratory experiments, is also valid for ordinary vision over a wide intensity-range up to daylight intensities sufficient to give accurate form vision. In this range the finest details visible are almost as fine as they could possibly be in terms of the amount of light absorbed by the photoreceptors. Visual acuity and retinal sensitivity are here linked together, reaching almost to the natural limit set by the quantum properties of light.

A large continuously exposed field, emitting light of wave-length 0·51 μ, can just be seen by the dark-adapted eye when it produces[5] a retinal illumination of about 30,000 quanta cm.$^{-2}$ sec.$^{-1}$. (This and all subsequent values for retinal illumination are uncorrected for the light losses in the eye media, the extent of which is not known with a high degree of certainty[7].) The above illumination corresponds approximately to one quantum striking a given rod on the average every 1,000 sec., a fine retinal rod (or central foveal cone) being 2–2·5 microns in diameter[8].

It follows that, at an intensity-level 10^5 times above threshold, about 100 quanta strike a given receptor, rod or cone, every second. Only a fraction of such quanta are absorbed by the photoreceptors. Absorption by visual purple, the visual pigment in the dark-adapted rods, is probably of the order of 10 per cent. In the case of the cones, about the pigment of which little is known, it is generally believed that the absorption is lower than, or at the most equal to[8], that in the rods. Thus at an intensity 10^5 times threshold a rod absorbs about 10 quanta per second, a central cone possibly less. Therefore, as Baumgardt[9,10] has emphasized, even at high subjective levels of illumination, we are dealing with chemical reactions of a very special kind, the photochemical side of light-adaptation due to the bleaching of visual pigments being probably unimportant since the number of quanta absorbed is so small in comparison with the number of pigment molecules in the photoreceptors.

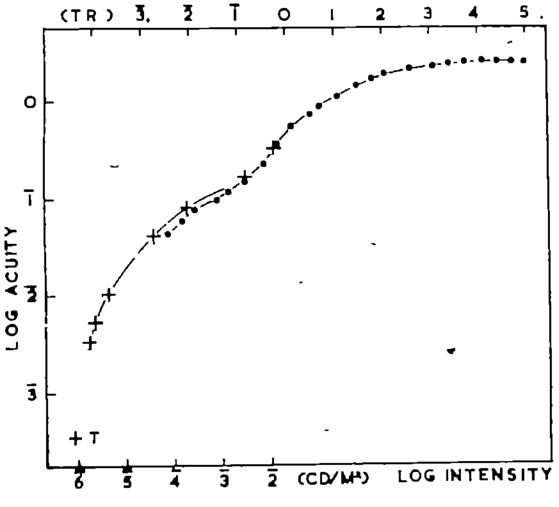

Fig. 1. Variation of visual acuity with light intensity. Acuity and intensity are both plotted on logarithmic scales. The upper scale gives the retinal illumination in trolands. One troland (0 on the log scale) corresponds to about 20 quanta of the most effective wave-length striking a retinal area 2 microns in diameter per sec. The lower scale gives the field intensity in candles per square metre. The point *T* represents the threshold intensity for a field 50° in diameter. The lower part of the curve up to about 1̄ (tr.) corresponds to peripheral (rod) vision; the upper part, from 0·5 (tr.), to foveal (cone) vision; the intermediate region to parafoveal vision. (+, unpublished measurements by M. H. Pirenne; ●, measurements by Shlaer, ref. 11)

Change of Visual Acuity with Intensity

With increasing light intensity, the ability of the eye to distinguish detail generally increases until it reaches a maximum value. Fig. 1 shows the results of experiments upon visual acuity made using black Landolt test objects (Fig. 2) upon an illuminated background. Visual acuity is defined as the reciprocal of the angle, in minutes of arc, subtended at the eye by the gap *a* of the smallest Landolt C which can be discriminated.

At any given illumination it is possible to calculate, from the data given in Fig. 1, the number of quanta which fall per second into the retinal image of the gap *a* of that Landolt C which can just be discriminated. For example, when the visual acuity is equal to unity, the gap *a* subtends an angle of 1′ at the eye, the retinal image of *a* is 4·85 μ square, the minimal illumination necessary is about 130,000 times the absolute threshold, and the retinal area corresponding to *a* receives (for the most effective wave-length) about 900 quanta per second. The results of similar calculations are tabulated in the accompanying table.

It is seen that for a wide range of acuities, from 0·01 to 1, and of intensities from 5 to 10^5 times the absolute threshold, the intensity of light striking the retinal image of the smallest detail detectable is of the order of 140–900 quanta per second.

Now the retina does not sum up the action of light over long exposures like a photographic plate. There

Acuity	No. of quanta falling into the gap *a* per sec.
0·003	1,200
0·01	270
0·03	138
0·1	270
0·3	780
1·0	890
1·6	2,240
2·0	5,600
2·4	120,000

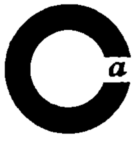

Fig. 2. Landolt test object. The letter *a* is added here merely to designate the gap in the broken ring; test objects used for acuity measurements do not contain it

is a maximum duration over which such summation can take place. For small areas in the periphery, the 'retinal action time' corresponding to complete physiological summation is about 0·1 sec. For larger areas it is shorter; but it is followed by an important period of incomplete summation[12]. For cone vision, the action time is apparently shorter than for the rods[13]. The value 0·1 sec. may thus be taken as an estimate of the retinal action time. In this connexion it will be borne in mind that, in the normal use of the eye, the eyeball moves in saccadic fashion, the retina generally taking a succession of discrete 'snapshots'[14,15] each with an exposure of the order of 0·2 sec.

Taking 0·1 sec. as unit time, the values of the amounts of light striking the gap *a* become 14–90 quanta. Now, experiments performed under special conditions by Hecht, Shlaer and Pirenne showed that, in order to be just visible to the dark-adapted subject, a flash of light must contain a nominal number of quanta of about 100 (54–148 quanta, at the cornea, depending on the subject[1,2]). The light, of wave-length 0·51 μ, was made to fall in the peripheral retina, 20° from the fovea, and came in a 0·001-sec. flash, from a test field subtending 10′ at the pupil. According to the experiments of Graham and Margaria[12], made 15° from the fovea, the threshold value, using the same time of exposure, would be almost the same for larger fields, up to 1° in diameter. For a 10′ field and a 0·1-sec. flash, the number of quanta necessary would be about 150; for 1° and 0·1 sec. it would rise to about 200. The quantities of light striking, per retinal action time, the retinal image of the smallest detail detectable, are therefore of the same order as those corresponding to the absolute threshold measured with a flash at the cornea of the eye. (They appear to be somewhat lower than the quantities corresponding to a flash, but the accuracy of the present calculations is not sufficient to prove that this difference is genuine. The upwards trend from acuity 0·01 to 1 in the values of the second column of the table should be regarded with the same caution.) We may conclude that the part of the retina receiving the image of the gap *a* can scarcely be excited above its absolute threshold under the conditions considered here. In the flash experiments, on the basis of various direct and indirect calculations, it is generally taken that the minimum number of quanta which must be *absorbed* by the retinal receptors for a threshold stimulation lies between 2 and 10 per flash[1–4]. Similar numbers of quanta must be absorbed here by the receptors receiving the image of the gap.

These calculations would be seriously in error only if effective light absorption by the cones were markedly higher than by the rods, which seems very unlikely. At the present stage, however, particularly because the properties of the cones are still imperfectly known, it is scarcely possible to determine the exact intensity-level at which the absolute threshold of the region corresponding to *a* is definitely passed. At the highest intensities, acuity is limited by other factors, including the wave properties of light[11,16].

Retinal Units

It would be impossible for each rod and each cone to act as an independent retinal unit, because the number of rods (120 million) and of cones (6 million) greatly exceeds the number of independent paths available in the optic nerve (1 million nerve fibres)[17,8]. It is known from anatomical studies that the retina contains bipolar or ganglion cells making connexions with greatly varying numbers of receptors, from tens of thousands of rods in the periphery to single cones in the fovea[18,19]. In many cases, rods and/or cones must function as compound units connected to one optic nerve fibre, as observed electrophysiologically in animal retinae[20–23].

Now, at a given level of illumination the areas of the retinal units used for discriminating a Landolt C cannot have diameters much greater than the size of *a*, the gap in the C which can just be discriminated. Otherwise the shape of the ring itself, the diameter of which is only 5 × *a*, could not be seen, whereas it is found that the shape of the ring always becomes visible at an intensity less than that necessary to see the gap. Since the retinal image of the just discriminated gap becomes smaller with increasing intensity, and since the size of the functional units must approximate to the size of this image, it follows that the retina must work in smaller and smaller functional units as the retinal illumination increases. It is known that the region giving the most accurate vision of detail shifts from the periphery to the parafovea and then to the fovea as the light intensity increases[11]. This is a movement to areas of the retina containing receptors organized in progressively smaller groups[18,19].

The following general explanation suggests itself. The sensitivity of the smaller units is lower in terms of retinal illumination because they are made up of fewer receptors, and perhaps because their constituent receptors (cones) are less sensitive. At any given intensity that retinal region is chosen which provides the finest mosaic of retinal units capable of working at this intensity. If the intensity were higher a mosaic of smaller units would be active in a more central region of the retina; but at the level considered, these units are not functioning because their absolute thresholds are not reached.

Organization of the Retina

Even in a given, constant, region of the retina, visual acuity increases considerably with increasing intensity, until it reaches a maximal value characteristic of the region chosen. Now, every retinal region contains ganglion cells connected to varying numbers of receptors and thus forming retinal units of various sizes[18,19]. Here, again, it is reasonable to think that the increase of acuity is due mainly to the coming into play of smaller and smaller units. Further, it is likely, because the threshold values are so low, that all the receptors are shared in common by functional units of different sizes. The following theoretical scheme gives a concrete illustration of this idea; to simplify the argument, only two groupings of rods are considered (Fig. 3). Consider 40,000 neighbouring rods connected to one single ganglion cell and optic nerve fibre. These rods form

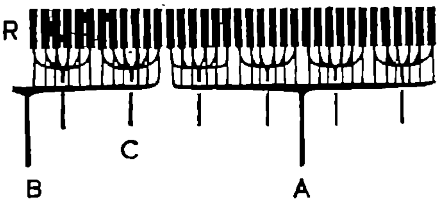

Fig. 8. Diagram of suggested retinal connexions. A large functional unit, *A*, and part of another, *B*, are shown. The same receptors *R* which form *A* and *B* are also connected in a different way to form smaller units such as *C*. At sufficiently high intensities, the small units absorb enough quanta to respond ; but at low intensities they do not, only large units summating enough light to remain active

one functional unit about 0·6 mm. in diameter on the retina, subtending a visual angle of 2°. Suppose the same group of rods is subdivided into 100 groups of 400 rods, each group being again connected to a separate ganglion cell and nerve fibre. In order to stimulate either the large unit or any one of the small units, a minimum of 6 quanta must be absorbed in the corresponding receptive field during a retinal action time of 0·1 sec. When the mean total number of quanta absorbed by the large unit is, for example, 10 quanta, the threshold of this unit will generally be passed and the unit will be active. But the small units then receive only an average of 0·1 quantum each, and remain generally inactive. If the retinal illumination is increased 100 times, however, the absolute threshold of the small units will be reached. Thus, without any switching mechanism to change nervous connexions in the retina, a finer mosaic of retinal units will automatically come into play when the intensity is increased.

At intensities near the absolute threshold for large fields, only the largest peripheral retinal units, which are indeed of the order of 2° in diameter[24-27], can be excited. Moreover, there must be a lower range of intensities in which even they are not all excited[28], since there is an intensity-range over which it is uncertain whether a retinal unit will respond or not. This uncertainty is an empirical fact of observation ; it is explainable to a large extent on the basis of the purely physical fluctuations of the stimulus itself, but there may also be biological variations of sensitivity[1-5]. On account of this uncertainty of response, and of possible threshold differences from unit to unit, the number of units active increases with intensity until all are excited. As this recruitment progresses, the unstimulated gaps between active units become smaller and eventually disappear. The retinal mosaic formed by the large units thus becomes functionally finer, up to a point, and visual acuity increases with intensity. Experiments on the visibility of black disks presented 20° from the fovea in the middle of a large field exposed in flashes gave results in agreement with this theory[24]. At a level about ten times the absolute threshold all the large units are active, the first branch of the acuity-intensity curve ending as a small plateau at an acuity value of 1/120. Then a break occurs and the curve rises again. Special measurement in the transition region showed that the break is genuine. By using blue light instead of white, it was also shown that the second branch is not due to cone vision coming into play but, like the first, to rod vision, for the relative position of the two branches is unaffected by the change of spectral composition of the light.

At higher intensities a similar recruiting must occur among the smaller functional units. Thus, as intensity increases from the absolute threshold to an intensity about 10^5 times higher, there is first a recruitment of large retinal units, very sensitive in terms of retinal illumination, but forming a very coarse mosaic giving only rudimentary form vision. Then this mosaic is progressively superseded by finer mosaics made up of smaller functional units, the *absolute* threshold of the various units being reached successively as the retinal illumination increases. At a certain level, cones may co-operate with rods in retinal units, particularly in the parafovea[18]. In the fovea, according to Polyak[19], cones are similarly arranged in units of different sizes, the ultimate units consisting of single cones.

The curve of Fig. 1 shows only the two main branches corresponding to rod and cone vision. Inside each branch, there is no break such as has been observed in the above experiments when fixation was used. This is most probably due to the fact that the retinal region changed progressively, the subject using the best part of his retina at each intensity.

Conclusion

Thus the absolute threshold of the smallest and least sensitive light detectors of the retina, namely the single-cone units, is probably reached only at intensities 10^5 or 10^6 times the absolute threshold for large fields—at somewhat lower intensities they generally absorb no light at all. It is in the range below this intensity-level that the major variation in such visual functions as acuity and intensity discrimination takes place. At any level within this range, the retinal units giving the best acuity performance must work in an all-or-none fashion, and the progressive recruitment of units explains the increase of acuity with intensity. It will be noted that, under such threshold conditions, nervous interaction between units (leading, for example, to phenomena of contrast) can play but little part.

The present theory takes up theories and suggestions from Hecht[29,30], von Buddenbrock[31] and Lythgoe[32]. We are indebted to many friends and colleagues for discussions and wish to thank particularly Dr. W. S. Stiles and Dr. W. A. H. Rushton. We are also grateful to Prof. A. V. Hill for his encouragement and unfailing help over many years, to Sir Frederic Bartlett, in whose laboratory experiments leading to the present theory were initiated, to Sir Henry Dale, Sir Eric Rideal, Sir Charles Lovatt Evans and Prof. E. W. H. Cruickshank, in whose laboratories they were continued, and to the Medical Research Council for its support of our investigations.

Note added in proof. Messrs. J. M. Otero and L. Plaza (*Optica Acta*, p. 8, May 1951) write : "In night vision, receptors (rods) are gathered into functional units which increase as the field brightness diminished as far as a limit value reached at the threshold. . . . The size of these functional groups controls the visual acuity for every luminous level". This seems to be the same as one of the basic ideas of our paper. Otero and Plaza give no further details, except on a form of astigmatism which they found and which they ascribe to irregularities in the shape of the rod units. Effects of the latter kind, as well as the probable overlapping of functional units, will have to be taken into consideration in a complete theory of acuity.

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SEPARATE NUCLEAR AND CYTOPLASMIC ACTIONS OF DRUGS*

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UNTIL quite recently pharmacology, with one exception, has proceeded without consideration of the separate actions of drugs upon the nucleus and cytoplasm of a cell. The exception is in the field of mitotic poisons, and even here we cannot yet decide whether the direct action of a mitotic drug is upon the nucleus or the cytoplasm. In a recent lecture, Mazia[1] remarked, "If the nucleus is a decisive organ of the cell, and yet physiological research has successfully ignored it, we can conclude either that physiology has been extremely lucky or obtuse . . . or that the nucleus in fact participates in physiological processes in a dimension which has been systematically neglected". Both respect for physiologists and an examination of experimental data lend strong support to the second of Mazia's alternatives. But in elucidating the actions of drugs on the nucleus and on the cytoplasm, caution obliges us to suspend judgment upon the degree to which the nucleus is a decisive organ of cells under conditions of interest to pharmacologists.

Two obvious methods of obtaining evidence of the function of the nucleus are (*a*) to remove the nuclei from cells, and (*b*) to damage nuclei, and then study the subsequent behaviour of the cells.

By enucleation of cells[1] it has been shown that the following phenomena will continue for hours, and sometimes for days, after enucleation of a cell: beating of cilia and flagella; pseudopod formation; bio-electric potentials; conduction of nerve impulse and associated recovery processes; myoneme contraction; tropistic responses; response to touch; capacity of egg cells to be fertilized; food capture; digestion of glycogen, fat and nucleic acid; contractile vacuole action; maintenance of selective permeability; mating reactions of protozoa; respiration; synthesis of phosphate esters and proteins; division of asters; cell division; the ability to exercise a morphogenetic effect; photosynthesis; plastid formation; cell extension; protoplasmic streaming. This formidable list shows that most of the 'daily life' activities of a cell can be carried on to a considerable degree without the immediate participation of the nucleus. But the ability to carry out these tasks is often reduced by enucleation, and may be lost after a few hours or days. In almost all cases enucleation results in cell death after a maximum of fifteen days: the mammalian red blood cells are exceptional in having a physiologically normal life of a hundred days or more after the loss of the nucleus.

Cells in which the nucleus has been irreversibly damaged by X-rays, ultra-violet irradiation or a nitrogen mustard show less abnormality than enucleated cells; for example, growth and division may occur normally, and life may be extended to forty days or more.

In general, failure due to enucleation first becomes evident in the more complex activities of cells. For example, differentiation is almost completely prevented; enucleated cells do not have the ability to organize themselves into a tissue; cell division is irregular; and the patterns of pseudopod formation and the degree of apparently purposive behaviour of amœbæ are affected within 5–10 min. by enucleation. It might be tempting to suppose that the changes in these complex activities are caused by the lack of the specific nuclear genes. This, however, can readily be shown to be untrue by studying the effect of transplantation of nuclei between amœbæ of different species[2].

When an enucleated amœba is renucleated with a nucleus of the same species, it recovers completely in a few minutes and will usually go on to divide and form a mass culture. When the renucleation is with a nucleus of another species, recovery is just as successful and may be followed by a few divisions, but in most cases after a few divisions death occurs[2]. However, during the period of recovery, the behaviour of the amœba is characteristic of the cytoplasm, and not of the nucleus. Thus while the nucleus is contributing one or more factors essential for short-term behaviour, these are not species-specific. On the other hand, the nucleus also contributes factors essential for long-term behaviour, and these are species-specific.

A third set of data which are of interest are the delays which occur between the application of a drug and the emergence of its action. These delays may vary between the widest limits. For example, the delay in action of acetylcholine at a neuromuscular junction may be measured in terms of milliseconds, of lewisite in causing vesication in minutes, and of mustard gas in causing vesication in hours. Agranulocytosis caused by sulphonamides may appear after a delay measurable in weeks; a tumour caused by benzpyrene after months or years; mutations caused by mustard gas only after one or more generations. Can all the instances of long delays be attributed to actions upon nuclei? To answer this question we must consider the factors involved in cellular inheritance[3]. The factors to be considered are chromosome genes, controlling characters which obey the Mendelian laws; plasmagenes, that is, genes not attached to chromosomes and so not obeying the Mendelian laws; and various intracellular parasites and symbionts of exogenous origin, including viruses which, in borderline cases, are in behaviour indistinguishable from plasmagenes. While it is widely recognized that mutations or deletions of chromosome genes may not be detectable until one or more generations later, it is not so generally realized that similar delays may occur when plasmagene changes are involved[3,4]. This is, however, the case, and consequently, while the existence of a prolonged delay before the action of a drug becomes apparent is a very good indication that its action is upon the factors involved in cellular inheritance, such delays do not permit a distinction to be made between nuclear and cytoplasmic action.

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* Based on a public lecture given in the Department of Pharmacology, University College, London, on February 29.

A fourth set of data to be examined are the degrees of reversibility of reactions to drugs. Many drugs which act as prosthetic groups, coenzymes or inhibitors, etc., of enzymes have a readily reversible action, if used in sub-lethal doses. But other drugs may have both reversible and irreversible actions in sub-lethal doses. Thus the œstrogens have a number of readily reversible physiological actions upon mammals, but can also act as morphogenetic evocators and as carcinogens, in which instances the action is irreversible[5]. Genes also have two, apparently different, types of function. The first is to exercise a control upon one or more cellular functions; the second is to reproduce itself. Can these two types of function, in some cases, be those affected respectively by the reversible and irreversible actions of a drug? At present we have so little information about the actual mode of action of genes that only theoretical possibilities can be considered. The most important point in this connexion is that reproduction of a gene must be a phenomenon of a remarkably high degree of specificity. Consequently, a gene is unlikely to be able to reproduce while it is combined with a drug. It is thus theoretically possible that, if a gene is combined with a certain drug (or hormone) for only part of the time, the action of the drug will be reversible, whereas if the combination persists for a longer time, the gene will not reproduce, except perhaps in a modified form. In the former case we are dealing with a reversible physiological effect, and in the latter case with a gene mutation or deletion. In the field of morphogenesis the two phenomena are covered by Weiss's use of the terms 'modulation' and 'differentiation'[6].

But if we consider the possibility that drugs act upon cells in a manner parallel to that by which exogenous substrates induce the formation of adaptive enzymes, we encounter a fresh and almost totally different explanation of varying degrees of reversibility. In the absence of its substrate the amount of an enzyme to be found in a cell may be negligible; yet after introduction of the substrate the enzyme may be formed in high concentration. In a similar manner, the introduction of a drug may induce the adaptive formation of a new protein, or enzyme. Formation of the new protein may be readily reversed on withdrawing the drug. In such cases the phenomenon would be classed as a reversible physiological action, or modulation. But there are experimental data which lead us to the belief that in some cases, if once formed, a new protein may be able to reproduce itself, in which case the action may be reversed with difficulty. There is an interesting parallel to this in the phenomena of antigen formation by paramecia, studied by Sonneborn and his colleagues. In a given strain, a group of antigens may be present as alternatives. Any one antigen if present excludes formation of others of the same group. The formation of such an antigen cannot readily be prevented by chemical or physical action. But treatment with the appropriate antibody will result in the replacement of the antigen by another member of the same group. We must thus admit that, although the majority of responses of type similar to the formation of adaptive enzymes may be readily reversible, others may be reversible with difficulty, or not at all.

Thus two different modes of approach permit possible explanations of both reversible and irreversible actions of drugs. In both modes the explanations of reversible and irreversible actions involve the intervention of genes, and so involve time-lags. Now consider briefly some cases of irreversible drug action of particular interest.

1. *Mutations of chromosome genes produced by drug action.* These were first demonstrated by Auerbach and Robson[7], and by Hadorn[8]. Some of the most potent substances, such as mustard gas, are lipoid-soluble and rather inert, but slowly give rise to highly reactive and violent reagents, such as carbonium ions. The effectiveness of these substances depends upon their lipoid-solubility, which permits ready penetration; upon their inertness, which prevents them from reacting exclusively with the peripheral cytoplasm, and upon the eventual formation of a vigorous reactant. But many other effective mutagens, although having the first two properties, do not appear to have any exceptional capacity for giving rise to violent reagents. The number of such compounds known is increasing so rapidly that we must consider the possibility that the majority of chemical substances, in appropriate circumstances, are mutagenic. This in turn leads us to a new possible explanation of mutations in Nature. Hitherto radiations have been thought of as the most probable sources of mutations in Nature. Living cells have a very large number of enzymes, which if applied in sequence are capable of producing a very great variety of substances. Normally, by a process of organization not yet understood, the sequences which are permissible are limited to a relatively small number, so that a relatively small number of substances are produced in comparatively large amounts, and the majority of possible products are produced in apparently negligible traces. But these traces may still suffice for the production of mutations.

2. *Elimination of kappa from Paramecium.* Sonneborn has shown that the plasmagene-like agent kappa, which infects some paramecia, may be eliminated by the action of drugs. Normally kappa is formed in the cells at a rate which keeps pace with cellular reproduction. The action of the drugs appears to be to impede the rate of formation of kappa relative to cellular reproduction, so that eventually kappa-free cells are produced. Streptomycin has a similar action in eliminating chloroplasts from plant cells. In both cases a decrease in the rate of formation of a cyto-

plasmic factor results in its ultimate elimination, which in turn causes an irreversible change in physiological behaviour.

3. *Carcinogenesis by butter yellow in rats.* Liver tumours may be produced in rats in a few months by administration of butter yellow. If a large part of the liver of an animal is removed, the remainder grows by mitosis, etc., to about the size of the original liver. This sequence of hepatectomy and regeneration accelerates tumour production in animals treated with butter yellow. The mechanisms involved are unknown. It seems possible that plasmagene mutations are involved, and that hepatectomy, by raising the relative rate of cellular reproduction, decreases the times required for expression of the mutations. This presents some affinities to the elimination of kappa and chloroplasts.

4. *Carcinogenesis by benzpyrene.* Berenblum[9] has shown that croton oil has a remarkable effect in accelerating the appearance of skin tumours resulting from benzpyrene. If benzpyrene only is applied to the skin, tumours appear after many months. If croton oil is applied before the benzpyrene, appearance of tumours is not accelerated. But if croton oil is applied any time after the benzpyrene application, tumours appear about six weeks after the croton oil application. The type of explanation which could be involved here is that the system involves a chromosome gene producing a plasmagene necessary for normal epithelium. Deletion of the chromosome gene by benzpyrene need produce no marked effect so long as plasmagene reproduction continues. But if the plasmagene also is eliminated (for example, by croton oil), then an abnormality will appear quickly. Application of the reagents in the reverse order will not have the same effect, since if the plasmagene is first eliminated by croton oil it can be restored by the uninfluenced chromosome gene.

5. *Development of resistance by trypanosomes to arsenoxides.* Trypanosomes may become resistant to one arsenoxide and not to another. The common explanation of this is that the trypanosomes become impermeable to the type of arsenoxide concerned. But one can readily calculate that, if the trypanosome cell membrane is like that of other cells, the arsenoxides used in therapy will all penetrate rather rapidly. Consequently the explanation based on changes of permeability implies that the resistant strains have membranes different from those of any other known cell and, worse than that, that for every type of arsenoxide resistance there is a new type of membrane which is not only unlike that of any known cell but also unlike that of any other resistant strain. A much more probable explanation is that resistance is based on the development of secretory units which can pump out some types of arsenoxide and not others. Such units, by analogy with Lwoff's[10] work on kinetosomes, may be regarded as plasmagenes, perhaps controlled by chromosome genes, but self-reproducing when present, in a manner not dissimilar to surface antigens of paramecia.

However, although the various sets of data mentioned are very stimulating, when they are considered critically only the techniques of sexual crossing and nuclear transfer appear at present to give thoroughly satisfying results. The new technique of nuclear transfer has at present had only a very limited application, but has already yielded valuable results. M. J. Ord has shown that one of the nitrogen mustards, when used in concentrations sufficient to cause cell death, is not highly selective for either nucleus or cytoplasm but attacks both independently. If a nucleus is sufficiently damaged by the nitrogen mustard to die, the nucleus cannot be saved by transfer to untreated cytoplasm; nor can the cytoplasm be saved by transferring to it an untreated nucleus. The nuclear damage appears to be of two types, one involving death in a few days, the other after many days of normal behaviour. On the other hand, in collaboration with Lamaton and Harriss of the Royal Cancer Hospital, it has been shown that X-rays are highly selective for the nucleus; this result confirms calculations based on purely physical studies. We must anticipate a wealth of new information from the continued application of this technique.

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[1] Mazia, "Trends in Physiology and Biochemistry" (Academic Press, New York, 1952).

[2] Lorch and Danielli, *Nature*, 166, 329 (1950).

[3] Danielli, "Pharmacology and Cell Physiology" (Elsevier, Amsterdam, 1950).

[4] A valuable review of behaviour affected by plasmagenes has been given by Caspari, *Adv. in Genet.*, 2, 1 (1948).

[5] Needham, "Biochemistry and Morphogenesis" (University Press, Cambridge, 1942, 1950).

[6] Weiss, "Principles of Development" (Holt, New York, 1939).

[7] Auerbach and Robson, Report to Ministry of Supply W3979 (1942); *Nature*, 157, 302 (1946).

[8] Hadorn and Niggli, *Nature*, 157, 162 (1946).

[9] Berenblum and Shubik, *Brit. J. Cancer*, 1, 379 (1947).

[10] Lwoff, "Problems of Morphogenesis in Ciliates" (John Wiley, New York, 1950).

CENTENARY OF THE PATENT OFFICE

By Sir JOHN BLAKE

Comptroller-General

THE "Great Seal Patent Office", formed at the end of 1852 as the single office for granting letters patent for new inventions, was the origin of the present Patent Office in London. It is true that letters patent for inventions had been granted in Great Britain for a long time previously. In fact, in the Patent Rolls of Henry VI for the year 1449, we find a grant to John Utynam for a process for making stained glass windows. The process was intended for the windows of Eton College; but it is doubtful whether it was so used. Grants of patents for inventions, at first rare, later became frequent, but the tendency was to grant monopolies even in cases where no new industry or invention had been created. This abuse was checked by the Statute of Monopolies of 1623, which limited valid grants to new inventions.

It is also true that a Patent Office had existed off Chancery Lane near the site of the present Office for a long period before 1852. The Office is referred to more than once in Pepys's "Diary": for example, under March 12, 1669, we find, "And so away to the Patent Office in Chancery Lane . . . and to the Crowne Office where we met with several good things that I most wanted and did take short notes of the dockets, and so back to the Patent Office and did the like there, and by candle-light ended". That Office was, however, concerned with only a small part of the procedure for the issue of letters patent of all kinds, a few for inventions but many for other purposes. It had no special connexion with the modern Office. Pepys describes elsewhere how he was "forced to run all up and down Chancery Lane" before receiving his letters patent of appointment as Clerk of the Acts of the Navy Office.

Before 1852, the unhappy inventor had to visit many different offices, some of them more than once and paying fees all the time, a cumbrous system satirized by Charles Dickens in his "Poor Man's Tale of a Patent". The passage of the Patent Law Amendment Act in 1852 ended this system after twenty years of agitation by inventors, scientists, engineers, industrialists and others. The reform was facilitated by the special legislation passed to enable inventors to exhibit their inventions at the Great Exhibition of 1851 without invalidating patents which might afterwards be granted to them.

The Act of 1852 placed the grant of patents in the hands of commissioners, consisting of the Lord Chancellor, the Master of the Rolls and the Law Officers of the Crown, and they set up the Office on its present site at 25 Southampton Buildings, off Chancery Lane. The Law Officers continued to hear cases where oppositions were lodged to the grant of patents and to report to the Lord Chancellor upon the advisability of granting patents; but the general control of the Office was in the hands of the Master of the Rolls. The commissioners were given power to print specifications, indexes and other publications, to present copies of these to public institutions and to set up a Register of Patents. The law relating to patents remained much the same; but the procedure for granting them was simplified and improved. Among the notable changes introduced was the obligation to file with the application a provisional or complete specification describing the invention. The provisional specification had to describe only the nature of the invention and was the direct outcome of the practice set up for the Great Exhibition. The complete specification had to describe "particularly" and "ascertain the nature of the invention and the manner in which the same is to be performed", and was the outcome of a practice which had started early in the eighteenth century requiring such a description to be filed within six months after a patent was granted as a condition of the validity of the patent. The names and purposes of these specifications have continued until the present day. The use of provisional specifications is now a valuable and special characteristic of many of the patent systems of the British Commonwealth.

One of the first tasks of the new Patent Office was to make information about patents available to the public. The specifications had formerly been enrolled in one or other of three offices, and although they could be inspected, many could only be found with considerable difficulty, if at all. Now these were printed and published with the utmost speed and distributed widely to public libraries and institutions. All the old patents prior to 1852, some thirteen thousand in number, were so printed. Classified lists of patents were prepared and a beginning was made with the preparation of a detailed scientific classification of the subject-matters contained in patents. Volumes of classified abridgments of patented inventions soon followed, and a library and a museum were established. The museum was soon transferred to South Kensington, but the library has developed into the fine scientific and technical reference library which is now open all day at the Patent Office for use by the public as well as by the staff of the Office.

The difficulty experienced by the commissioners in giving much time and attention to the affairs of the Patent Office led in 1883 to the setting up of a more business-like organization under the control of the Board of Trade. A comptroller-general was appointed and was given responsibility for trade marks and registered designs as well as for patents. It was much later that he took over responsibility for literary and artistic copyright; but here we are dealing only with his functions in connexion with patents. He was given judicial powers to decide oppositions to grants and applications for revocation of patents and other issues, the Law Officers retaining a connexion with the Office as advisers to the comptroller on legal matters and as the tribunal to hear appeals from his decisions.

Under the new organization, the initial fees for taking out patents were greatly reduced, with the result that the number of patents granted annually, which had risen from about 500 to about 2,000 on the passage of the 1852 Act and to about 4,000 by 1883, increased quickly in the next few years to as many as 10,000. In spite of the reduction in fees, more work was done in granting each patent. The examination of the specifications by a scientific staff was commenced, to ensure that the descriptions were clear and adequate and that only one invention was included in one specification. The staff gave much attention to schemes for classifying and indexing inventions, but no search was as yet made to determine the novelty of the inventions for which patents were granted. The view was expressed that the Office need not exercise paternal care for the inventor by making his search for him, but should give him every facility for making the search himself. The system allowed the inventor to get a patent relatively easily but led to the grant of many worthless patents, or patents with vague claims, which were a trap for the inventor and a nuisance to the public.

A basic change in the work of the Office was made in 1905. From then on, although the Office continued to help the inventor to help himself, it also undertook to make the search for the novelty of inventions the subject of applications for patents. The search was at first confined to British patent specifications and has been gradually extended to cover other publications, but the work of the Office in this and other respects has been gravely hampered by the two World Wars. During the Second, the Office was severely damaged by enemy bombs, and it was only due to the devotion of the staff that essential records were preserved and the building saved from complete destruction.

In recent years, the judicial duties of the comptroller have been extended and appeals from his decision have been heard by one of the judges of the High Court instead of by the Law Officers. The most recent steps in the process of enlarging his duties to protect the public and reduce the number of invalid patents granted were taken so recently as 1949, following a departmental committee of inquiry under the chairmanship of Sir Kenneth Swan. Patents for inventions which, as claimed, are lacking in novelty are now refused and notice is given to the public of all overlapping grants. In addition, the subject-matter or merits of an invention may now be considered during opposition proceedings, and the patent refused if the invention is clearly obvious to those skilled in the art.

The Office now has power to deal with most issues in connexion with the grant, amendment and revocation of patents and with other matters, such as compulsory licensing when a patented invention is not being worked to the fullest practicable extent, and disputes between employers and their employees about ownership of inventions. Although these are unusual duties for Civil servants, the topics involved are frequently highly technical and have been found to be such as can be handled reasonably and economically in the Patent Office.

The immediate problems for the Office are to dispose of the arrears of work resulting from the Second World War and its aftermath, and to make more effective the search for novelty over as wide a field as possible. At the moment, the Office is in serious need of scientific and engineering graduates to deal with the technical side of its work. Most scientists naturally look to research for their careers, but the application of research is also of vital importance; and in that connexion, the Office offers useful and interesting work for university graduates with the appropriate training and aptitude.

OBITUARIES

Prof. E. G. Conklin

By the death of Edward Grant Conklin we have lost the last representative of the great American school of classical experimental embryology which dominated this science in the period from 1900 until the rise of the Spemann school in the 1920's. Conklin retired in 1933 from the professorship of zoology at Princeton, which he had held for twenty-five years; but the fact that he had become emeritus was very far from bringing the fruitful period of his life to an end.

Conklin's main scientific work is enshrined in a series of large and fundamental papers dealing with three groups: Ascidians, *Amphioxus* and Molluscs (*Crepidula*). His work on the mollusc *Crepidula* began in 1890 but was not published until 1897. It was immediately recognized as a classical study on cell lineage. Other contemporaries of Conklin had, however, studied molluscan eggs, and his main fame rests on his description and experimental investigations on Ascidians, particularly *Styela* and *Amphioxus*. His careful descriptions of the cleavage and later development in these two groups is the foundation on which not only his own but also a very large quantity of later work by others has been based; but it was his experimental work which placed him in the front rank. In the early 1900's he found in Ascidians evidence, the clarity of which has not been surpassed to this day, for the existence of several different kinds of cytoplasm within the newly fertilized egg. Further, he demonstrated by experiment that the 'ooplasms', as they are now called, exert a determining influence over the course of the later development, so that any region composed of a particular ooplasm will always develop into the corresponding organ or tissue. He spoke of the special types of cytoplasm as 'organ-forming substances', and although our outlook on them has somewhat changed in the past forty years, the facts he produced have stood the test of time, and they, together with his discussion of them, remain as one of the three main bases of the existing theories of experimental embryology.

Although he published more than two hundred scientific papers, it would give the wrong impression to speak of Conklin as a prolific writer; his work is outstanding for that quality of clarity and precision which comes only through the long processes of checking and counter-checking the observations and maturing the thought. In spite of the time he devoted to this, he played a very full part in the general scientific life of his time, acting for long periods as editor or co-editor of the *Journal of Morphology*, the *Journal of Experimental Zoology*, the *Biological Bulletin* and *Genetics*.

Conklin's interests were not confined to the narrowly professional aspects of zoology. By birth the son of a country doctor in the Middle West, he originally intended to enter the Methodist ministry, and spent his undergraduate years at the Ohio Wesleyan University, graduating both in science, in 1885, and in arts in the following year. Even after he took the decision to devote his main energies to science, he never relinquished a profound interest in wider matters of philosophy and of man's spiritual life. During the course of his long life he published several books on such subjects, of which the best known are "The Direction of Human Evolution" (1921) and "Man, Real and Ideal: Observations and Reflections on Man's Nature, Development and Destiny" (1943). He thus earned the distinction of becoming the president both of the American Philosophical Society and the American Academy of Arts and Sciences, as well as of several purely scientific organizations such as the American Association for the Advancement of Science, the American Society of Zoologists and the American Society of Naturalists.

C. H. WADDINGTON

Prof. J. G. Lawn

JAMES GUNSON LAWN, whose eminence as a mining engineer had received world-wide recognition, died at Eshowe, Natal, on October 21 in his eighty-fourth year. Of Cornish descent and the son of a mining engineer, he was born at Dalton-in-Furness on January 4, 1868.

Before entering the Royal School of Mines in 1888 he had already acquired practical experience in the hæmatite mines in Cumberland, and this experience enabled him to smooth some of the difficulties of his fellow-students, by whom he was remembered for the readiness with which, as a somewhat senior student, he was always ready to help them.

On completing the course in 1891 and with the award of the Murchison Prize and the De la Beche Medal, Lawn returned to Cumberland as chief surveyor to the Barrow Hæmatite Steel Co. and as a lecturer in mining for the Cumberland County Council. During 1893–96 he was back at the Royal School of Mines as the instructor in mine surveying and assistant to Sir Clement Le Foster. Then began his first association with mining education and practice in South Africa. When the first South African School of Mines was set up at Kimberley in 1896 Lawn became its first principal and, in the years that followed, the organization of that School owed much to his energy and foresight. During 1903–6 his long association with the Johannesburg Consolidated Investment Co. as a consulting engineer began, although there were interludes between 1907 and 1910 when he became, in succession, head of the Camborne School of Mines (Cornwall) and the first principal and professor of mining, at Johannesburg, of the South African School of Mines and Technology, to which the Kimberley School had now been transferred.

Thus, both in the last decade of the nineteenth century and in the first of this century, Lawn's activities had been divided between mining education and the gold mining industry. It was to the latter, however, that the greater part of his life was to be devoted. For the next forty years—1910–50—(except for a period during the First World War, when he occupied posts with the Explosives Department of the Ministry of Munitions, finally as controller of that Department) his professional work was entirely linked with the manifold activities of the Johannesburg Consolidated Investment Co., first as consulting engineer, then as managing director in Johannesburg, and later as director and consulting engineer in England.

Lawn possessed wide technical knowledge and experience and, above all, was one of the wisest of the long line of mining engineers whose reputations have been made on the goldfields of South Africa.

During his long association with the Institution of Mining and Metallurgy, of which he was elected president for 1930–31, he took a very active part in discussions on technical and scientific matters. His comments were clear, concise and always constructive, even when critical. The award of the Institution's Gold Medal in 1935 and his subsequent election as an honorary member were fitting tributes to his long and unremitting services to mining education and to the mining industry.

In 1934 the University of the Witwatersrand conferred on him the honorary doctorate of science and in 1943 he was elected to the honorary fellowship of the Imperial College of Science and Technology, thus forging another link with the Royal School of Mines which he had entered as a student fifty-five years before.

In later years Prof. Lawn had found an absorbing hobby in botanical pursuits. I well remember a chance meeting with Prof. Lawn in a hotel on the Great North Road, after returning from a successful plant-hunting expedition on the slopes of Ingleborough; he was most enthusiastic about some of his finds. His last letters from South Africa were also full of details regarding interesting plants he had recently discovered near his South African home

J. A. S. Ritson

We regret to announce the following deaths:

Sir William Dampier, F.R.S., senior Fellow of Trinity College, Cambridge, on December 11, aged eighty-four.

Dr. Sven Hedin, Hon. K.C.I.E., known for his explorations of Central Asia, aged eighty-seven.

Dr. C. H. Kellaway, F.R.S., director-in-chief of the Wellcome Research Institution, London, on December 13, aged sixty-three.

NEWS and VIEWS

Long Range Weapons Establishment, Australia: Dr. C. F. Bareford

Dr. C. F. Bareford has been appointed to the post of chief superintendent of the Long Range Weapons Establishment, Australian Department of Supply, in succession to Mr. H. C. Pritchard, who returns to the United Kingdom next year. In his new office, Dr. Bareford will be responsible for the operation of both the base research and development establishment at Salisbury, and the ranges at Woomera, where trials are carried out for the Australian Government and also the Guided Weapons Directorate of the U.K. Ministry of Supply.

Dr. Bareford is a graduate of the University of Sheffield, where he carried out research under Prof. S. R. Milner on the vacuum arc and spark discharges. He gained some industrial experience with the Mazda Valve Organization during 1934–36, before joining the experimental staff of H.M. Signal School, Portsmouth. He was one of the small band of early workers on naval radar. As early as 1937, together with the late Mr. E. M. Gollin, he built a 20-cm. radar equipment, and a little later the first experimental prototype of the 50-cm. gunnery radar. In 1940, when the need for radar navigational aids became more pressing, he transferred his attention to this field, and to the associated field of precision direction-finding equipment. An early form of pulsed navigational aid was conceived and developed by a team under his leadership in the New Cavendish Laboratory in Cambridge. Special direction-finding equipments using radiation from 100 Mc./s. (33 cm.) to 10,000 Mc./s. (3·3 mm.) were evolved by this team, and were used extensively in the months prior to the Normandy landings by the Allies in 1944. Dr. Bareford had, meanwhile, assumed the control of the Radio Reception Division of the Admiralty Signal Establishment in Haslemere, and sponsored the development of the communication receiver series which is now standard equipment in H.M. ships. In 1947 Dr. Bareford became head of the Mullard Research Laboratory. Under his leadership the staff of the laboratory has grown from less than twenty to more than a hundred scientists, in addition to the ancillary staff, and has completed many important projects in the broad field of electronic engineering. In particular, the 15-MeV. linear electron accelerator and neutron spectrometer now in use at Harwell were built there. A radar system for the automatic exploration of the meteorological conditions in the upper atmosphere has been developed. The laboratory has also studied extensively cavitation phenomena, and developed instrumentation for various measurement problems and techniques for the mass production of precision components.

Melchett Medal for 1953: Dr. H. Hartley, C.B.E.

The Institute of Fuel has awarded the Melchett Medal for 1953 to Dr. Harold Hartley, in recognition of his high scientific attainments in the development of domestic heating appliances, coupled with the administrative skill with which he has guided a great industrial organization devoted to the practical efficient use of fuel. Dr. Hartley is chairman of Radiation, Ltd., manufacturers of heating and cooking appliances for domestic, commercial and industrial purposes. A native of the Isle of Man, he was educated there, at the Manchester Grammar School and at the University of Manchester, graduating in chemistry in 1907. He was then elected to a Gartside scholarship of industry and commerce, and, after a year spent in the School of Economics at Manchester, he visited Norway and Canada to study the production of power for electrochemical industries. Returning to England, he worked for three years as a Gas Research Fellow at the University of Leeds under the late Prof. W. A. Bone. In 1912 Dr. Hartley was appointed chief chemist to the Richmonds Gas Stove and Meter Co., where he built up a technical and research section and continued the work on the measurement of the radiant efficiency of gas fires which had been started at Leeds in 1908. In 1919 he was appointed head of the research department of Radiation, Ltd., on the formation of that company. At the new central research laboratories in Grosvenor Place, London, he directed many important investigations into the design of gas-fired appliances, including those culminating in the production of the Bennett/Hartley integrating radiometer for determining the radiant efficiency of domestic heating appliances. He was awarded the C.B.E. in 1952.

Official Seed Testing Station for England and Wales

MR. P. S. WELLINGTON has been appointed chief officer of the Official Seed Testing Station for England and Wales in succession to Mr. C. C. Brett, who retired in April. Born in 1919, Mr. Wellington entered the Imperial College of Science and Technology, London, in 1937. During 1939–46 he served in the Air Branch of the Royal Navy and was awarded the D.S.C. On returning to the University of London after the War, he obtained a first-class honours degree in botany. He was appointed to the Official Seed Testing Station as senior assistant to the chief officer in 1947, and has been investigating the premature sprouting in the grain of wheat. The Official Seed Testing Station is administered, on behalf of the Ministry of Agriculture and Fisheries, by the National Institute of Agricultural Botany, Cambridge.

The Imperial Institute

IN the House of Lords on December 9, Viscount Falmouth, directing attention to the report of the Tweedsmuir Committee on the Imperial Institute, asked whether the Government would consider the transfer of the Institute to a more suitable place and thus free the present site for expansion of the Imperial College of Science and Technology in order to provide additional facilities for the higher training of scientists and engineers. Viscount Falmouth was specially concerned with the expansion of the Imperial College; but, while there was general agreement in the subsequent debate as to the desirability of expanding the Imperial College, other speakers were not prepared to support its claims against the Imperial Institute, and Lord Hailey asked for a specific assurance from the Government that it did not contemplate the abandonment of the present Institute building in favour of the College. Earl De La Warr, replying for the Government, declined to make any definite statement regarding the Government's future schemes for higher technological education or the Government's views on the Tweedsmuir Report. A definite statement of the Government's policy with regard to higher technological education, it was said, would be made early in the New Year. As regards the Imperial Institute, since the Institute is financed and supported by forty-nine governments in all, transfer of the Institute to another site could only occur, if at all, after discussion with the Institute and all those Dominion and Colonial governments which are partners in its maintenance. He added that, as soon as it is possible to discuss definite proposals, the Government, which already controls so much of the land adjoining the College buildings at South Kensington, will be concerned to assist the development of the Imperial College in the best way that it can; but he could not say in advance how far that may involve the Imperial Institute.

Journal of the Royal Society of Arts: 1852–1952

THE first issue of the *Journal of the Royal Society of Arts* was published on Friday, November 26, 1852, and to mark this event the centenary number of the *Journal* (101, No. 4887; 1952) briefly records its history. The Royal Society of Arts is, of course, nearly twice as old as its *Journal*, having been founded in 1754, and its activities were at first chronicled in various publications and in its annual *Transactions*. Dr. James Booth, F.R.S., vicar of Wandsworth, who was an ordinary member of the Society, first suggested the idea of a weekly journal in a letter addressed to the Council of the Society in 1852. In this letter he set out in considerable detail the scheme for a weekly newspaper, which should record all the Society's proceedings, serve as a medium between the Society and allied institutions and form a permanent record of the progress of science, art and industry. This project was taken up, and weekly publication was continued until March 22, 1940, since when the *Journal* has appeared at fortnightly intervals, still published, as was the first issue, on a Friday. The circulation almost automatically follows the membership of the Society: in 1853 it was 2,250, and this more or less consistently increased until 1873, when it was 4,350; during 1873–1932 it dropped to 3,000–3,500, but since then it has regularly increased to its present figure of about 6,000 members. The chief aim of the *Journal* has remained constant—namely, the publication of the great mass of information contained in the authoritative papers read to the Society and the often most interesting and sometimes entertaining discussions which they have provoked. There has been virtually no limit to the range of subject-matter, provided only that there is, in each individual exposition, some germ of progress, some new line of approach that tends to the advancement of human welfare. To the published papers there have been added reports of the Society's activities; illustrations in the shape of photographs, drawings, maps and diagrams; book reviews; obituaries; miscellaneous notes of interest; and announcements of meetings of other societies. For a centenarian, the *Journal of the Royal Society of Arts* is an active old gentleman; may the second hundred years of its existence be as flourishing as the first.

University of Paris: Honorary Degrees

AT a Séance solennelle de Rentrée in the amphitheatre of the Sorbonne held on November 29, and in the presence of the President of the French Republic and the Minister of National Education M. le Recteur Sarrailh conferred the degree of doctor *honoris causa* of the University of Paris on the following: Dr. O. da Fonseca, director of the Instituto Oswaldo Cruz of Rio de Janeiro; Prof. R. F. Loeb, professor of medicine in Columbia University; Prof. M. Siegbahn, professor in the Royal Academy of Sciences of Sweden; Prof. H. Weyl, honorary professor in the Institute for Advanced Study in Princeton; Sir Rudolph Peters, professor of biochemistry in the University of Oxford; and Prof. A. I. Virtanen, professor of biochemistry in the Valio Institute of Helsinki. Similar degrees were also conferred upon four other persons distinguished in law and letters.

Agricultural Education

The Minister of Agriculture and Fisheries, after consultation with the Minister of Education, has set up a 'working party' with the following terms of reference: "To review the relations between the agricultural education service of Local Authorities and the National Agricultural Advisory Service, and to make proposals for their more effective co-operation; to examine the need for an inspectorate of agricultural education; and to consider the future of the Joint Advisory Committee on Agricultural Education".

The membership of the 'working party' is as follows: Lord Carrington, Joint Parliamentary Secretary to the Ministry of Agriculture and Fisheries (*Chairman*); F. Bray, under-secretary in the Ministry of Education; E. Shaw Browne, chairman of the Nottinghamshire Agricultural Executive Committee; W. S. Gibson, provincial director, National Agricultural Advisory Service; Dr. T. Loveday, chairman of the Joint Advisory Committee on Agricultural Education; J. H. Parker Oxspring, director of education, Staffordshire; Prof. R. Alun Roberts, University College of North Wales, Bangor; F. Rollinson, recently of the National Union of Agricultural Workers; Sir James Scott-Watson, chief scientific adviser to the Ministry of Agriculture and Fisheries; W. J. Simmons, farmer; Sir Offley Wakeman, chairman of the Shropshire Education Committee; C. H. M. Wilcox, under-secretary in the Ministry of Agriculture and Fisheries. All communications should be sent to Mr. H. F. Greenfield, at the Ministry of Agriculture and Fisheries, 1–4 Cambridge Terrace, Regent's Park, London, N.W.1.

Science in Communist States

The Society for Freedom in Science has recently published Occasional Pamphlet No. 13, under the title "Science in a Satellite State of the Soviet Union" (pp. 16; from the Department of Zoology, University Museum, Oxford; 1*s.* 3*d.*), which is a summary, without comment, of speeches made at the "Ideological Conference of University Scientific Workers", held at Brno, Czechoslovakia, during February 27–March 1, 1952, the material being taken from bulletins of the Czechoslovak News Agency. No more dignified way could have been adopted of correcting the impression sometimes held that in Communist States the man of science is free to pursue the search for truth wherever it may lead him. The speeches summarized in the pamphlet show clearly the domination and direction of science by political ideologies in such countries, how secondary can be the loyalty of the scientific worker to his own discipline, and the way his thinking is required to be subservient to the doctrines and needs of the State.

Royal Society: Officers and Council

The following have been elected Officers and Council of the Royal Society for the ensuing year: *President:* Dr. E. D. Adrian; *Treasurer and Vice-President:* Sir Thomas Merton; *Secretaries and Vice-Presidents:* Sir Edward Salisbury and Sir David Brunt; *Foreign Secretary:* Sir Cyril Hinshelwood; *Other Members of Council:* Prof. P. A. Buxton, Mr. H. Constant, Prof. P. I. Dee, Prof. E. C. Dodds, Prof. H. J. Emeléus, Sir Howard Florey (*vice-president*), Prof. D. R. Hartree, Prof. E. G. T. Liddell, Prof. E. J. Maskell, Prof. R. A. McCance, Prof. H. H. Plaskett, Prof. W. J. Pugh, Prof. Alexander Robertson, Dr. R. Stoneley, Prof. G. Temple, Prof. C. M. Yonge.

Announcements

Prof. Arthur Holmes, regius professor of geology in the University of Edinburgh, has been elected a corresponding member of the Geological Society of Stockholm.

Prof. R. J. W. LeFèvre, professor of chemistry in the University of Sydney, has been awarded the H. G. Smith Memorial Medal by the Royal Australian Chemical Institute, in recognition of his contributions to physical organic chemistry over the past ten years.

Dr. T. H. C. Taylor has been appointed as from April 1953 to the recently created post of deputy director, in the senior principal scientific officer grade of the Scientific Civil Service, at the Anti-Locust Research Centre, London. Dr. Taylor is at present assistant director of the Commonwealth Institute of Entomology, which he joined in 1944, after long and distinguished service in Fiji and Uganda, mainly connected with research on the ecological and biological control of insects.

Mr. M. W. Perrin, at present research adviser to Imperial Chemical Industries, Ltd., has been appointed chairman of the Wellcome Foundation, Ltd., in succession to Mr. H. E. Sier, who is retiring at the end of January. Before the Second World War Mr. Perrin was a member of the Research Department of the Alkali Division, and also of the Headquarters Research Department of Imperial Chemical Industries, Ltd. During the War he was assistant director of Tube Alloys (the war-time atomic energy organization), and from 1946 until 1951 was deputy controller (technical policy) in the Division of Atomic Energy of the Ministry of Supply.

In order to encourage the writing of papers at a standard suitable for assimilation by a non-specialist reader having some general scientific knowledge, the publishers of the scientific journal *Research* are organizing an essay competition, with prizes of £100, £50 and possibly others as well, for which entries may be made by persons actively engaged on research work. Such essays should be about three thousand words in length and should deal with any recent scientific investigation (not necessarily the writer's own work) and its potential application to industry. Entries, which will be judged by a committee to be appointed by the Scientific Advisory Board of *Research*, should reach the offices of *Research*, 4–6 Bell Yard, London, W.C.2, on or before April 30, 1953.

The Institution of Naval Architects is offering during 1953 the following scholarships to British subjects (age limit shown in brackets), which, except where otherwise stated, must be applied for before May 30, 1953: Institution scholarship in naval architecture (23), for apprentices or pupils in the Royal dockyards or private shipyard (entries before January 15); Trewent scholarship in naval architecture (20), for apprentices or pupils in private shipyards; Denny scholarship in naval architecture and one in marine engineering (19), tenable for four years in the University of Glasgow, with apprenticeship of five years; Parsons scholarship in marine engineering (21), for apprentices or pupils in marine engine works or the Royal dockyards. Further particulars can be obtained from the secretary of the Institution at 10 Upper Belgrave Street, London, S.W.1.

UNUSUAL FOODS FOR HUMAN CONSUMPTION

IT has been estimated by M. Sorre[1] that, of the two million known species of animals, only fifty have been domesticated and normally contribute to the food supplies; and that, similarly, out of the quarter of a million known vegetable species, only about six hundred are cultivated by man. J. De Castro[2], in discussing the figures, has contrasted the limited range of foods used by the inhabitants of Europe and North America with the vast number of native plants which contribute to the diet of primitive peoples. These observations received full support at a conference organized at Bedford College, London, on October 18 by the Nutrition Society when, under the general title of "Unusual Foods for Human Consumption", a series of seven papers was presented. Dr. R. B. Hawes acted as chairman of the symposium, which attracted some two hundred members and guests.

During the morning session, consideration was given to three types of unusual foods: Dr. W. A. P. Black spoke on "Seaweeds and their Value in Foodstuffs"; Dr. J. Ramsbottom on "Mushrooms and Toadstools"; and Dr. W. S. Bristowe on "Insects as Food".

In the first paper, an account was given of the uses of seaweeds in different parts of the world, and it was evident that investigations carried out during the past decade, in Scotland and elsewhere, have made important contributions to our knowledge of the chemical composition of different species and have also provided valuable information regarding methods for the efficient harvesting and processing of marine vegetation. Dr. Black surveyed, among other matters, the production from seaweeds of substances of nutritive value which are now finding a place in food manufacture.

The report on the edible fungi directed attention to their widespread use in many countries of continental Europe where, in contrast to the position in the British Isles, the fungi are regarded not as relatively expensive luxuries but as important vegetables, eaten both in the fresh state and also, during the winter months, in preserved forms.

Insects, etc., are not normally held in high esteem in Europe; but it was clear from Dr. Bristowe's review that, in Siam, Indo-China and in certain parts of India, spiders are regarded as normal items in the diet and that in many other countries insects of different types are used as minor foods. Dr. Bristowe gave an account of his personal experiences in Asia, where he was able to follow local dietary customs.

The contrast between the European town-dweller and the inhabitants of other regions was frequently demonstrated in the afternoon sessions of the symposium, when reviews were given by Dr. H. M. Sinclair on "The Diet of Canadian Indians and Eskimos"; by Dr. G. H. Bourne on "The Food of Australian Aborigines"; by Dr. F. Aylward on "The Indigenous Foods of Mexico and Central America"; and by Dr. B. M. Nicol on "Protein in the Diet of the Isoko Tribe of the Niger Delta".

These papers all revealed the ingenuity of man in making full use of the local plants and animals, and in becoming master of his environment. Certainly, of the Australian aborigine, it may be said that, in terms of food, nothing living is alien to him—the caterpillar and the moth, the frog and the kangaroo, are trapped by appropriate but effective methods and eaten with relish. Similarly the African tribe examined by Dr. Nicol was shown to be catholic in taste; snails, frogs and crocodiles, as well as a variety of plant foods, have their place in the diet. Dr. Nicol's paper revealed the difficulty in making satisfactory dietary surveys in areas where the ordinary staple foods are supplemented, perhaps at irregular intervals, through hunting, shooting and fishing. These occasional supplements make important contributions to the diet.

A similar difficulty in making dietary surveys was experienced in Mexico and Central America where, as reported by Dr. Aylward, the inhabitants preserve dietary traditions that go back into prehistory. Examples were given of methods of food preparation which, although long in use, have only recently been shown to have a sound biochemical basis. Thus the Indian is able to use certain varieties of plants which are poisonous in a raw state, by methods which involve a preliminary grating followed by cooking, a technique which is now known to be effective in destroying toxic components such as the cyanophoric glycosides. Recent scientific investigations have also revealed the advantages of the traditional method of making the tortilla, the daily bread of the Indian; the whole maize is treated with lime, and thus the mineral content of the final product is increased and the danger of widespread dietary calcium deficiencies diminished[3].

By comparison with the inhabitants of tropical and semi-tropical regions, the Eskimos live on a much more restricted diet, especially during the long Arctic winters. Dr. Sinclair showed how the Eskimos have successfully adapted themselves to an unfavourable environment so as to obtain a diet normally adequate in calories and in both major and minor nutrients. Contrary to reports from other northern areas, the groups examined did not eat excessive amounts of fat.

The discussion of the papers ranged over many topics. Dr. H. E. Magee, for example, stressed the importance of quantitative considerations. A food constituent such as vitamin B_1 present in very small amounts in a staple food may be of great value because of the relatively large amounts of the staple eaten per day; on the other hand, a minor or occasional food is of value when it contains a high proportion of one or more accessory factors.

Mr. A. L. Bacharach, commenting on the Mexican tortilla, directed attention to the war-time controversies in Great Britain relating to the addition of calcium carbonate to National flour; it would appear that we had belatedly followed the good example of the Indian.

Other speakers, drawing on their experiences overseas, gave further examples of unusual food habits, and the symposium as a whole reflected the newer 'global approach' to nutrition; the fundamental biochemical investigations of the past half-century, carried out mainly in Europe and in North America, provide the basis for the approach to the nutrition problems on all continents, yet there is clearly much to be learnt from well-established food habits in Africa and elsewhere, in that primitive peoples in many areas have succeeded in reaching good dietary standards.

The papers given at the conference (which will be published in the *Proceedings* of the Society) may be regarded as a continuation of earlier symposia on Colonial problems[4] and on nutritional conditions in prisoner-of-war camps in Asia[5]. They should serve a useful purpose in providing information regarding the actual and potential food supplies of under-developed areas, and in this way should assist in furthering the work being carried out on these topics under the auspices of the Colonial Office and other national and international agencies.

FRANCIS AYLWARD

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[1] Sorre, M., "Les Fondements de la Géographie Humaine", 1 (Paris, 1947).

[2] De Castro, J., "Geography of Hunger", 36 (London: Victor Gollancz, 1952).

[3] Aylward, F., *Nature*, 168, 1100 (1951)

[4] Symposium, *Proc. Nutrit. Soc.*, 5, 1 (1946).

[5] Symposium, *Proc. Nutrit. Soc.*, 5, 107 (1946).

APPLICATIONS OF COMMUNICATION THEORY

TWO years ago, during September 26–29, 1950, a symposium was held in London of a group of some hundred and twenty men of diverse scientific interests —communication engineers, mathematicians, physicists, biologists, psychologists and others—all of whom were concerned in one way or another with the concept of the communication of information (see *Nature*, 167, 20; 1950). The meeting was prompted by the recognition of the importance of recent developments in the theory of communication which revealed, and gave promise of clarifying, connexions between previously largely unrelated fields of research concerned with different aspects of the processes by which living organisms convey information. The purpose of the symposium was to afford the opportunity for a discussion of the nature of this recent work and of its potentialities in various branches of science.

It was decided that there should follow in due course a second symposium having the more limited objective of examining what of practical value had resulted from the application of this theoretical work to the problems of electrical communication, and this second meeting was held in London in the Lecture Theatre of the Institution of Electrical Engineers, during September 22–26. The participants on this occasion were mainly practising communication engineers, though other interests were well represented, and they were even more international than those who attended the earlier symposium. The two hundred and seventy present included ninety visitors from sixteen countries abroad. The chairman of the opening session was Sir Noel Ashbridge, retiring director of technical services of the British Broadcasting Corporation.

In the opening address, Prof. Willis Jackson referred to the two distinct, though closely interrelated, sides of the recent theoretical work: one, the theory of the representation of signals, that is, the analysis of signals into the basic elements—the 'alphabet'—in which it is intended to communicate; and the other, the statistical theory of communication, that is, the application of probability theory to the communication of these elements. Prof. Jackson remarked on the value of the theory in affording means for the quantitative comparison of different transmission systems (different forms of modulation and coding); on the progress being made in the development of techniques for the extraction of signals from a noisy background; and on the considerable activity which it had stimulated in studies such as the analysis and synthesis of speech, the improvement of speech recognition in noisy conditions, the possibilities of compressing the band-width required in speech and television channels, the mechanism of hearing, etc. He remarked that communication theory has perhaps achieved little as yet in the last-named fields, but that to make a reproach of this would be on about the same level as pointing out that Carnot and Kelvin did not invent the gas-turbine. A basic theory is a compass rather than a vehicle, and there is little reason to doubt that, in this case as in others, it will be supported in due course by the inventive imagination on which progress largely depends.

Prof. Jackson then directed attention, in the absence of the author, to the "Summary of Communication Theory" which Dr. D. Gabor had prepared for the benefit of the participants. In this paper Dr. Gabor discussed the parts played, in the development of the theory of communication, by classical Fourier analysis, its modification by treating time as a 'running' variable and the application of probability theory to signal data; and he detailed, in terms based mainly on the work of Dr. C. E. Shannon, the principal concepts, theorems and results concerning the two aspects of the modern work, signal analysis and the statistical theory of communication, mentioned above.

The first two days of the symposium were devoted mainly to problems concerning the detection of signals when mixed with noise, and served to emphasize that the detector must be regarded essentially as giving a probability distribution rather than a precise, error-free, extracted signal. A paper by P. H. Blundell suggested that it is not permissible to regard the whole of this (*a posteriori*) distribution, in the mean, as a rate of information, since at any instant during the communication it cannot all be used. This argument aroused considerable discussion which served to clarify some important misconceptions. Prof. Z. Jelonek followed with a summary of the results of a comparative study of various modulation systems in which he had calculated their respective theoretical rates of transmission of information. This paper, and an allied one by Prof. S. Goldman (United States), demonstrated the quantitative value of the statistical theory, and revealed the limited practicable scope which is available for improvement in the methods of modulation now in use.

New contributions to the theory and art of pulse modulation were made by F. de Jager (Netherlands), who described a one-unit code system of pulse-code modulation to which he had given the name "delta-modulation"; by C. W. Earp, who discussed a possible modified form of pulse-code modulation, which he called the "ambiguous index system"; by H. W. F. Groenewout (Netherlands), who gave the results of an investigation of distortion in pulse-code modulation systems; and by Dr. D. M. MacKay, who raised an interesting problem concerning the transmission of neural impulses.

Allied to these papers were others by R. H. Barker, who dealt with the important problem of the group synchronization of binary digital systems, and by Drs. A. E. Laemmel and D. A. Huffman (United States), who discussed the construction of codes, the former of error-correcting codes involving the deliberate inclusion of redundancy, in the form of additional code signals, for the purpose of combating noise, and the latter of codes to remove excessive redundancy, where this exists.

The discussion of the extraction of signals from noise, related more particularly to the detection of pulsed radar signals, and to the comparative efficiency in this respect of alternative methods of detection, was continued in papers by D. E. Hampton, by Dr. W. Meyer-Eppler (Germany), and by Profs. R. M. Fano and D. Middleton (United States). The two latter directed attention to calculation of the *a posteriori* probability of the received message from the *a priori* distribution and the assumed statistics of noise, and extended and generalized earlier work on the theory of ideal detectors. Middleton discussed his comparative studies based on several types of optimum test of a statistical hypothesis against an alternative —signal and noise as against noise— and his consideration of three types of 'observer', namely, the 'Neyman-Pearson', the 'ideal' (Siegert) and the 'sequential', for which he had computed the corresponding betting-curves. He also described an analogue electronic device constructed by Dr. R. A. Johnson and himself for measuring the correlation functions of modulated carriers and noise following a non-linear device. One interesting conclusion to be drawn from this series of papers is that no marked inefficiency is associated with the types of detector now in use, and that in fact we cannot hope to go much better, which further illustrates the value of the modern communication theory in enabling calculation of the limits of performance which practical systems cannot hope to exceed. There followed a series of papers by Drs. A. E. Bailey, R. L. Beurle and P. L. Waters, dealing with the question of information storage, and the comparative merits of magnetic, acoustic and electrostatic systems applied to signal integration.

On the morning of the third day the discussion moved from statistical communication theory to a series of papers by D. H. Hamsher (United States), Dr. M. Cotte (France), Prof. K. Küpfmüller (Germany) and Prof. T. Laurent (Sweden), concerned with the transient distortion and delay characteristics of transmission channels and with general signal analysis, chiefly with reference to telegraph and television systems, where the wave-shape of the signals is of prime importance. This was followed during the afternoon by consideration of the information content of pictures and of its transmission by facsimile and television. Papers by Dr. J. Loeb (France), and by Dr. E. C. Cherry and G. G. Gouriet, emphasized the excessive redundancy which exists in facsimile and television signals by virtue of the fact that the probability of a black or grey 'dot' on any real picture is far less than that of a plain surface element. Thus existing practical systems are potentially capable of transmitting patterns which are far more complex than ever arise in real pictures. Dr. Loeb pointed out that scanning is a wasteful and unnecessary procedure with simple pictures, such as sketches, charts, handwriting, etc., and described the principles of pantograph and stopping-spot devices which can trace the picture automatically and the output of which can be coded for transmission to a tracing pencil at the receiver. The second authors proposed a system of velocity modulation applied to television to accomplish the same end. The discussion of these papers centred, somewhat naturally, round the psychological problem of 'recognition'. A succeeding paper by Dr. G. Valensi (Switzerland) dealt with the coding of colour-television signals. He stressed the merits of the modern view of the problem, which regards the black-white version of the picture as one signal and the superposed colour as a second—as distinct from the simultaneous transmission of three pictures, red, blue and green—and proceeded to discuss the possible use of a sub-divided Maxwell colour triangle for defining the colour information.

Speech and hearing formed the subject-matter of the programme on September 25. One group of papers, by J. Berry, D. L. Richards and J. Swaffield, dealt with studies of conversational speech on the telephone. They described statistical measurements of the frequency of occurrence of particular words and syllables, consonants and vowels, strong and weak word-forms, etc., and also an attempt to relate the conventional methods of measuring the performance of speech-links to the concepts of 'channel capacity' and 'information rate' as defined in the modern theory of communication. Another group of papers, by Drs. G. E. Peterson, K. H. Davis, R. Biddulph and S. Balashek (United States) and by Drs. D. Fry and P. Denes, was devoted to the problem of speech recognition and to consideration of the principles whereby a 'machine' might print in standard symbols, or respond in some other recognizable way, to received human speech. These papers emphasized that a great deal of information is lost when speech is transformed to writing and that the main problem is to determine what are the minimal elements of speech which ensure identification. Dr. G. Raisbeck, who presented the paper by Drs. Davis, Biddulph and Balashek, described a machine which is able to identify each of the numerals, one to nine, though only when spoken by the same individual. The problems involved in making it capable of responding similarly to different voices, and of recognizing continuous phrases and sentences, are indeed complex and difficult ones, but carry some far-reaching implications.

These papers were followed by two demonstrations, by W. Lawrence and by Dr. W. G. Tuller (United States), of machines which performed the complementary operation, that of uttering 'spoken' words when driven by electrical stimuli of comparatively simple form. This fascinating work may provide an important 'synthesis' approach to the study of the speech recognition problem.

A particularly interesting supplementary paper describing a new approach to the theory of hearing was presented by Dr. W. H. Huggins (United States). He began by considering the measurement of the pitch of a damped wave by means of a 'phase detector' and proceeded to suggest that while the basilar membrane itself does not possess suitable elastic properties to account for the fine pitch discrimination of the human ear, the tectorial membrane, with which it is connected by hair-cells, has similar frequency-selective properties to those of the phase detector. Dr. Huggins showed that these proposals conform well with the experimental results obtained by von Békésy, Galambos and Davis in studies of the cochlea of the cat.

The topics considered on the final day lay somewhat aside the main theme of the symposium but were nevertheless much appreciated by a large audience. Two papers concerned with language and linguistics, presented by D. A. Bell and by Prof. B. Mandelbrot (France), afforded opportunity for a considerable discussion among the linguists present, and revealed how closely the theories of communication and of language are related and how beneficial progress in one can be to the other. An important succeeding paper by Dr. Y. Bar Hillel and Prof. R. Carnap (United States) referred to the mis-application by some men of science of the terminology and theorems of statistical communication theory to fields in which the term information is used, presystematically, in a semantic sense (one involving the contents or designata of symbols) or even in a pragmatic sense (one involving the users of these symbols) and to the misleading consequences which can result. They presented the outlines of a theory of semantic information based on the theory of inductive probability recently developed by Prof. Carnap, and suggested that this should serve as a better approximation than the present statistical theory for application to fields like psychology and the social sciences.

An interesting application of the results and methods of communication theory to optics was described by Prof. A. Blanc-Lapierre (France); and in a paper entitled "Generators of Information", Dr. D. M. MacKay raised a number of difficult questions, such as—Can we trace the information in a channel back to an ultimate source, or are we restricted to considering information transducers only? Communication theory generally accepts the *a priori* existence of an agreed alphabet. where does this arise?—and illustrated his arguments by descriptions of simple electrical machines.

The symposium concluded with a general discussion, in which Dr. E. C. Cherry gave a summary of the main questions which had been raised during the week, and with an expression of appreciation by Prof. Willis Jackson to the British Broadcasting Corporation and the Ministry of Supply for the financial assistance they had afforded. The proceedings of the symposium are to be published by Butterworths Scientific Publications, Ltd.

THIRD INTERNATIONAL CONGRESS ON ASTRONAUTICS

THE Third International Congress on Astronautics, held in Stuttgart during the week September 1–6, was attended by fifty official delegates and more than a hundred visitors. During the first two days the business of the International Astronautical Federation was discussed. The major item was the constitution of the Federation, which was agreed to and signed by all societies represented, these being the national societies of the Argentine, Austria, Denmark, Germany, Great Britain, Holland, Italy, Norway, Sweden and Switzerland, together with the American Rocket Society, Chicago Rocket Society, Detroit Rocket Society, Pacific Rocket Society and Reaction Research Society of the United States. The following officers were elected: ***President***, Dr. E. Sänger (Germany); ***Vice-Presidents***, Andrew G. Haley (United States) and Dr. L. R. Shepherd (Great Britain); ***Honorary Vice-President for International Relations***, Dr. G. Loeser (Germany); and ***Secretary***, J. Stemmer (Switzerland).

Of the twenty-three papers presented during the technical sessions the majority were devoted to problems of detail in space-flight. In his paper "Inter-orbital Transfer with Minimum Propellant Expenditure", D. F. Lawden (British Interplanetary Society) discussed the problem of the transfer of a rocket between two coplanar elliptic orbits, about the same centre of inverse square law attraction, along a trajectory requiring a minimum of propellant expenditure. His solution involved a number of impulsive thrusts, and equations were obtained from which the magnitude and directions of these thrusts could be calculated in particular cases. In the case of transfer between circular orbits, the solution was shown to be equivalent to that due to Hohmann[1].

In "Exposure Hazards from Cosmic Radiation at Extreme Altitudes and in Free Space", Dr. H. J. Schaefer (American Rocket Society) reviewed the present position. In recent years direct evidence has been obtained of the existence of a component of primary cosmic radiation consisting of heavy nuclei. It is known that other types of primary radiation and secondary radiation are not dangerous, but this discovery places the problem of a possible exposure hazard for human beings, in the region of the primary radiation, on a new basis. The heavy primaries are characterized by an extremely high specific ionization and by a large radial spread of the ionization dose around the particle tracks. Either of these properties might endow them with a greatly increased biological effectiveness which cannot be measured effectively in terms of ordinary biological dosage units. The screening effect of the geomagnetic field is such, however, that these particles of comparatively low energy and heavy nuclei would be almost totally excluded from reaching the earth except near the poles. It remains an open question whether such particles are present or not in large quantities in the primary cosmic-ray spectrum in free space away from a body with a shielding magnetic field. It appears that it would probably be safe for human beings to venture a few hundred miles from the earth's surface, but no definite statement can be made for more remote space. A further alternative is the possible existence of a heliomagnetic field which could screen part of the solar system. However, no clear experimental evidence of its existence is available.

Experiments to investigate the biological effects of these heavy primaries were described by Prof. J. Eugster (Schweizerische Astronautische Arbeitsgemeinschaft) in his paper "Die biologische Wirkung der Kosmischen Strahlung, Methoden und neueste Ergebnisse". Investigation of the biological effects on eggs of *Artemia salina* and human and animal living tissue was carried out by taking the specimens to heights of 28,000–30,000 m. in sounding-balloons. Direct hits by highly ionizing components on *Artemia* eggs had a lethal effect, the hatching-rate after exposure being zero. The comparative rates at the surface and at a station shielded by some 2,100 m. of rock were 96 and 9 per cent, respectively. The low hatching-rate of the eggs exposed underground was due to considerable neutron radiation which was found to be present. Evaluation of the results of exposure of human and animal tissues was not complete.

A further medical problem of great interest in astronautics was discussed by Dr. A. E. Slater (British Interplanetary Society) in his paper "Sensory Perceptions of the Weightless Condition". It has been suggested that the otolith organs of the inner ear might give confused results when not subjected to a gravitational force or acceleration, and might thus induce a feeling of 'space-sickness'—perhaps akin to sea-sickness. In the weightless condition, the impulse frequency of the maculæ might or might not fall to zero. If there is a certain basic minimum frequency which is present during the weightless condition, then the different otolith organs the maculæ of which face in different directions would give contradictory information, and a feeling of 'space-sickness' might exist. However, it has been shown by both Adrian and Lowenstein that some nerve fibres of the otolith organs do not carry impulses when the head is in certain positions. In the weightless condition, therefore, it seems improbable that any impulses would be present. Some forms of deafness are due to both middle ears being out of action. No impulses can be transmitted under these conditions, and yet no ill-effects are felt. It is therefore thought that weightlessness also would bring no ill-effects. The main function of the otolith organs is almost certainly that of adapting the body to the effects of gravity by controlling the tone of the muscles used for balancing, and causing instant adjustments of muscular tension whenever necessary.

J. Humphries

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[1] Hohmann, "Die Erreichbarkeit der Himmelskörper" (Oldenbourg, Berlin, 1925).

PAN-AMERICAN INSTITUTE OF GEOGRAPHY AND HISTORY

AMONG the specialist agencies set up by the Governments of the American Republics is the Pan-American Institute of Geography and History (PAIGH). Much of the work of the Institute is carried out by the three Commissions which were set up at the fourth general assembly held at Caracas in 1946. These three Commissions deal, respectively, with cartography, geography and history.

The first meeting of the Commission on Geography or, as it has come to be called, the Pan-American Consultation on Geography, was held in Rio de Janeiro during September 1949; the second in Santiago, Chile, during October 1950; and the third in Washington, D.C., during July 25–August 4, 1952. Future plans are to hold meetings of the Commission every two years. The twenty governments which are members each send official representatives, and interested international organizations, such as Unesco, participate in an observer capacity; the Canadian Government also sends observers.

The chairman of the Consultation meeting at Washington, D.C., was Prof. Preston E. James (United States). All the proceedings were in English, Spanish or Portuguese, with simultaneous translation available for all meetings, which were held in conference rooms provided by the United States State Department. As an official gathering, attendance was limited to delegates officially appointed or special invitees.

Some indication of the wide range of subjects covered by the conference is indicated by the existence of five sections which carried on their meetings simultaneously, and which dealt, respectively, with physical geography and biogeography, human geography, regional geography, geography of the Americas, teaching and methodology.

Between Consultations the action programme of the Commission is entrusted to five permanent committees, which deal, respectively, with basic natural resources, settlement and colonization, land classification and survey of land use, geography of the Americas, and teaching and methodology.

The American republics are acutely aware of the need for a comprehensive study of their geographical resources as a prelude to schemes of land planning and conservation of resources. Not only are land-use surveys planned and in progress in many areas, but also active steps are being taken to set up a training centre or training centres where those with a basic university training can be given the necessary instruction to enable them to take their place in the survey teams which are planned. It is proposed to set up a government-sponsored college for this purpose, probably in Rio de Janeiro.

L. Dudley Stamp

REACTIVITY OF PROTEIN FIBRES

DURING the annual conference of the Society of Leather Trades' Chemists, held at the University of Leeds during September 19–20, the fifth Procter Memorial Lecture was delivered by Prof. J. B. Speakman, professor of textile industries in the University of Leeds, his subject being "The Reactivity of Protein Fibres: Some Analogies between Keratin and Collagen".

After paying tribute to Prof. Procter, and those members of the staff of the Department of Leather Industries in the University of Leeds—Mr. F. C. Thompson and Prof. W. R. Atkin—who had worked with him, Prof. Speakman began to develop his comparison of keratin and collagen in terms of the amino-acid composition. Because of the close similarity in the proportions of basic and (free) carboxylic acid side-chains, close similarity in the reactions with acids and alkalis is to be expected, apart from complications due to the presence of cystine in keratin. The titration curves of the two proteins were compared and their reaction with acids discussed in detail. Prof. Speakman suggested that differences in the acid titration curves of different forms of collagen are due to neglect of differences in swelling, and to errors in the calculated amount of combined acid when no account is taken of the difference in concentration of acid inside and outside the collagen. In terms of the Donnan theory of membrane equilibrium, methods of calculating the 'true' titration curve were outlined, the 'true' curve representing the correct amounts of acid combined at different internal *p*H values.

Prof. Speakman next turned his attention to the action of neutral salts on keratin, potassium chloride and lithium bromide being chosen as examples of two main types. It was shown that the former causes breakdown of salt linkage through the association of potassium and chlorine ions with the oppositely charged ions of the linkage. Lithium bromide has the same effect but, in addition, causes breakdown of hydrogen bond at concentrations below about 5·8 *M*. Above this concentration, co-ordination with hydrophilic groups in neighbouring chains leads to some measure of cross-linking.

Close analogy between keratin and collagen is also found in the supercontraction of the former and the hydrothermal shrinkage of the latter. Although the molecular structure of keratin is more stable than that of collagen, because of cystine linkages in the former, breakdown of hydrogen bond by means of a 50 per cent solution of phenol promotes the contraction of wool fibres at high temperatures. By determining the temperature at which 20 per cent contraction occurs in 20 minutes, in accordance with

Zahn's procedure, it was shown that the least plastic wool fibres have greater cohesion than the most plastic.

In relation to tanning, it was shown that formaldehyde, benzoquinone and basic chromium acetate cross-link keratin, and that cross-linking reactions are to be expected with collagen. The fact that the strength of collagen is reduced by tanning is probably due to the effect of cross-linking on the extensibility and surface friction of the ultimate fibres. It was suggested that frictional measurements on tanned and untanned collagen fibres would be a profitable study.

Finally, some attention was given to the proportions of crystalline and amorphous material in protein fibres. A new method of measuring the proportions with heavy water was described, and it was suggested that the polymerization of suitable monomers within the fibres, with subsequent cross-linking where possible, provides an interesting possibility of overcoming the accessibility problem and, at the same time, of developing new tanning processes.

NATIONAL RESEARCH COUNCIL OF CANADA

REPORT FOR THE YEAR 1951–52

THE thirty-fifth annual report for 1951–52 of the National Research Council of Canada* is the last to appear over the name of Dr. C. J. Mackenzie as president, for he has now become president of the new Crown company, Atomic Energy of Canada, Ltd., an organization to which the responsibility of operating the Chalk River project was transferred from the Research Council on April 1, 1952.

Considerable expansion occurred in the work of the National Research Laboratories during the year, but especially in the field of defence production; new buildings are being erected to provide much-needed accommodation for several Divisions, and that for the Applied Chemistry Branch was expected to be occupied during the summer of this year. The largest outside unit now operated by the Council is the Prairie Regional Laboratory at Saskatoon. This is primarily concerned with research designed to promote new uses for agricultural products. Fundamental studies on the mechanism of the biosynthesis of ustilagic acid, a product of the corn smut fermentation, in which the fungus is grown in media containing radioactive carbon compounds, have been started, and many samples of ustilagic acid have been despatched for testing. Investigations on the control of loose smut of barley by treating infected seed with antibiotics are being continued. The carbohydrate metabolism of bacteria is being studied with radioactive carbon dioxide, and the concentration of the active carbon atom in the fermentation products shows that different organisms vary in their ability to incorporate carbon dioxide in their metabolic products. A new method has been developed for preparing radioactive cyanide, and fundamental studies in sugar chemistry were continued. The development of a rapid continuous process, which will produce a chemical pulp having properties similar to ball-milled straw, is being investigated and also the factors responsible for the increased resistance of these strawboards to water, while the fractionation of rape-seed oil with furfuraldehyde as solvent was being tested on a pilot scale.

Food investigations have had a major share in the Division of Applied Biology; but emphasis on long-term fundamental research is increasing. The Wiltshire bacon project was concluded with a study of the effects of varying temperatures and salt concentrations on storage life. Production of butylene glycol from beet molasses and sulphite liquor reached the pilot-plant stage, and a rapid method giving high yields of citric acid by the submerged fermentation of beet molasses has been developed in the laboratory. Studies in photosynthesis have shown that the Hill reaction is stimulated by anions at pH levels above the optimum, and that malic enzyme has a possible role in photosynthesis. Activity in the colloid section of the Division of Chemistry has been mainly concerned with the properties of suspensions, but the physical properties of anhydrous soaps have also been examined. The Division has continued its calorimetric investigation of the thermodynamic properties of simple gases adsorbed on solid surfaces; its study of the chemistry of liquid ammonia solutions; and its work on the thermal decomposition of gaseous organic compounds, using a mass-spectrometer, designed for the quantitative analysis of the stable products and of the short-lived intermediates, such as free radicals, which are formed. Investigations of critical-temperature phenomena have led to a better understanding of the nature of the liquid–vapour transition, and many measurements were made, in the project on the permeability of fabrics, of the air flow through wire gauze of varying fineness for different drops of pressure. The structures of all the alkaloids of the sparteine group have been established, and much attention given to the preparation of steroids containing deuterium.

In the Division of Applied Chemistry work on the simultaneous drying and thermal cracking of Alberta wet crude water-separated bitumen has given a cheap dry oil of low viscosity in a single operation. A very sensitive microbalance has been constructed for use in investigating the first stages of the oxidation of metals, and an automatic-recording balance has been designed and built to measure the oxidation-rates of heat-resistant alloys. A moisture-permeable white paint has been formulated for exterior use, and the adsorption of anionic- and non-ionic-type synthetic detergents has been studied on three types of carbon taken as representing the important components of normal 'dirt', and also their adsorption on textile fibres. Two new reactors with multi-point sampling and feed connexions have been built for the small-scale plant for the oxidation of ethylene to ethylene oxide to determine optimum conditions and flow design for a full-scale pilot plant.

The Canadian defence programme has particularly affected the Division of Mechanical Engineering, and assistance to industry in the design and development of new aircraft constitutes a large part of the work of the Division's aerodynamics and flight research laboratories. A thermodynamics laboratory was being constructed for work on compressors and gas turbines, and in the low-temperature laboratory work on aircraft-icing included measurement of the physical characteristics of icing-clouds and the development of electrothermal protection for aircraft wings, propellers, windscreens and tail units. The Division of Medical Research made special provision for research into the action and uses of adrenocorticotropic hormone and cortisone, under an *ad hoc* advisory committee, while under the regular research programme 125 grants-in-aid were made during 1951, including eleven for studies in arteriosclerosis or in cholesterol metabolism, a large grant to Dr. L. B. Jacques to study the clotting of blood, and nine for investigations bearing on the development of bone, the natural alignments and proportions of the bony skeleton and the reparative processes which follow damage.

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* Thirty-fifth Annual Report of the National Research Council of Canada, 1951–52 (N.R.C. No. 2780). Pp. 46. (From the Council, Ottawa, 1952.)

In the Department of Physics the newly established laboratory to investigate the nature of the solid state is already undertaking work on thermal and electrical conductivity, the nature of superconducting materials and the study of specific heat and thermal dilatation, and much important preliminary work has been carried out in the new photogrammetric research laboratory. Studies of the factors involved in the reduction of the noise associated with the testing of jet engines, and of photographic resolution in contact printing have also been made by the Division. Apart from projects for the Armed Services, the Division of Radio and Electrical Engineering has completed a long-term study of the absorption of micro-wave radiation by snow and has continued studies on the fundamental aspects of electron emission from oxide-coated cathodes and on radio-frequency re-warming techniques for treatment of patients with lower body temperatures; it has developed further the micro-wave beacon system as well as a remote-control system for unattended fog-horn stations and also an experimental wired television system for viewing submerged objects.

SYNTHETIC ACTION OF ALMOND EMULSIN

By Prof. STANLEY PEAT, F.R.S., Dr. W. J. WHELAN and Mrs. K. A. HINSON

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THE literature contains numerous references to the synthetic action of α- and β-glucosidases. Thus Croft-Hill[1] claimed the synthesis of maltose from glucose by the action of a yeast extract. Bourquelot and Bridel reported the synthesis of β-glucosides by the action of almond emulsin (a β-glucosidase) on glucose and alcohols[2] and also the synthesis of gentiobiose by action on glucose alone[3]. These workers recognized that gentiobiose is not the sole product of this action, and suggested that cellobiose was also formed[4]. The products obtained by Croft-Hill were ill-defined[5]; but the synthesis of gentiobiose by emulsin is a well-established fact and is recommended as a preparative method for this disaccharide[6].

As part of a study of the synthetic activity of glucosidases, we allowed almond emulsin (0·6 gm.) to act on a concentrated aqueous solution of glucose (60 gm./102 ml. solution) at 35° for five weeks (under toluene). Paper chromatograms of the digest indicated that gentiobiose made its appearance within three days, and later revealed the formation of other synthetic products. After the incubation, the digest was fractionated on a charcoal-'Celite' column[7] and, following the removal of glucose, five products were obtained. One was a pure substance; the others were mixtures which were, however, completely separated into four pure sugars by further fractionation on charcoal and, in one case, on filter paper. Each product proved to be a disaccharide, and examination of the physical properties of each sugar and its β-octa-acetate identified the five substances as gentiobiose (β-1 : 6 link), cellobiose (β-1 : 4), laminaribiose (β-1 : 3), sophorose (β-1 : 2), and ββ-trehalose. The properties and approximate yields are listed in the accompanying table. The synthetic disaccharides have R_F values identical with those of authentic specimens.

Emulsin displays a group rather than an absolute specificity, inasmuch as it catalyses the hydrolysis of many β-glucosides, including the five disaccharides under discussion. It is evident that in its synthetic action the enzyme also displays group specificity. Each of the available hydroxyl groups in the glucopyranose 'acceptor' can be utilized for the formation of a β-linkage, although some selectivity appears to be exercised with respect to the α- or β-configuration of C_1 since αβ-trehalose has not been detected. It would seem that emulsin catalyses the reversible reaction:

$$\text{Glucose} + \text{glucose} \overset{\text{Emulsin}}{\rightleftharpoons} \text{disaccharides} + \text{water}.$$

The equilibrium does not lie completely on the side of hydrolysis, and the extremely slow rate of disaccharide formation suggests that the energy for synthesis is derived from the thermal motion of the molecules rather than from a chemical reaction. It is also reasonable to suppose that the relative yields of the disaccharides will be inversely related to the rates at which they are hydrolysed by emulsin. It is known, for example, that cellobiose is more readily hydrolysed by acid than is gentiobiose[12], and the table shows that the latter is preferentially synthesized. On this basis, the order of stability of the disaccharide links would be β, 6 > β, 4 > β, 3 > β, 2 or β, β. It may be mentioned that prolonged action of emulsin on glucose leads to the synthesis of saccharides of a higher order than the disaccharides described. These higher saccharides have not yet been examined. If the synthesis proceeds in the

Properties of the Synthetic Disaccharides

Disaccharide	Yield (gm.)	Experimental values			Values for authentic specimens			
			β-Octa-acetate			β-Octa-acetate		
		[α]D in water*	[α]D in chloroform	m.p.	[α]D in water*	[α]D in chloroform	m.p.	Reference
Gentiobiose	7·0	+ 11·8°	− 5·1°	193°	+ 9·6°	− 5·3°	193°	8
Cellobiose	1·0	+ 34·5°	− 6·1°	192·5°	+ 34·6°	− 7·0°†	193·5°†	—
Laminaribiose	0·5	+ 20·3°	− 28·5°	159·5–160°	+ 20·8°	− 28·8°	160–161°	9
Sophorose	< 0·1	+ 18·4°	− 3 (± 2°)	189·5°	+ 20·0°	− 3·8°	192°	10
ββ-Trehalose	0·1	− 38·2°	− 17·9°	179·5°	− 39·4°	− 18·4°	180·5–181·5°	11

* Equilibrium values. † Values determined by the authors.

random fashion displayed in the case of the disaccharides, there could be formed forty trisaccharides and four hundred and forty tetrasaccharides.

We believe this to be the first authenticated synthesis of cellobiose by enzymic action, and while it is highly improbable that cellulose is synthesized in plants by the action of a β-glucosidase on glucose, the fact that a β-1 : 4-link is synthesized by emulsin may not be without significance.

We wish to express our thanks to Dr. F. Cramer (Heidelberg) and Dr. G. H. Coleman (Wayne University, Michigan) for authentic specimens of sophorose and ββ-trehalose octa-acetate respectively.

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FLIGHT-TONE AND WING-STROKE FREQUENCY OF INSECTS AND THE DYNAMICS OF INSECT FLIGHT

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MANY methods have been employed for determining wing-stroke frequency in insects[1,2]. The kymograph was mainly used by the older authors[3-5], and the chronophotographic method has also been used by investigators of insect flight[6-8]. Modern investigators have successfully applied the stroboscope[9-15] and the oscillograph[2,16-17].

An isolated position is occupied by the acoustic method, which, like the oscillographic method, determines the wing-stroke frequency by the flight-tone, that is, by the hum emitted by a flying insect's wings. One of the first investigators of wing-stroke frequency, Landois, applied this method[18], and I also have used it[1,2]. Since no registering instrument is required, the technique is more or less subjective and must therefore be used under strictly critical conditions. The difficulties that an inexperienced or 'quasi-musical' observer will readily encounter include the 'soprano-tenor-error', which is of a psychological nature[1,2], and this has, unfortunately, produced a systematic error of one octave in the determinations of some of the earlier authors, including Landois himself. I have shown that the critical use of this technique will produce results fully consistent with those obtained by instrumental methods; and the agreement between the frequency of the wing-strokes and the flight-tone has recently been beautifully confirmed by Williams and Galambos with practically simultaneous stroboscopic and oscillographic observations on the flying insect[15]. Moreover, the acoustic method makes it possible to observe insects in free flight, while the other methods more or less limit observation to insects attached to a support.

The wing-stroke frequency, ranging in the insect world from 0 to about 1,000/sec., is found to have a certain relationship to the wing and body dimensions and to the wing-stroke angle of the insect[2]. In some insects (for example, among the Diptera) it varies, moreover, with the environmental temperature[2,9], while in others (for example, among the Hymenoptera) it is independent of this factor[2]. The results concerning the relationship between the frequency and the atmospheric pressure or density have hitherto been discrepant[2,18]. It has also been found that mutilation of the wings by cutting increases the wing-stroke frequency, though this fact has been given a variety of explanations[2,4,7,18,19].

Chadwick, Williams *et al.*[10-14] have shown that the wing-stroke frequency in *Drosophila* is an indicator of the consumption of energy by this insect, and is thus a method by which a quantitative approach to the dynamics of the flight of insects is possible. An investigation carried out in the Department of Zoology, University of Cambridge, during 1948–50[20] has shown that the wing-stroke frequency seems to indicate delicately the state of balance between the dimensions of the insect and the dynamics of its flight. When the wings of an insect are mutilated or loaded, the frequency of wing-stroke varies in inverse proportion to the cube root of the total moment of inertia of the wings, independent of whether the alterations are made symmetrically or asymmetrically on the two sides. When the insect is exposed to subatmospheric pressures, the frequency of wing-stroke is unaffected or shows a certain negative correlation with the pressure (actually, with the density[18]) of the gas medium, depending on the size and the frequency of wing-stroke of the insect.

In one series of experiments, the wings were mutilated by transverse, longitudinal or oblique cuts, or loaded with a drop of collodion. The moment of inertia (I) was calculated by approximate methods and the wing-stroke frequency (ν) determined mainly acoustically. The results were examined on a two-way logarithmic co-ordinate system, and showed the following relationship :

$$\nu \propto I^{-0 \cdot 33 \pm 0 \cdot 05}.$$

In another series of experiments, the insects were allowed to fly in a pneumatic bell-jar, connected with a water-jet pump. The atmospheric pressure (p) was read from the manometer and the frequency of wing-stroke determined mainly acoustically by aid of a microphone inside the bell-jar. The results were examined as above, and showed the following relationship :

$$\nu \propto p^{0 \to -0 \cdot 25},$$

the exponent depending on the size and frequency of wing-stroke of the insect

Considering the wings of an insect as bodies simultaneously performing simple-harmonic rotary motion and as paddles working against the air, and assuming (1) that the kinetic energy of the wings is destroyed after each single up or down wing-stroke, and (2) that the rate of energy output of the insect and the stroke-angle (φ_0) of the wings (that is, the amplitude measured) from the 'equilibrium' position remain constant, the energy used for keeping the wings in motion during a time t is calculated to be

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$$E_t = 2\pi^2\nu^2 I\varphi_0^2 \, . \, 2\nu t = 4\pi^2\nu^3 I\varphi_0^2 t,$$

$$\text{and therefore } \nu \propto I^{-0.33},$$

which very well agrees with the experimental results of the first series. The theoretical value of the amount of work done against the air[20,21] under the same conditions is estimated to be variable—less than 1 per cent of the work done in keeping the wings in motion, that is, against the effect of wing inertia, and therefore negligible, in insects of a large ('usual') size and a relatively high wing-stroke frequency, and more significant in insects with a small size and/or a low wing-stroke frequency. This fully agrees with the experimental results of the second series, and therefore also explains the inconsistency in the earlier results of the effect of atmospheric pressure or density on the frequency of wing-stroke.

If further experiments continue to support the theory advanced here, it follows that: (1) the energy economy in a big insect is very wasteful; (2) the rate of energy output does not vary greatly; (3) it is more economical for the insect to vary the aerodynamic work of the wings by altering the amplitude rather than the frequency; (4) the distribution of energy in flight is delicately balanced; and (5) the frequency must be low and the amplitude large in insects of a very large size, and that a very high frequency and a small amplitude can be afforded only by small insects. Many observations that have been made in Nature agree with these inferences. Attempts were also made to calculate the theoretical muscle efficiency of some insects.

Some laws relating to different morphological characters of the wings of insects have also been formulated, and in some cases a striking correlation is recorded between these characters.

Contrary to the assumption made here, Chadwick[11] has found that, in *Drosophila*, the amplitude shows a correlation with atmospheric density. However, as the amplitude in insects is generally relatively large, the percentage change in it cannot be so great as to produce distinct changes in the balance of other factors involved, such as those described in the present article.

That the mutilation of wings must be symmetrically equal on both sides before an effect on the wing-stroke frequency is observed has been claimed by Roch[5]. This conclusion has been proved wrong by the present author[2,20] and by Chadwick and Williams[13].

The earlier theories of the present author and others[1,18,21,22] relating the wing-stroke frequency to the dimensions of insects or to the dynamics of flight are therefore incomplete, since they neglect the effect of wing inertia; this, however, seems in most insects to be a major factor involved in the dynamics of flight.

Pringle[23] concluded that the main principle in the contraction of the flight muscles in flies was the existence of a non-reflex myogenic oscillation, the frequency of which is controlled by the direct loading of the flight muscles, and which continues so long as the requisite state of excitation is maintained by arrival of motor nerve impulses. He discovered that the nerve impulses recorded in the thorax arrived in a rhythm of one impulse to several wing-strokes; and Roeder's[17] observations that in the fly and wasp the changes of potential (arriving nerve impulses) in the thorax are not synchronous with the thorax movements, while in the moth and cockroach they are, extend this view. The observations presented here would also be in accord with the findings of these authors. [May 8.

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EFFECT OF THE 'MARSH FACTOR' ON THE SHORTENING OF MUSCLE FIBRE MODELS IN THE PRESENCE OF ADENOSINE TRIPHOSPHATE

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In recent papers from this laboratory, B. B. Marsh[1,2] has described a factor present in extracts of fresh rabbit's muscle which inhibits the shrinkage of muscle fibres when treated with adenosine triphosphate (ATP) and also markedly inhibits the breakdown of adenosine triphosphate in a suspension of washed fibres. In view of the important physiological implications of these observations, they have now been extended to a study of the action of the factor upon strips of anatomically intact muscle, modified physiologically so as to render them suitable for demonstrating the action of the factor.

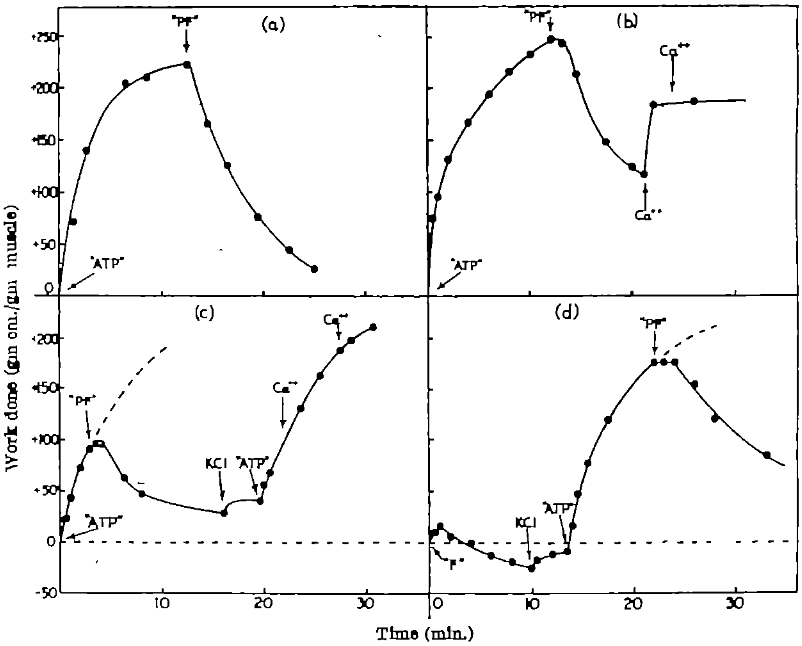
The first difficulty to be overcome was the preparation of a reasonably stable active extract, since, as Marsh showed, the active factor is extremely labile and is inactivated in a large number of cases without apparent cause. After many trials, it was found that an active extract could best be prepared from the psoas muscles of rabbits paralysed with myanesin for 15 min. before death by decapitation. The paralysis ensures a high *p*H (> 7·0) in the muscle[3]. Weighed samples of muscle are then minced with scissors into four volumes of 0·04 M potassium chloride with 0·004 M iodoacetate solution, and immediately homogenized in the Marsh–Snow homogenizer[4] for 1–2 min. The resulting brei is left 30 min. at room temperature to attain full chemical equilibrium and then centrifuged for 5–10 min. at 3,000 r.p.m. About 60 per cent of the original total volume is recovered as a slightly cloudy, opalescent extract. The potassium chloride concentration of the extract is then made 0·16 *M* by addition of 1·6 *M* potassium chloride, and the final solution is stored at 0° C. It is stable for at least 12 hr. The purpose of the iodoacetate in the extractant is to prevent glycolysis and to maintain a *p*H in the range 6·95–7·05. Marsh[3] showed that iodoacetate has no inhibitory effect on the activity of the factor under investigation.

Two methods were employed for preparing a model fibre system on which to test the factor extracts. The first of these (system 1) was a modification of a method of Perry[5], by which the psoas muscle of a rabbit, paralysed for 15 min. with myanesin before death, was exposed and from it were separated with a blunt scalpel thin strips, about 0·3 mm. thick. The strips were tied off with cotton thread at either end, the distance between the ties being 2·0–3·0 cm. The strip was then cut away, attached at one end to the bottom of a vertical muscle-bath and at the other to a light kymograph lever, and fixed at the rest-length. A solution of 0·9 per cent sodium chloride and 0·004 *M* iodoacetate was then run into the bath and left in contact with the strip until rigor had occurred (2–3 hr.). The solution was then run out, and the muscle-bath attached to the supporting column was removed to a room at – 20° C. for 24 hr. It was then brought back to room temperature and fixed in the kymograph machine, and a solution of 0·16 *M* potassium chloride with 0·005 *M* magnesium chloride added to the bath and left there for 10 min. before addition of adenosine triphosphate or Marsh factor.

The second method (system 2) was to prepare strips about 1½ mm. thick from a psoas muscle (as above), attach them to cork supports and submerge them in 50 per cent glycerol at 0° C. for 24 hr. (cf. Szent-Györgyi[6]). At the end of that time they were removed and strips 0·2–0·3 mm. thick were separated from them at 0° C. These were tied off with cotton at either end, the length between ties being 2–3 cm. The strips were then placed in 0·16 *M* potassium chloride with 0·005 *M* magnesium chloride solution, brought to room temperature, and placed in position in the muscle-bath. They were left in potassium chloride solution to attain osmotic equilibrium for 20 min., and additions of adenosine triphosphate or factor were then made. In both systems a gentle stream of nitrogen bubbles was used to stir the fluid in the bath.

Both types of preparation normally shorten under load on addition of adenosine triphosphate. (During a brief period in the spring, system 1 lengthened on addition of adenosine triphosphate and would only shorten on subsequent addition of calcium ions. This effect is as yet unexplained, but may be connected with membrane impermeability.) It was possible with the iodoacetate-poisoned frozen system (system 1) to make a full study of the relation between thickness of fibre-bundle and work done under optimal load and to show that the Webers's contention[7] was correct that only an outside ring of single fibres was fully reactive to adenosine triphosphate over a range of thickness of bundle of 0·2–1·0 mm. It has also been possible to study the effect of the Marsh factor upon it. Such an experiment is illustrated in Fig. *a*. At the first arrow a solution of 0·006 *M* adenosine triphosphate/0·16 *M* potassium chloride/0·005 *M* magnesium chloride was added to a strip 0·3 mm. in diameter. About 220 gm.cm. of work was done per gm. of muscle in 12½ min. under a load of 500 gm./sq. cm. At this point (second arrow) the adenosine triphosphate solution was run out and a factor preparation to which 0·006 *M* adenosine triphosphate had been added for 7 min. previously, was run into the muscle bath. The muscle immediately lengthened, and within another 12½ min. the load had done 195 gm.cm. of work upon it. This effect is typical of normal muscles in the presence of the factor preincubated with adenosine triphosphate. If adenosine triphosphate is added to the factor preparation and the latter then added immediately to the muscle there is a delay of 3–5 min. before lengthening begins.

Exactly similar results are obtained with glycerinated fibres (system 2). Curves of three-factor experiments with such fibres (system 2) are illustrated in Figs *b*–*d*. 0·006 *M* Adenosine triphosphate was used throughout, with or without the presence of the factor. Salt concentrations are as mentioned above for system 1. All the fibre samples were taken from the same glycerinated psoas strip. In addition, three control strips were studied under optimal loading conditions with adenosine triphosphate/



Effect of Marsh Factor preparation when added at various stages during the shortening of fibre-models in the presence of adenosine triphosphate. (*a*) Iodoacetate-poisoned frozen fibres (*b*)–(*d*) Glycerinated fibres
"ATP": 0·006 *M* adenosine triphosphate/0·16 *M* potassium chloride/0·005 *M* magnesium chloride.
"PF": Factor pre-incubated with 0·006 *M* adenosine triphosphate for 3–7 minutes as in text.
"F": Factor mixed with 0·006 *M* adenosine triphosphate and added to muscle immediately
Ca++ Addition of calcium chloride to 0·006 *M*.
KCl: Wash with 0·16 *M* potassium chloride/0·005 *M* magnesium chloride

potassium chloride/magnesium chloride solution alone. These are not shown, but they all shortened immediately on addition of adenosine triphosphate, and at thicknesses between 0·25 and 0·35 mm. gave an average work performance of 316 gm.cm./gm. of muscle in 13 min., with a range of variation of ± 35 gm.cm./gm.

In Fig. *b*, adenosine triphosphate/potassium chloride/magnesium chloride solution was added to the muscle at the first arrow. 250 gm.cm. of work was done in 12 min. At the second arrow a factor preparation pre-incubated with 0·006 *M* adenosine triphosphate for 7 min. was added. Immediate lengthening occurs, and 130 gm.cm. of work is done on the muscle by the load in 9 min. As calcium ions are known to inhibit[1] the increase of fibre-volume in the brei system, calcium chloride (final concentration 0·006 *M*) was added here (at the third arrow) while the factor was still present. The muscle immediately begins to shorten again, and in 4 min. does 40 gm.cm. of work. The curve then straightens out and addition of further calcium ions has no effect. This effect could also be demonstrated in system 1. However, addition of calcium ions only rarely brings about 100 per cent recovery from the lengthening caused by the Marsh factor. It is noteworthy that addition of calcium ions to the system shortening in adenosine triphosphate alone has little or no effect on the rate or amount of shortening (cf. the control curve in Fig. *c*, arrows marked Ca^{++}).

In Fig. *c*, the muscle was allowed to shorten in adenosine triphosphate solution to about half the maximum. At this point, pre-incubated factor was added (arrow 2), and immediately the rate of shortening slows down and within 1 min. the muscle begins to lengthen. This it was allowed to do for 13 min. Then, at arrow 3, the factor was washed out with a solution of potassium chloride/magnesium chloride. This brings about an immediate small shortening, indicating that some active part of the factor complex has been washed out of the muscle before all the adenosine triphosphate is removed. It is an invariable effect of washing with potassium chloride after factor addition. This was allowed to proceed for 3½ min., and then a fresh solution of adenosine triphosphate / potassium chloride / magnesium ions was added at arrow 4. This brings about its normal shortening effect. Addition of 0·006 *M* calcium chloride at arrows 5 and 6 brought about no change of rate, as mentioned previously.

In Fig. *d*, 0·006 *M* adenosine triphosphate was added to a factor preparation and the latter added to the muscle immediately. The muscle begins to shorten and do work, but after 1 min. the shortening ends abruptly and lengthening begins, proceeding almost linearly for 9 min., by which time the muscle has been stretched 5 per cent beyond its rest length. At this time the factor was washed out with a solution of potassium chloride/magnesium chloride (arrow 2) and again the muscle shortened slightly. When this shortening was complete (arrow 3), 0·006 *M* adenosine triphosphate/potassium chloride/magnesium chloride solution was added. Again the muscle shortens and does 185 gm.cm./gm. of work in 8½ min., which is a normal amount in this time. Then at arrow 4 a pre-incubated factor preparation (3 min. only) was added and lengthening sets in after a delay of 2 min.; 100 gm.cm. of work is done on the muscle by the load in 13 min.

All the experiments on addition of the factor and adenosine triphosphate to both model systems thus elicit a lengthening effect. Shortening, if it occurs in the presence of the factor, is of short duration and is followed by lengthening which, however, sets in without delay only if adenosine triphosphate is incubated with the factor for some minutes before addition to the system, thus indicating that time for the formation of the active substance or complex is needed. These results are therefore exactly comparable to Marsh's observations on breis, where addition of adenosine triphosphate to washed breis results in massive decrease of fibre-volume, but addition in the presence of an active muscle extract results in an increase of fibre-volume. The fibre-model system, however, has great advantages over the brei system both in speed of reaction and ease of observation, and is far closer to the physiological system.

Other outstanding similarities between the two systems are the effects of the addition of calcium ions in the presence of the factor and of lowering the ionic strength of the medium.

Addition of calcium ions invariably inhibits increase of fibre-volume in the brei system and lengthening in the fibre-model system, and immediately brings about a decrease in the former and shortening in the latter.

Extraction of the factor at low ionic strengths (for example, extraction with 4 vol. water) results in its temporary inactivation both in the brei and the fibre-model systems. However, addition of potassium chloride to 0·05–0·16 *M* to such an extract re-activates it.

It should be noted that the factor is inactivated by heating to 85° C. for 1½ min., and by holding at *p*H 4·0 for 5 min., as Marsh found. Dialysis, however, even for 48 hr. does not appear to result in loss of activity, at least with preparations at *p*H 6·80–7·10. Moreover, recent work has indicated that the undialysed preparations can be stored at 0° C. without loss of activity for much longer periods than was at first thought. Preparations have been found active after at least a week's storage. From these results it appears that the factor is a large non-dialysable molecule of protein nature, and is stable if stored under the conditions described.

The probable existence of a controlling factor of the nature described was postulated by Englehardt[8] as being necessary in the living muscle to prevent access of adenosine triphosphate to the contractile sites during relaxation and rest. The Marsh factor would fulfil this role, as its marked inhibitory effect on shortening in the presence of adenosine triphosphate and its lengthening effect on shortened muscle clearly show. In a full theory of contraction and relaxation in living muscle, however, the effect of the stimulus and of the subsequent action potential in evoking contraction would, in the light of these findings, have to be explained as at once an inhibition of the factor and an activation of the contractile sites.

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APPARENT ANGULAR SIZES OF DISCRETE RADIO SOURCES

Observations at Jodrell Bank, Manchester

THE existence of discrete sources of extra-terrestrial radio-frequency radiation is now well established[1,2] and the positions of more than one hundred sources have been published[3–6]. Attempts to identify these sources with any particular class of visual object have so far failed, and the origin of the radiation remains unexplained. One of the fundamental requirements in the study of these sources is a knowledge of their apparent angular size, and although attempts to make this measurement have been made by several observers[1–5], it has proved to be beyond the resolving power of their equipment. The present communication gives a preliminary account of a successful attempt to measure the angular size of the two most intense sources the positions[6] and intensities[4] of which are given in Table 1.

Table 1. CO-ORDINATES AND INTENSITY OF THE TWO MOST INTENSE RADIO SOURCES

Source	Right Ascension epoch 1950	Declination epoch 1950	Intensity* at 81 Mc./s. (watts/sq.m./c.p.s.)
Cygnus	19h. 57m. 45·3s. ±1s.	N 40° 35·0′ ±1′	$13·5 \times 10^{-23}$
Cassiopeia	23h. 21m. 12·0s. ±1s.	N 58° 32·1′ ±0·7′	$22·0 \times 10^{-23}$

* The intensity given is twice that observed in one plane of polarization.

The co-ordinates are those given by Smith (ref. 6), and the intensities are those given by Ryle, Smith and Elsmore (ref. 4).

Previous measurements have been made with interferometers. Bolton and Stanley[1], using an interferometer mounted on a cliff and operating in a manner analogous to 'Lloyd's mirror', have shown that the apparent size of the source in Cygnus is less than 8 minutes of arc. More recently, Stanley and Slee[3], using a similar instrument, claim to have reduced this limit to 1½ minutes of arc. Ryle and Smith[5], using an instrument analogous to Michelson's stellar interferometer and with a base-line of 500 metres, have shown that the source in Cassiopeia has an angular size of less than 6 minutes of arc.

The resolving power of an interferometer depends primarily on the ratio of the wave-length to the base-line, and the limits quoted above represented the best performance obtained with the instruments. These limits cannot be reduced significantly without a corresponding extension of the base-line.

In 1950 it was decided at Jodrell Bank to attempt to measure the angular size of the two sources shown in Table 1, or at least to reduce the upper limits given for their size. It was assumed that this angular size might lie anywhere between the limit of a few minutes of arc and the diameter of the visible stars, and an instrument of the highest possible resolving power was therefore sought. While it appeared to be possible to extend the base-lines of existing interferometers to lengths of the order of 10–50 km., it was considered that for much longer base-lines the problem of maintaining an adequate stability of phase in the transmission of signals along the base-line would prove to be difficult. For this reason an interferometer of completely new design was developed.

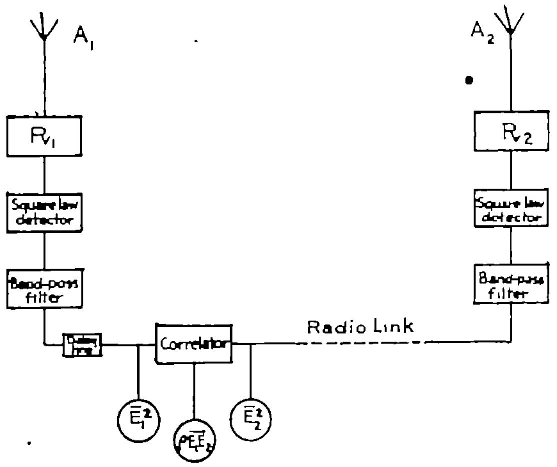

Fig. 1. Schematic diagram of the equipment

Fig. 1 shows a simplified block diagram of the instrument. Two aerial systems A_1 and A_2, each with an aperture of 500 square metres, are connected to two independent superheterodyne receivers R_1 and R_2. These receivers are both tuned to 125 Mc./s. and have a band-width of 200 kc./s. The intermediate frequency output of receiver R_1 is rectified in a square-law detector and is fed to a low-frequency filter the pass-band of which extends from 1 to 2 kc./s. The output from receiver R_2 is treated in an identical manner and the two low-frequency outputs are then multiplied together in a 'correlator' and their 'cross-correlation coefficient' is obtained. When a long base-line is used, one low-frequency output is transmitted over a radio-link by modulating a high-frequency carrier. The time of arrival of the two low-frequency outputs at the 'correlator' is equalized by inserting in one output a delay equal to the time of transmission along the base-line. It is essential that all the components should preserve the relative phase of the two low-frequency signals. In practice, this problem is considerably simpler than the corresponding one of preserving the relative phase of the

Table 2. EXPERIMENTAL RESULTS

Base-line			Cygnus		Cassiopeia	
	Length* (km.)	Bearing†	Correlation coefficient	Angular width of equivalent strip	Correlation coefficient	Angular width of equivalent strip
A	0·30	349·5°	0·99 ± 0·10	< 5′	0·96 ± 0·09	3′ 40″ (< 5′ 30″)
B	2·16	113·0°	0·30 ± 0·03	2′ 10″ ± 4″	0·08 ± 0·02	3′ 55″ ± 10″
C	2·16	235·5°	0·79 ± 0·08	1′ 00″ ± 7″	< 0·01	≮ 3′ 30″
D	3·99	177·0°	0·79 ± 0·07	0′ 34″ ± 8″	0·07 ± 0·01**	

* The value given is the actual distance between the two stations. The effective length of the base-line is calculated from the elevation of the source and the orientation of the base-line.

† The bearing is measured east from north, and is the relative bearing of the base-line from the fixed station at Jodrell Bank.

** This value is not taken into account in Fig. 3, since the other results indicate that the point may lie on a secondary maximum of the curve relating correlation coefficient to base-line.

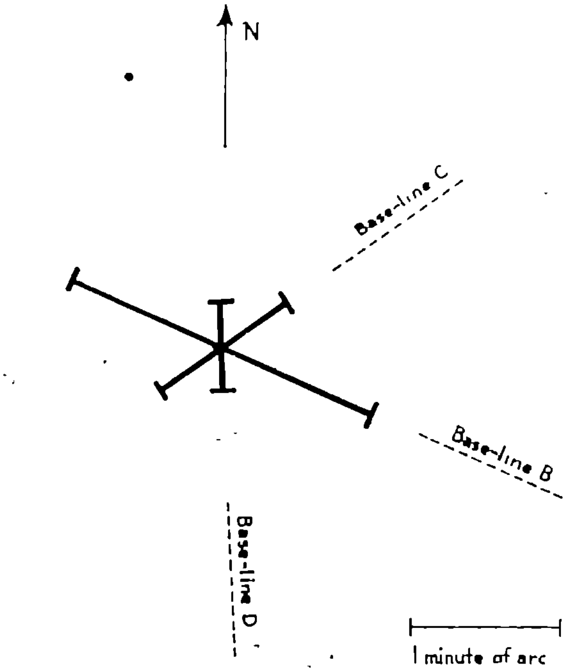

Fig. 2. Equivalent angular width of the source in Cygnus observed from different base-lines. The value shown is the width of an equivalent rectangular strip of constant surface intensity

radio-frequency signals in a conventional interferometer, and hence it should be easier to use the new type of instrument with long base-lines.

In operation, the two aerials (A_1 and A_2) are fixed in azimuth (due north or south) and at an elevation corresponding to the declination of the source. As the source transits the aerial beam, the increase in the mean square value of the two low-frequency outputs ($\overline{\varepsilon_1^2}$ and $\overline{\varepsilon_2^2}$) is recorded together with their product ($\rho\,\overline{\varepsilon_1\varepsilon_2}$). The value of the 'cross-correlation' coefficient' (ρ) is then found from an analysis of the three records.

The theory of the instrument is involved, and it will be given in detail elsewhere[7]. It can be shown that the value of the cross-correlation coefficient (ρ) is given by an expression similar to that for the visibility of the fringes in a Michelson stellar interferometer:

$$\rho = \frac{\sin^2(\pi\alpha b/\lambda)}{(\pi\alpha b/\lambda)^2}, \qquad (1)$$

where α is the angular width of an equivalent rectangular source of constant surface intensity; b is the effective length of the base-line; and λ is wave-length.

Equation (1) shows that by a suitable choice of the base-line it is possible to obtain a value for the angular width of an equivalent rectangular source of constant surface intensity. The shape and angular width of the actual source, together with the distribution of brightness across its disk, can only be found from a large number of observations made with base-lines of different length and orientation.

A model of the instrument, built in 1950, was used to measure the apparent diameter of the sun at 125 Mc./s. As the results of this test were satisfactory, a full-scale instrument was built in 1951, and this has since been applied to the two sources shown in Table 1. Measurements have so far been made on both sources with four different base-lines and the results are given in Table 2. The length and orientation of the base-lines are given in the table, together with the observed values of the cross-correlation coefficient (ρ). The angular size of the equivalent rectangular strip has been calculated for each base-line and the results are also shown in Table 2.

The interpretation of these results in terms of the precise actual size and shape of the sources must be treated with caution, since the three extended base-lines differed in length; and until more results are available it is uncertain what effect variations in the length of the base-line may have on the equivalent angular size of the source.

Figs. 2 and 3 show a plot of the measurements given in Table 2. Fig. 2 shows clearly that the source in Cygnus exhibits a pronounced asymmetry. The value of its equivalent angular size varies from 35″ to 2′ 10″ of arc with the orientation of the base-line, and the major axis of the source appears to be inclined at an angle of between 90° and 120° to the celestial meridian. A preliminary analysis indicates that the results are incompatible with a source of simple elliptical shape and constant surface intensity, and that a more complicated model must be used. Further progress in this analysis must await more observations. The results in Fig. 3 suggest that the source in Cassiopeia is not markedly asymmetrical. The equivalent angular size of the source appears to be about 4′ of arc.

These preliminary measurements establish two major points. First, the apparent angular size of the two most intense radio sources is thousands of times greater than that of the visible stars and is of the order of a few minutes of arc. Secondly, the source in Cygnus exhibits a pronounced asymmetry

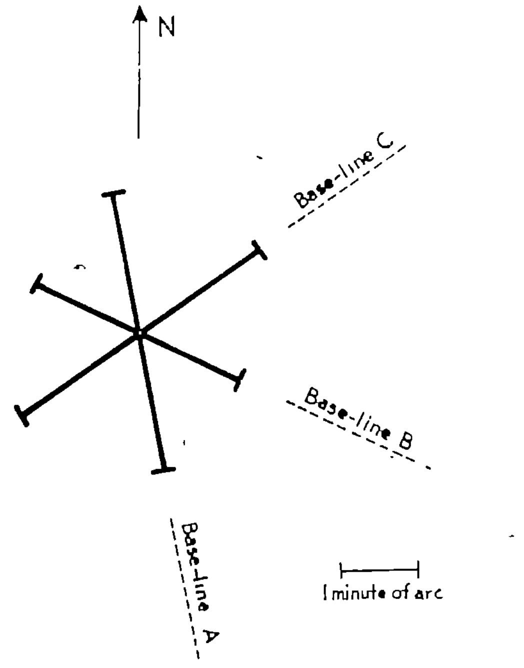

Fig. 3. Equivalent angular width of the source in Cassiopeia observed from different base-lines. The value shown is the width of an equivalent rectangular strip of constant surface intensity

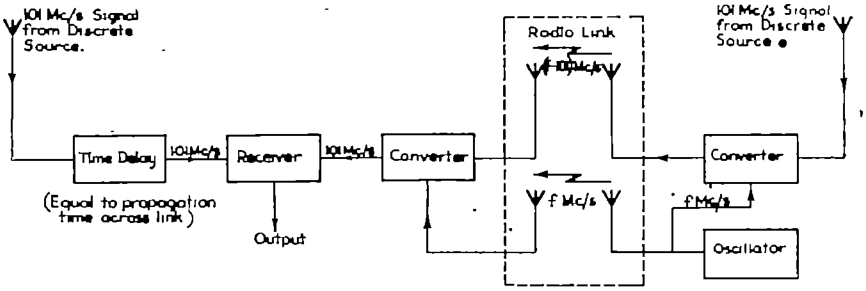
101 Mc/s Signal from Discrete Source.
Time Delay
101 Mc/s
Receiver
101 Mc/s
Converter
(Equal to propagation time across link)
Output
Radio Link
f+101 Mc/s
f Mc/s
101 Mc/s Signal from Discrete Source
Converter
f Mc/s
Oscillator

Fig. 1. Simplified diagram of the interferometer

in angular size, whereas the source in Cassiopeia appears to be roughly symmetrical. The measurements are not yet adequate to define satisfactorily the shape of the sources or the distribution of intensity across their disks. Further observations are now being made with the present apparatus, using different base-lines, and the results will be published later.

The work was carried out at the Jodrell Bank Experimental Station of the University of Manchester. The construction of the apparatus was made possible by a grant from the Department of Scientific and Industrial Research. We wish to thank Dr. R. Q. Twiss for his assistance with the mathematical theory, and Prof. A. C. B. Lovell for making the necessary facilities available and for his interest in the investigation. One of us (R. H. B.) is indebted to Messrs. Imperial Chemical Industries for a fellowship, and one (M. K. D. G.) to the Government of India for a scholarship and to the Department of Scientific and Industrial Research for a maintenance grant.

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Observations at Sydney

The first observers of the discrete sources of cosmic noise were unable to determine their size, and many considered that they might be of stellar dimensions. However, recent observations have shown that a number of these apparently 'point' sources have angular extensions of the order of $\frac{1}{4}^\circ$ [1-3]. Position measurements have also suggested that the stronger sources might be identified with nebulæ of an angular size ranging from half a minute to several minutes of arc[3,4,5].

In order to check the hypothesis that the discrete source radiation originates in nebulæ rather than in individual stars, an interferometer with a lobe spacing as small as 1 minute of arc was considered necessary. At a frequency of 100 Mc./s., which is convenient because small low-gain aerials may be used, a Michelson-type interferometer requires an aerial separation of 10 km. to achieve this resolution. Such an interferometer was constructed using one small, easily portable aerial and one large fixed aerial. The signal from the portable aerial is transmitted back to the main receiver by a radio link. A simplified diagram of the equipment is shown in Fig. 1.

The local oscillator frequency must be transmitted together with the converted signal, as it is necessary to preserve the phase of the reconstituted signal at the receiving end of the link. Also a time-delay must be inserted in the signal-path from the fixed aerial to equalize the propagation times from each aerial to the mixing point. This time-delay is obtained with a mercury-filled acoustic delay line. Automatic gain controls are used to ensure equality of the signal-levels from each aerial and pre-amplifier system before they are combined in the receiver. The equipment has shown a variation in sensitivity of about 15 per cent over the period of six months that it has been in operation.

Preliminary measurements have been made on the four most intense sources observable from Sydney with various aerial spacings in an east–west direction. With the range of aerial spacings used, the four sources show a reduction in the amplitude of their interference patterns as the aerial spacing is increased, indicating that all four sources have been resolved by the equipment. The effects of aerial separation on the amplitudes of the interference patterns are summarized in Table 1.

Table 1

Aerial spacing	0 29 km.	1 02 km.	5·33 km	10 01 km.
Relative amplitude of interference pattern for Cygnus A	1	1	0 3	0 05
Taurus A	1	0·55	*	*
Virgo A	1	0 4	*	*
Centaurus A	1	0 3	*	*

* In these cases the amplitudes of the interference patterns were less than the noise fluctuations of the equipment and could not be observed. The relative amplitudes are less than 0·1–0 2

The probable errors in the relative amplitudes are thought to be about 10 per cent. The errors will be discussed in detail elsewhere; but it is worth mentioning one potential source of error. This is phase instability in the equipment and propagation link. It was checked using 101 Mc./s. transmissions from a small transmitter, which were received by both aerials and compared in phase at the mixing point. The resulting error was found to be negligible.

An inspection of the table reveals that the amplitudes of the Taurus A, Virgo A and Centaurus A sources are all significantly reduced with an aerial spacing of 1 km., whereas a spacing of 5 km.

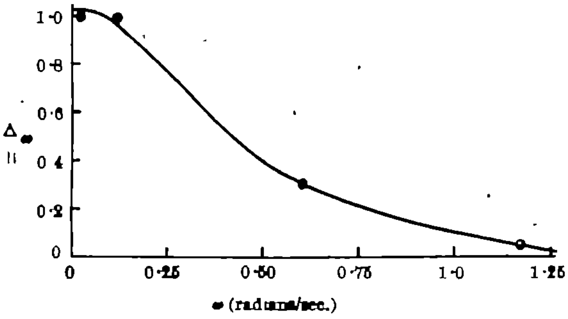
is required to produce a comparable reduction in the amplitude of the Cygnus source. The first-mentioned sources are all, therefore, of similar size and approximately five times the size of Cygnus A.

It has been shown that the amplitude and phase of the interference pattern produced by a source when observed with a given aerial spacing is related to the radio brightness distribution across the source by a Fourier transform[6] (the brightness being measured as the integrated emission across a strip at right angles to the interferometer axis). Thus, if the amplitudes and phase angles are known at a sufficient number of spacings, the brightness distribution may be obtained by Fourier synthesis. In the case of an interferometer with an east–west axis as we have here, this synthesis is given by

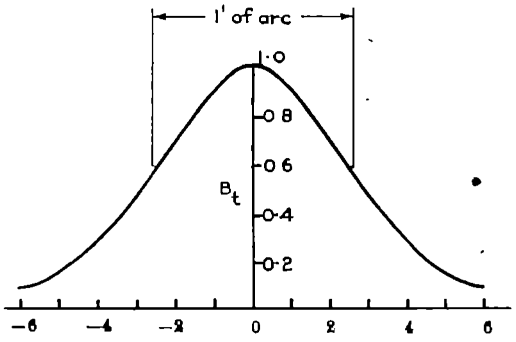
$$B_t = \int_0^{\sigma} A_\omega \cos\,(\theta_\omega + \omega t)\, d\omega,$$

where B_t is the brightness distribution in right ascension in arbitrary units, ω denotes the pulsatance of the sinusoidal interference pattern, corresponding to the aerial spacing, and A_ω and θ_ω the amplitude and phase of the pattern.

The present interferometer cannot be easily adapted to measure phase, so that the true distribution B_t is not easily obtained. If, however, the distribution is assumed to be symmetrical, θ_ω is then zero and an 'equivalent symmetrical distribution' can be obtained. This equivalent distribution is merely the cosine transform of the amplitude–pulsatance spectrum.



(a) Amplitude–pulsatance spectrum of Cygnus *A*



(b) Derived equivalent brightness distribution across Cygnus *A*

Fig. 2

For the Cygnus source we have four points from which to determine this spectrum. In Fig. 2(*a*) these points are shown and a smooth curve is drawn through them. Because of the absence of observations in the region between 1 and 5 km., there is some uncertainty in the exact shape of the curve, but its general features are clear. The equivalent brightness distribution corresponding to this spectrum is shown in Fig. 2(*b*). Because of the uncertainty in the spectrum, there is a corresponding uncertainty in the shape of this curve, particularly with regard to the skirts.

In the case of the other sources, there are not enough points to determine the spectra; but, if the reasonable assumption is made that their brightness distributions are similar to that of Cygnus A, it is possible to estimate their sizes. Defining an 'effective' size as the angle between half-brightness points on the equivalent distribution curve, we have the results of Table 2.

Table 2

Source	Effective size (E–W) (minutes of arc)
Cygnus A	1 1
Taurus A	4
Virgo A	5
Centaurus A	6

The size of the Centaurus source has been given previously as about $\frac{1}{3}$°[1,2]. It has been shown, however, that it consists of an extended source of nearly 2° in size with a strong concentration near its centre[3]. The size quoted in Table 2 is that of the central concentration. Measurements with very close spacings have confirmed the interpretation in terms of two apparently quite distinct contributions.

The four sources have been found to have positions very close to nebulæ, and it is now found that their angular sizes are comparable with those of the nebulæ in question. We may therefore say that the suggested identifications of the four sources concerned have been strengthened, almost to the point of certainty. The confirmation is particularly welcome in the case of Cygnus A, as when it was first pointed out that this nebula was near the radio position of the source[4] it appeared to be a typical galaxy, too faint to be responsible for the radiation. Minkowski has now shown, however, that it has very peculiar features (personal communication). Taking these sources in conjunction with the others for which angular sizes have been obtained, there is now strong evidence that the discrete sources are largely, if not entirely, nebulæ. Both galactic and extra-galactic nebulæ have been identified.

This work is continuing and will be described in more detail elsewhere.

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Observations at Cambridge

At the recent meeting in Sydney of the International Union of Scientific Radio, reports were given of three separate experiments designed to measure the angular diameter of radio stars by the use of interferometers of large resolving power. Two of the experiments, by Hanbury Brown and by Mills, have been extended and are the subject of the present communication. The third, carried out at Cambridge in the first half of this year, has been described elsewhere[1]; since a rather different range of apertures was used in this experiment, it is thought appropriate to describe the results briefly for comparison with the other accounts.

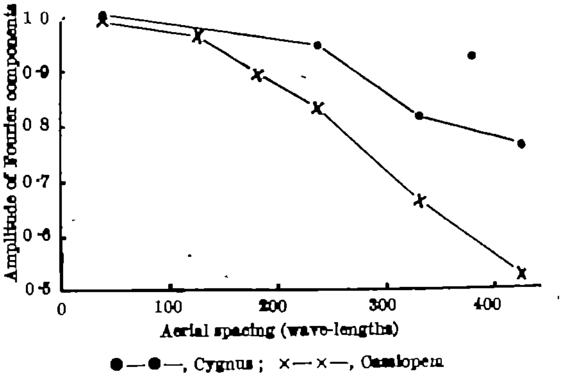
It was first pointed out by McCready, Pawsey and Payne-Scott[2] that interferometer aerials could be used to determine the angular distribution of radio 'brightness' across a source of radio waves. They showed that this distribution could be resolved into Fourier components by the use of different aerial spacings. The application of this principle to the determination of the distribution of radio brightness across the sun has already been described[3,4]; it was shown that a determination of the complete variation of the amplitude of a recorded signal as the aerial spacing was changed allowed the radial distribution of a circular source to be derived.

Similar observations have been made in an attempt to determine the distribution of brightness across the intense radio stars in the constellations of Cygnus and Cassiopeia. Owing to the smaller angular diameter of these sources, it was necessary to determine the amplitudes for the smaller spacings with considerable accuracy. It was not possible to determine the whole amplitude spacing curve with the maximum aerial separation available; the fine structure in the distribution of radio brightness across the source could not, therefore, be determined.

In these observations, which were made at a wavelength of 1·4 m., the phase-switching method of detection[5] was used with aerials spaced along an east–west line up to distances of 400 wave-lengths. This method of detection allows the use of pre-amplifiers at the aerials and, therefore, enables large spacings to be used without difficulties due to the attenuation in the transmission lines. In order to avoid the necessity for long-term stabilization of the gain of a movable aerial system, a new system of observation was devised in which measurements were made of the ratio of the amplitudes of the records obtained with two different aerial spacings. These two spacings were obtained by using the movable aerial alternatively with two fixed aerials, and it was then no longer necessary for its gain to remain constant. Each observation then provides a measure of the ratio of two Fourier terms; although it was not possible to derive the separate Fourier components uniquely from the results of these experiments, a fair approximation to the actual curve of Fourier components could be derived. The results obtained by this method are therefore comparable with those obtained in the two other methods; and although the present method cannot conveniently be used to make measurements at very great apertures, it has advantages for determining the Fourier terms related to the larger-scale structure of the brightness distribution.

MEASURED RATIO OF FOURIER COMPONENTS

Aerial spacing in wave-lengths		Cygnus	Cassiopeia
87	423	0·79 ± 0 05	0·62 ± 0 05
131	330	0·83 ± 0 02	0 70 ± 0 02
36	234	0·94 ± 0 03	0·84 ± 0 02
13	186	—	0·92 ± 0·03
75	124	—	0·97 ± 0·02



Measured Fourier components of the distribution of radio 'brightness' across the radio stars in Cygnus and Cassiopeia

The results of the Cambridge observations on the radio stars in Cygnus and Cassiopeia are shown in the accompanying table.

A possible interpretation in terms of Fourier components is shown in the diagram.

The measurements are consistent with those to be expected from a uniformly bright disk of 3·5′ diameter for Cygnus, and 5·5′ diameter for Cassiopeia. The measurements at larger resolving powers reported at the Sydney meeting of the International Union of Scientific Radio by Hanbury Brown and by Mills showed that there is also some structure of smaller angular width, and that there might be some considerable departure from circular symmetry. It is of interest to compare these results with those that might be expected from the visible nebulæ which have been identified with those two radio stars (Baade and Minkowski, in course of publication).

The Cygnus nebula is extragalactic. It has a central concentration about ¼′ of arc across, surrounded by a more diffuse region. The nebula is faint, so that it is difficult to estimate the extent of this region, but it is at least 2′ of arc in diameter.

The Cassiopeia nebula is a gaseous nebula in which the brightness is distributed unevenly over a roughly circular region about 5′ of arc in diameter. There are some particularly bright regions concentrated in an area extending 2′ of arc east–west and 1′ of arc north–south.

It appears that the radio measurements are in good agreement with the brightness distributions which might be expected from these nebulæ; this conclusion further strengthens the evidence for their identification with the two radio stars.

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LETTERS TO THE EDITORS

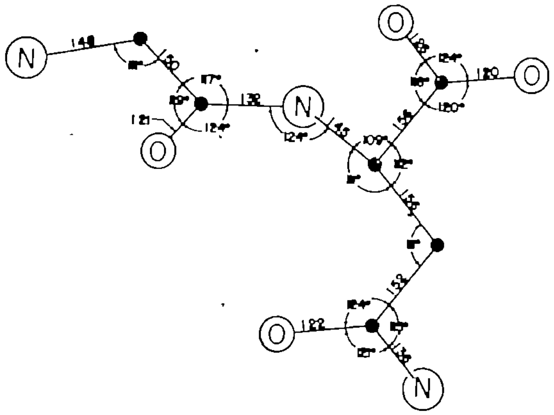
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Configuration of the Peptide Link and of Asparagine in Glycyl-L-Asparagine

Since the geometrical problem of protein structure is mainly that of the configuration of the polypeptide chains, the geometry of the peptide link itself is a matter of prime importance. However, very few crystal-structure data have yet been published from which precise dimensions of the peptide link may be derived. We have recently carried out a three-dimensional X-ray analysis of the structure of glycyl-L-asparagine which provides an additional source of these data. Our analysis also provides information concerning the molecular configuration of asparagine, an amino-acid the structure of which has recently been discussed in *Nature* by Steward and Thompson[1].

The crystal data for glycyl-L-asparagine are: density, 1·506 (by flotation); space group, $P2_12_12_1$ (orthorhombic); unit-cell dimensions, $a = 4·81$, $b = 12·85$ and $c = 13·52$ A.; number of molecules per unit cell, 4. The intensities of all observable copper $K\alpha$ reflexions (more than a thousand) were estimated visually. These data were used to prepare a sharpened three-dimensional Patterson synthesis, from which, aided by application of the vector convergence method[2,3], we were able to deduce a satisfactory model for the molecule. Refinements of the thirty-nine positional parameters (excluding hydrogens) were made by using two- and three-dimensional Fourier synthesis and least squares methods. Most of the calculations were carried out with I.B.M. machines. The average standard error in the final parameters is 0 010 A.

The molecule of glycyl-L-asparagine (see diagram) can be described most simply by reference to two planes approximately at right angles to each other. One plane contains the succinamic acid part. The other contains the five atoms of the peptide group; the C—N bond to the amino-nitrogen atom points 8° out of this plane. One carbon atom is common to both planes. As is found in other amino-acids and peptides, the molecule of glycyl-L-asparagine contains the charged groups $—NH_3^+$ and $—COO^-$.



A drawing of the molecule of glycyl-L-asparagine viewed along the *a*-axis of the crystal. Bond-lengths are given in angstroms

The dimensions of the peptide (see diagram) agree, within the limits of error of the structure determination, with those postulated by Pauling and Corey[4] in their models of proteins. In particular, their assumption of planarity for the peptide group is supported, since we find the average distance of the atoms from a plane to be 0·002 A. The atoms of the asparagine residue, excluding its α-amino-nitrogen atom, form a nearly planar extended chain. Thus, our structure does not conform to the cyclic structure proposed by Steward and Thompson[1] for free asparagine, and visualized by them as a possibility also when the molecule occupies the terminal position at the carboxyl end of a peptide chain.

There is a significant difference in the lengths of the C—O bonds of the carboxyl group. This difference is consistent with the distribution of hydrogen bonds; the oxygen atom of the longer bond participates in three N—H···O bonds, the other oxygen atom in only one. The carboxyl group is co-planar as expected. The same is true of the terminal amide group, and its bond-lengths are close to those found in the peptide amide group. However, the bond-angles around the carbon atom of the terminal amide group are significantly different from the corresponding angles in the peptide amide group; their magnitudes are reminiscent of those reported for the molecule of acetamide[5].

Of the six possible hydrogen bonds, five are found to have satisfactory lengths (2·75–2·93 A.) and bond-angles. The sixth, which involves the amino-nitrogen atom, has a length of 2·99 A. but is open to question, because its angles with the other H-bonds deviate appreciably from the tetrahedral.

We wish to thank Dr. John Leonard for the preparation of the glycyl-L-asparagine and for his assistance in reading the intensities. We are indebted to Dr. Jerry Donohue for valuable discussions and for instruction in the I.B.M. computing techniques.

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Aug. 18.

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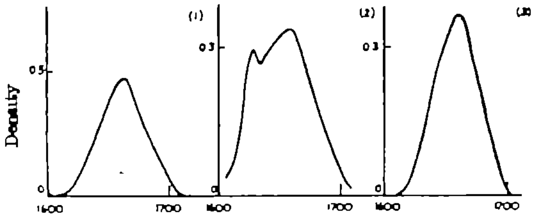
Behaviour of a Synthetic Polypeptide analogous to Protein Denaturation

Some observations made recently in this laboratory suggest a considerable resemblance, in certain respects, between poly DL-alanine and the soluble form of silk obtained from solution in cupriethylene diamine or lithium bromide solution[1,2].

Poly DL-alanine (degree of polymerization estimated from end-group analysis, about 500) is readily soluble in cold water, giving a mobile solution from which coherent films may be cast. The infra-red spectrum of these films (Fig. 1) shows a single C=O stretching mode at 1,662 cm.$^{-1}$, the frequency corresponding to a folded polypeptide chain[3]. If the solution is heated, a gel quickly separates out; this gel is not redissolved



Infra-red spectra of dried poly DL-alanine films. (1) Cast from aqueous solution at room temperature, (2) cast from boiled aqueous solution (gel), (3) cast from gel dissolved in formic acid

on cooling. A gel is also formed if the solution is kept at room temperature for several weeks. The spectrum of the dried gel (Fig. 2) shows a distinct additional peak of 1,629 $cm.^{-1}$, corresponding to the frequency of an extended (β) polypeptide chain. The dried gel is soluble in formic acid, and the film cast from this solution is water-soluble and shows only the 1,662 $cm.^{-1}$ peak (Fig. 3); this shows that the polypeptide has been taken through a cycle back to its original condition.

An alternative method of changing the water-soluble film to the insoluble form containing a proportion of extended chain is to roll it out. In this case, the β-material is oriented and measurements with polarized infra-red radiation confirm, from the type of dichroism observed, that the 1,629-$cm.^{-1}$ band is associated with an extended chain.

Another point of interest was observed during experiments on the effect of deuteration on poly DL-alanine. It was found that the polymer goes much less readily into solution in D_2O than in H_2O. In view of the complication of the α–β transformation, it is not certain at present what significance is to be given to this observation.

It is evident that in poly DL-alanine the equilibrium between α- and β-forms is very nicely balanced, and the transition from one to the other is readily induced. A similar state of affairs is known to exist in the soluble form of silk which in aqueous solution sets to a gel after some days, and which in the solid may be rendered insoluble by mechanical treatment[1]. Changes in the C=O band similar to those here reported accompany the insolubilization of silk[2].

Changes in synthetic polypeptides from α- to β-forms have been described before[3-5], but this is the first case in which the change can be brought about in aqueous solution, or by mechanical working at room temperature, earlier examples being produced by the action of formic acid, or by stretching in steam. It was an unexpected result that poly DL-alanine dissolved in formic acid gives an α-film, for this reagent, in the case of several polypeptides, produces a change from α- to β-configuration. However, it is highly satisfactory that a synthetic polypeptide exists which is capable of changes which are so reminiscent of denaturation and renaturation of proteins. In this case, there is no complication of active side-chains which, in proteins, may complicate the effect of various processes on solubility. The results speak strongly for the view[6,7] that an α–β transformation is often involved in protein denaturation.

It would be of great interest to know whether the α–β change in poly DL-alanine ever goes to completion, and, if not, why. It must be remembered that in a racemic chain there may be a succession of D- (or of L-) residues, whereas in other parts the order may be —D—L—D—L—. Such differences in the succession may be significant in a system like poly DL-alanine, and some parts of the chain may change over to the extended form more readily than others.

I am greatly indebted to Mr. W. E. Hanby, Dr. S. G. Waley and Dr. J. Watson for samples of poly DL-alanine, and to Mr. G. Ingram for the end-group analyses.

A. Elliott

Courtaulds, Ltd.,
Maidenhead,
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Sept. 6.

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The Hydrogen-Oxygen Reaction Sensitized by Nitrosyl Chloride

In studies[1] of the explosions of mixtures of hydrogen and oxygen sensitized by nitrogen peroxide and nitrosyl chloride, the following reactions have all been suggested as chain-initiating steps.

$$NO_2 \rightarrow NO + O \tag{1}$$

$$NOCl \rightarrow NO + Cl \tag{2}$$

$$NO + O_2 \rightarrow NO_2 + O \tag{3}$$

We have devised experiments which appear to give a direct demonstration that nitric oxide is concerned in generating centres.

A cylindrical 'Pyrex' vessel was built with a 'multiple-entry' tube centrally disposed (Fig. 1). The dead space, including the Bourdon spoon gauge, was made less than 6 per cent of the volume of the vessel by inserting the solid rod; at the same time the entry tap could be of wide bore.

In the first series of experiments, comparisons were made at 360° C. between the behaviour of mixtures of nitrosyl chloride, hydrogen and oxygen made up (*a*) outside the vessel, and then admitted, and (*b*) with the nitrosyl chloride put into the reaction vessel for a definite time, and the premixed hydrogen and

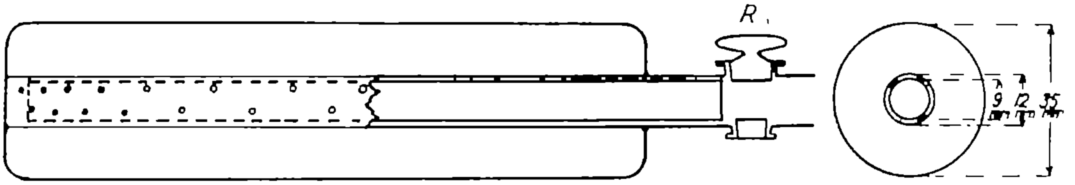

Fig. 1. Annular reaction vessel with multiple entry tube

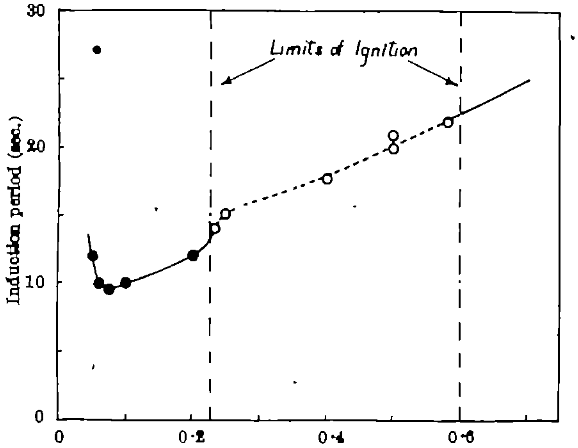

Fig. 2. Variation of the induction period with pressure of nitrosyl chloride, for 120 mm. of hydrogen and 60 mm. of oxygen at 360° C. Ignition between the limits, ----; slow reaction outside the limits, ———

oxygen then run in to give the same total pressure as in (*a*), namely, 120 mm. of hydrogen and 60 mm. of oxygen. With method (*a*) the results previously reported were confirmed; the existence of upper and lower sensitizer limits, and the trend of induction periods were as expected, as is shown in Fig. 2. With method (*b*), however, the induction periods between admitting the hydrogen and oxygen and the onset of ignition were considerably shortened. Fig. 3 shows a typical set of results, and it will be noticed that the induction periods become zero with quite short times of decomposition of the nitrosyl chloride.

In the second series of experiments, nitric oxide was put in the reaction vessel, and hydrogen and oxygen mixtures were run in, first without, and then with, traces of nitrosyl chloride, to give a total pressure of hydrogen and oxygen of 180 mm. With nitric oxide in the vessel and no nitrosyl chloride with the reactants, instantaneous ignitions were observed with all the pressures of nitric oxide used, from 0·25 mm. up to 10 mm. If there is an upper sensitizer limit under these conditions, it is extremely high. However, when sufficient nitrosyl chloride was run in with the reactants, the ignitions were suppressed; with smaller quantities of nitric oxide and

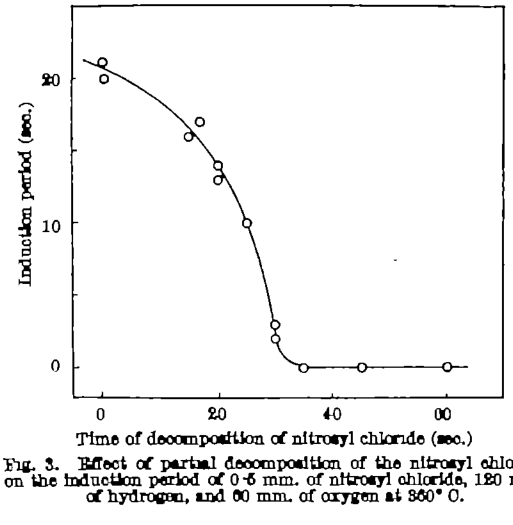

Fig. 3. Effect of partial decomposition of the nitrosyl chloride on the induction period of 0·5 mm. of nitrosyl chloride, 120 mm. of hydrogen, and 60 mm. of oxygen at 360° C.

In reaction vessel at 360° C.	Run in with hydrogen and oxygen	Induction period
0·25 mm. NO	—	Instantaneous ignition
0·50 mm. NO	—	Instantaneous ignition
0·25 mm. NO	0·25 mm. NOCl	17 sec.
—	0·50 mm. NOCl	20 sec.
—	0·50 mm. NO	10 sec.
0·50 mm. NO	0·50 mm. NOCl	No ignition

of nitrosyl chloride in the reactants, the induction periods reappeared before ignition. The accompanying table gives examples of these results.

In considering the relation of these facts to previous work[1], it is important to note that evidence has recently been obtained[2] that the rate of decomposition of nitrosyl chloride is much faster at temperatures above 300° C. than would be predicted from studies[3] of the decomposition at lower temperatures.

The experiments establish that a reaction of nitric oxide, such as (3), is concerned with an initiation step in the reaction between hydrogen and oxygen sensitized by nitrosyl chloride, and that the chief function of nitrosyl chloride is as a chain terminator. They suggest that part of the induction period is the time required for the nitrosyl chloride to decompose, yielding nitric oxide. In these respects, nitric oxide and nitrosyl chloride appear to play a similar part in the hydrogen – oxygen – nitrosyl chloride and in the hydrogen – chlorine – nitrosyl chloride systems[3].

We wish to thank Prof. R. G. W. Norrish and Prof. F. S. Dainton for many helpful discussions.

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July 18.

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Determination of the Velocity of Burning

In a recent paper by Linnet and Conan[1], it is pointed out that the *Schlieren* cone is better suited for determining the velocity of burning than the luminous flame cone and the shadow cone. The *Schlieren* cone lies closer to the centre, as has been demonstrated by Broeze[2] and by others. Consequently, the deflexion of the outflowing gas through the combustion wave is considerably smaller at the *Schlieren* cone than at the luminous cone. Linnet and Conan justly remark that the cone at which the above-mentioned deflexion starts (which lies still deeper in the flame) is the most suitable for determining the velocity of burning. However, they did not recognize such a cone. I suggest it can be made visible by a phase-contrast photograph[3]. In order to attain this, the diffraction images of the light source are not intercepted in the focal plane *F* (see Fig. 1), as is done when applying the *Schlieren* method. Instead, the central image of this light source is changed in phase by 90° with respect to the diffraction images. Zernike[3] developed this method for the microscope. Calculations by Zernike show that the phase-contrast image is identical in structure and intensity with the gradients of the refractive index in the object (that is, the flame zone).

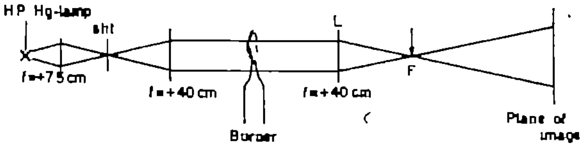

Fig. 1. Optical system for photographing *Schlieren* or phase-contrast cones
↓ Razor or phase strip. This must be placed exactly at *F*, as otherwise the plane of image is not uniformly illuminated if there is no flame interposed

By the *Schlieren* method, on the contrary, an image is obtained which does not give an absolutely correct representation of the object if there are steep gradients, owing to a relatively small contribution of diffraction images of higher order to the formation of the image.

This is expressed by the fact that velocities of burning determined with the *Schlieren* cone and those determined with the phase-contrast cone do not show the same values, as can be seen from Fig. 2. At the maximum velocity of burning (when the gradient is steepest) the divergence of the curves is greatest.

As structurally the phase-contrast image is identical with the gradient in the object, the starting point of the flame zone must coincide with the starting point of the deflexion of the outflowing gas. In Fig. 3 this is demonstrated by a photograph of the flame cone itself, taken together with a phase-contrast photo. A flow line (made visible by titanium chloride smoke) indicates the course of the outflowing gas.

Consequently, we must determine the velocity of burning with the help of the inside of the phase-contrast cone. In order to eliminate disturbing influences from base and tip, it is desirable to apply nozzle flow and use the middle part of the cone. This middle part must, in this case, show a straight generatrix. So long as no extremely poor or rich mixtures are used and the outflow velocity is sufficiently high, this is always realizable. With mixtures having extreme mixing ratios, deviations are caused by diffusion normal to the flow tubes[4]. Consequently, in this case we have to put up with a mean value over a certain length of cone.

The flame front selected in this manner is the only one which, both in the application of the surface method and of the angle method, gives the same value of the velocity of burning.

J. van Steennis

Central Laboratory of Staatsmijnen,
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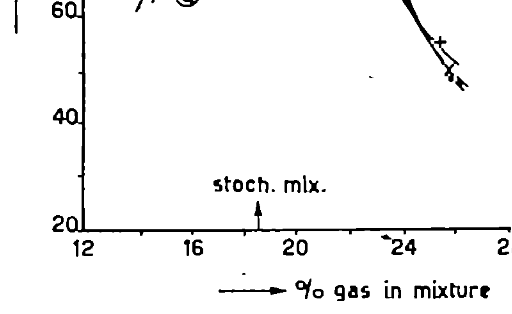
June 5.



(1) + — +, *Schlieren* method,
(2) × — ×, phase-contrast (outside cone);
(3) — · , phase-contrast (inside cone).

Gas composition

H_2	63·1
CH_4	25·2
N_2	4·9
CO	4·8
unsat. (C_{2-4})	1·6
O_2	0·4

Fig. 2. Burning velocity of mixtures of coal gas and air

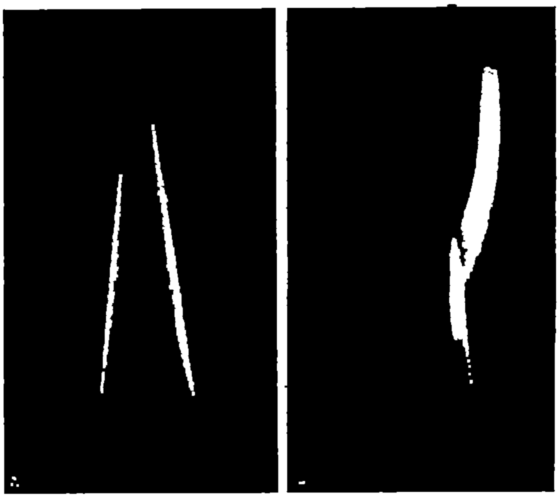


Fig. 3. (*a*) Phase-contrast photograph of a coal gas – air flame. (*b*) Phase-contrast cone together with luminous cone and stream tube made visible by titanium chloride smoke. Deviation of stream tube starts at inside of phase-contrast cone

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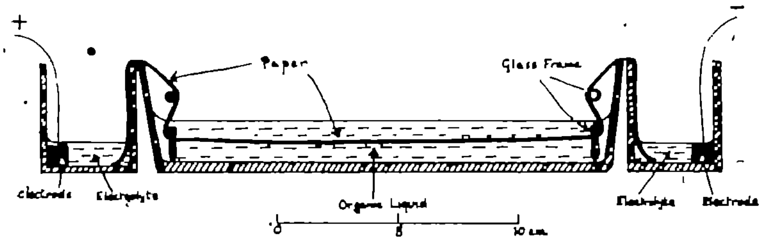
A Simple Paper Electrophoresis Apparatus

Electrophoresis and ionophoresis on paper are being widely used, and a number of different forms of apparatus for carrying out this technique have already been described. The purpose of this communication is to give further details of an apparatus already briefly described[1], which has been used for a considerable time with satisfactory results. While we do not claim that it is superior to other types of apparatus, it has the advantage of simplicity, results are reproducible, and the movement of a given substance varies linearly with time. The cross-section is shown in the accompanying diagram. The apparatus consists of a flat rectangular glass tray in which stands a closely fitting glass frame which carries the paper strip and rectangular 'Perspex' electrolyte boxes. The dimensions of the apparatus are not critical, but glass drip-trays from refrigerators are very convenient, the outside measurements being about 35 cm. × 20 cm. × 5 cm. The frame is constructed of two rectangles of glass rod, mounted one over the other, and separated from each other by



Cross-section of paper electrophoresis apparatus

about 1·5 cm. by means of sealed-on pieces of glass, or by pieces of cork at the corners. The frame stands on short legs to keep the paper away from the floor of the tray. Each electrode box has a hole drilled through the end about 1 cm. above the bottom. This enables electrolyte-levels in both boxes to be balanced prior to electrophoresis, and also permits old electrolyte to be run out and replaced by fresh, should this be desired.

The usual procedure is to soak the paper in electrolyte, remove excess liquid by blotting, and drape through the frame as shown in the diagram. The whole apparatus is mounted level, and the levels of electrolyte are not higher than that of the paper. The solution to be analysed is applied to the paper in the usual way[1,2]. An organic liquid is now poured into the tray, so that the paper is covered. Glass pieces are placed in the electrolyte boxes to keep the paper from contact with the electrodes, and the whole tray may be covered with a glass lid. At the end of the experiment the frame with the paper is removed and dried.

Voltage, current and other conditions are as already described[1]. It has not been usual to control the temperature, but if the heating effect is too high, the tray is stood in a larger tray carrying cooling water. The organic liquid acts as a cooler and prevents undesirable evaporation of electrolyte. Chlorobenzene has normally been used in the organic liquid, because its specific gravity is similar to that of wet paper, and so allows the strip to remain horizontal; this helps to prevent secondary flow of electrolyte.

For a voltage gradient of about 10 V./cm. and with Whatman No. 1 paper, 2–3 hr. is normally sufficient for substances of moderately high mobilities; but for slower-moving substances, for example, serum proteins, 4–5 hr. is required. The distance of migration and also of electroendosmosis will, of course, vary with the type of paper. This is shown in the accompanying table, which gives the migration of human serum albumin in borate buffer, *p*H 8·6 at 10·3 V./cm. and average temperature 20°. Electroendosmosis was measured by the movement of creatinine from the origin. Migration refers to the distance between albumin and creatinine. All the papers listed were found to be suitable for simple substances such as amino-acids and sugars, but some were not suitable for serum proteins, and these are indicated. The migration of other given substances on the different papers varies similarly to that of albumin.

MIGRATION OF HUMAN SERUM ALBUMIN AND ELECTROENDOSMOSIS (CM./HR.) ON VARIOUS WHATMAN PAPERS IN BORATE BUFFER, *p*H 8·6 AT 10·3 V./CM. AT 20°

Whatman No	Electroendosmosis	Migration of albumin
1	0·9	3·2
2	0·9	2·8
3	0·9	3·4
4	0·6	2·8
5	0·4	2·1
20	0·9	2·7
42	0·7	2·4
50	0·2	1·4*
52	0·7	2·1
54	0·8	2·4
542	0·5	1·6*

* Not measurable accurately. These papers are unsuitable for serum proteins.

It is often desirable to carry out chromatography after the electrical separation in a direction at right-angles to that of ionophoresis[1]. The dimensions of the frame limit the length of paper available for chromatography, but an extra length can be obtained by folding a sheet of paper which is too long, so that it can be draped through the frame. An additional advantage of the frame for chromatography is that it eliminates undesirable contamination of the paper by the hands.

The choice of paper will be influenced by speed of migration and electroendosmosis (see table). Other considerations may limit the choice further. Thus, for quantitative work, a higher-grade paper than No. 1 may be necessary (for example, No. 20), or where more material is to be handled, a thick paper such as No. 3. The latter has been used for the isolation of milligram quantities of carbohydrates after ionophoresis. For certain purposes the ratio of electroendosmosis to migration of a given substance should be small[2], and papers Nos. 4, 5 and 50 have this property. In addition, the chromatographic properties of the paper will have to be taken into consideration, where two-dimensional separations are to be carried out, in view of the limits set by the apparatus on the length of paper available for chromatography. As is well known, a given substance will move chromatographically at different speeds on different papers in a given solvent system. Movement is relatively fast on No. 4, and this paper is therefore not suitable for substances of high R_F value, unless a short period of development is employed. Movement on Nos. 1, 3 and 54 is similar, while on No. 20 it is somewhat slower, and on No. 42 slower still. The latter is suitable for substances of high R_F value, and it also has the advantage of a high wet strength.

One of us (W. M. S.) is in receipt of a grant from the Medical Research Council.

R. CONSDEN
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Special Unit for Juvenile Rheumatism,
Canadian Red Cross Memorial Hospital,
Taplow, Maidenhead. Oct. 3.

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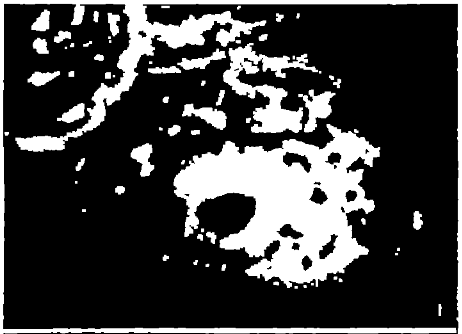
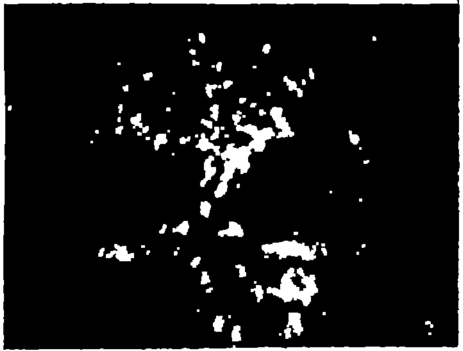
Pectinase Technique for Isolating Plant Cells

PLANT root meristems are a readily available source of mitotic cells which are ideal for cytological examination on account of their large size, high mitotic index and, in selected cases, small number of fairly large chromosomes. The root tip, in which the meristem is found, can be easily handled for experimental studies such as those on the uptake and distribution of phosphorus-32 relative to the mitotic





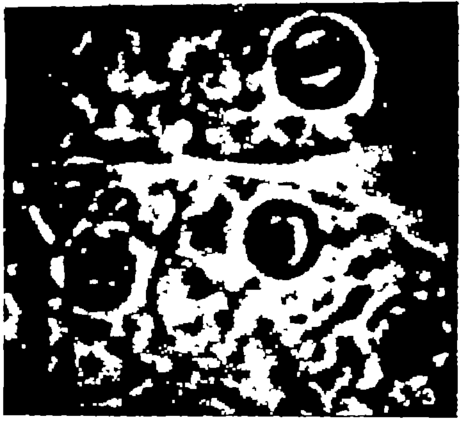


Fig. 1. A cell from the meristem of a lateral root of *V. faba* macerated in a living condition by pectinase. The cell was mounted in Tyrode solution diluted four times and photographed, unstained, in green light, final magnification, about 1,150. Note the dark nucleolus surrounded by a clear nuclear area and the presence of discrete granules in the cytoplasm

Fig. 2. Meristematic cells of a lateral root of *V. faba* treated with the pectinase and then with hot acetic-carmine. Photographed as for Fig. 1. Note the very dark nucleus and lack of discrete cytoplasmic particles

Fig. 3. Meristematic cells of a lateral root of *V. faba* treated for too long with the pectinase. Mounted in Tyrode solution and photographed as for Fig. 1. Note the dark nucleolus surrounded by a dark nuclear region; some nuclei show a light perinucleolar halo, probably due to the middle zone (ref. 3)

cycle[1]; or it can be used as a concentrated source of cell components such as nuclei[2] or cytoplasmic granules[3]. In general, the cells are studied after they have been fixed and subjected to some technique designed to render them clearly visible with a microscope. Such methods include embedding and sectioning, or treatment with hot acid, either normal hydrochloric or 45 per cent acetic, to weaken or remove the intercellular cement so that whole cells may be examined separately. Plant mitochondria, however, are extremely delicate and are destroyed by the fat solvents used in the process of embedding in paraffin wax and by the acids employed to remove the intercellular cement. The destruction of the mitochondria allows material which, in life, is localized on these bodies to diffuse about the cell, giving rise to serious artefacts. Thus the diffusion of ascorbic acid on to the chromosomes following the breakdown of the mitochondria has been reported[4], and it is likely that other acidic substances, if originally localized on cytoplasmic granules, could be similarly redistributed[5].

It is therefore desirable to be able to examine the living cells. A method for doing this was described[6] in 1949; the intercellular cement was removed by the action of a solution of a fungal pectinase. The technique required a period of treatment lasting three days, during which time it was difficult to keep the growth of micro-organisms to within suitable limits. The enzyme was obtained from *Penicillium digitatum* growth on bran. Different strains of the same fungus, and slight variations in the method of culture, were found to yield very different results when tested for maceration potency. It was clear that, while the technique was useful once the correct strain and culturing procedure were discovered, it could not obtain general acceptance until it was standardized with an enzyme preparation of constant composition which was universally obtainable.

Recently, the Nutritional Biochemicals Corporation of Ohio, U.S.A., has produced a commercial pectinase powder which is generally available and which has now been tested on root tips with good results. It is essential to use the pectinase in the presence of peptone and to restrict its time of action. Thus the root meristem cells of lateral roots of *Vicia faba* were treated for 50–60 min. with a 10 per cent solution, by weight, of this enzyme powder dissolved in a 1 per cent aqueous solution of peptone (bacteriological); the cells separated very readily when the root was gently teased with a needle. After this treatment many clearly outlined cytoplasmic granules were observed; the nuclei were optically homogeneous and contained well-defined nucleoli (Fig. 1). These cells were therefore very unlike root-tip cells viewed after the action of most standard techniques.

These living cells could be used to study the various artefacts produced by fixation. Thus, when alcohol was added to such cells, an obvious hardening or coagulation of the cytoplasm was observed. Treatment with hot 45 per cent acetic acid, or aceto-carmine, destroyed the cytoplasmic granules and made the nuclei appear dense and inhomogeneous (Fig. 2).

An artefact which in some ways resembled that observed after fixing with hot acetic-carmine was also seen after unduly long treatment with the enzyme solution. Thus, after two hours digestion, the large, clearly defined cytoplasmic granules had disappeared from all the meristematic cells and the nuclei were no longer optically homogeneous (Fig. 3).

The need for peptone and the importance of the length of treatment not exceeding the optimum suggest that the enzyme preparation may have a potential effect besides that of hydrolysing the intercellular cement. It may be that an impurity, such as a proteolytic enzyme, is present for which the peptone acts as a substrate so that only after this peptone is destroyed does the enzyme attack cell proteins.

The particular value of the present technique lies in the production, within one hour of removing the root apex from the seedling, of a 'squash' type of preparation in which the cells are apparently alive and show the detailed cytoplasmic organization and nuclear optical homogeneity usually lost on fixation. That such a cytological preparation can now be produced by the use of a commercial product which should not be very variable may allow the method to become of general application.

I wish to acknowledge the encouragement and advice given me by Prof. J. T. Randall and by Dr. Honor B. Fell, and to record my debt to Mrs. U. J. Horne for her help in this work. The investigation has been aided by a grant from the British Empire Cancer Campaign.

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A New Pyrimidine Base from Bacteriophage Nucleic Acids

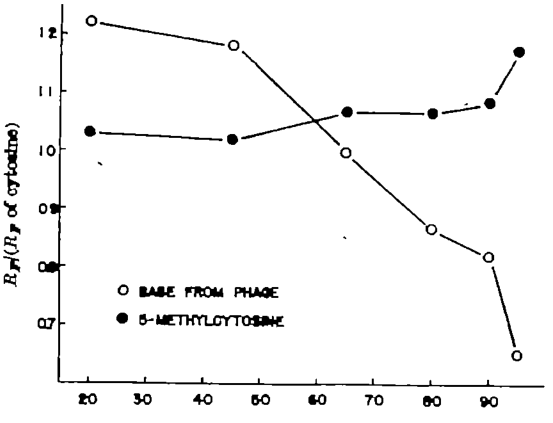
THE pyrimidine cytosine[1] and its deoxynucleotide[2] have been reported as constituents of the deoxyribonucleic acids of coliphages *T2* and *T6* respectively, but in another analysis of *T2*[3] no cytosine could be found. We have now resolved this discrepancy by isolation from *T*-even bacteriophages of a new pyrimidine base, identified as 5-hydroxymethylcytosine, which was previously mistaken for cytosine or missed. A nucleotide has now also been isolated which gives rise to this base on hydrolysis[4].

The nucleic acid bases liberated by hydrolysis of whole viruses or virus deoxyribonucleic acid were separated on paper chromatograms using isopropanol – water – hydrochloric acid[5] as the solvent. When formic acid (88 per cent at 175° C. for 30 min.) was used for hydrolysis, a substance was obtained having the same R_F value in this system as cytosine but a slightly different ultra-violet absorption spectrum. Perchloric acid, which gives good yields of the other nucleic acid bases, largely destroys this substance.

Its structure was suggested to us by its spectral and chromatographic characteristics. The ultra-violet absorption maxima were close to those of cytosine and 5-methylcytosine, having parallel shifts with change in *p*H :

	Wave-lengths of maxima, mμ		
	0·1 *N* hydrochloric acid	*p*H 7·4	0·1 *N* sodium hydroxide
Cytosine	275	267	280
5-Methylcytosine	283	274	287
Base from phage	279	269·5	283·5

The relative positions of cytosine and the new substance on chromatograms were independent of the *p*H of the solvent, suggesting similar ionizable groups. The effect of the water content of the solvent on R_F values, however, illustrated in the accompanying graph, showed the relatively hydrophilic nature of the new base.



By treatment with nitrous acid, the base was deaminated to a product which was related in spectral and chromatographic properties to uracil in a similar way as the parent substance was to cytosine.

These properties suggested 5-hydroxymethylcytosine as a possible structure. A specimen of the base, isolated by a combination of chromatographic and chemical procedures from a large preparation of $T6r^+$ bacteriophage (for which we are indebted to Dr. J. Spizizen, of Sharp and Dohme, Inc.), had an elementary composition compatible with this structure (analyses after drying *in vacuo* at room temperature : calc. for $C_5H_7O_2N_3.\frac{1}{2}H_2O$: C, 40·00 ; H, 5·37 ; found : C, 40·23 ; H, 5·35 per cent. Analyses after drying over phosphorus pentoxide at 100° C. : calc. for $C_5H_7O_2N_3$: N, 29·78 ; found : N, 29·33 per cent). A sample of 5-hydroxymethylcytosine, kindly synthesized for us by Dr. C. S. Miller, of Sharp and Dohme, Inc., had ultra-violet spectra and chromatographic behaviour identical with those of the natural substance. On heating, both natural and synthetic products decomposed without melting. We conclude that the base found in the *T*-even bacteriophages is 5-hydroxymethylcytosine.

By hydrolysis of whole viruses in formic acid, the following analyses were obtained :

	Moles per 100 moles total nucleotide				Base recovery / P
	Adenine	Thymine	Guanine	Hydroxymethylcytosine	
$T2r^+$	33·2	35·2	17·9	13·6	0·91
$T4r^+$	32·7	35·7	18·1	13·5	0·91
$T6r^+$	33·2	35·6	17·8	13·3	0·92

Neither cytosine, 5-methylcytosine, nor uracil could be detected. The values for 5-hydroxymethylcytosine are based on the extinction coefficient in 0·1 *N* hydrochloric acid (E = 9,700) ; they may be subject to correction for loss in hydrolysis. Repeated analyses of the *r* and r^+ mutants of *T2*, *T4* and *T6* phages did not indicate any significant differences in composition of the deoxyribonucleic acid.

Careful examination of deoxyribonucleic acid from thymus and from *E. coli* and whole dried *E. coli* failed to reveal any of the new pyrimidine in these materials, and it appears that it may be a unique virus constituent. This would then provide the first demonstration of a virus containing a chemical unit qualitatively different from those of its host.

These results will be reported more fully elsewhere. This work was done while one of us (S. S. C.) was in receipt of a grant from the Commonwealth Fund.

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Cytoplasmic Polyhedral Virus Diseases

In the literature on the polyhedral virus diseases of insects, apart from the many nuclear polyhedroses of the fat-body (and cuticular tissues), only one case of a nuclear polyhedrosis of the gut and one cytoplasmic polyhedrosis of the fat-body have been described. Previously, no cytoplasmic polyhedrosis of the gut has been reported.

Several different cytoplasmic polyhedroses of the gut have now been found, and cross-infection to other species established with them. For example, cytoplasmic gut polyhedroses have been obtained on infecting *Vanessa io* larvæ with the polyhedra of *Rhypara purpurata*. The silkworm, *Bombyx mori*, develops similar polyhedroses on infection with the polyhedra of *R. purpurata*, *Arctia villica*, or the cytoplasmic gut polyhedra of *Sphinx ligustri*. Such polyhedroses have also been obtained in *Lymantria dispar* and *Aglais urticæ*, etc. It has been established that *villica* polyhedra give rise to a gut cytoplasmic polyhedrosis in their host species, *A. villica*. It is suspected, though not demonstrated, that this is also the case with *purpurata* virus in its natural host.

In all these cases, as with others, the cytoplasmic gut polyhedra have been found to be blue-staining with methylene blue even after only a very light heat treatment of gut smears. Nuclear polyhedra do not stain after such treatment. It has been previously established[1] that *villica* and *purpurata* polyhedra show an absence of membrane and virus rods when examined under the electron microscope after being treated with weak alkali. The same is true for *purpurata* polyhedra in the silkworm, and for the naturally occurring cytoplasmic gut polyhedrosis of the privet hawk (*S. ligustri*), the only ones of those mentioned so far examined[2]. All polyhedra of this type which have been examined showed the 'honey-comb' structure described by Smith and Wyckoff[1].

Provisionally, then, it can be suggested that two distinct types of polyhedral diseases exist. The polyhedra from nuclear polyhedroses do not stain with methylene blue, are readily soluble in alkali, and possess membranes. The polyhedra from cytoplasmic polyhedroses are readily stainable with methylene blue, are less readily soluble in alkali, are without membranes and leave a pitted 'honey-comb' structure after alkali treatment.

It is hoped that further research will establish the conditions favouring the development of one or other type of polyhedrosis, and whether under appropriate conditions a given polyhedral virus may give rise to a polyhedrosis in a different cytological and histological site from its original one.

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Tainting of Tobacco by a Dichloropropene–Dichloropropane Soil Fumigant

One of the most serious pests of tobacco in Southern Rhodesia is the eelworm, *Heterodera marioni*. Control of this organism is effected by injecting the soil, by means of a plunger-type injector, with ethylene dibromide or a dichloropropene–dichloropropane mixture. During the 1951–52 growing season, it has been estimated that the latter fumigant has produced 'off-odours' in approximately five per cent of the tobacco crop. These odours first become apparent during the curing process, and persist through all subsequent stages of processing. Impurities in the fumigant mixture have been shown to be responsible for this tainting and have been isolated and characterized by the methods described below.

Green tobacco leaf was extracted twice successively with its own weight of ether, the combined extracts filtered and the ether distilled off. The residue was extracted with ethanol and chromatographed on aluminium oxide, using ethanol to develop the column. Spectrophotometric examination of the primary colourless eluate, collected before any pigment bands had passed through the column, showed that the tainted tobacco contained material absorbing in the deep ultra-violet that was not present in untainted leaf.

Fractionation of the primary eluate yielded two components, boiling at 69° (fraction *F*) and at 148° (fraction *X*). Comparison of the spectrophotometric absorption curves, boiling points, refractive indices and the melting points of the S-alkylisothiourea picrate derivatives (prepared according to Brown and Campbell[1]), together with mixed melting point determinations, have led to the identification of these two fractions with two of the components of the soil fumigant mixture, fraction *F* being tentatively identified as 2 : 2-dichloropropane and fraction *X* as 1 : 2 : 3-trichloropropane.

The concentration of the contaminating substances in the green tobacco leaf was found to be approximately nine parts per million. No such compounds could be isolated from untainted tobacco.

Paper chromatography of the leaf pigments, using methanol – hydrochloric acid – water (50 : 25 : 25) and ethanol – acetic acid (98 : 2) as the solvents, followed by elution of the separated pigment spots and their spectrophotometric examination, showed differences between tainted and normal leaf, several of the pigments from the tainted leaf exhibiting a shift of absorption maxima towards the red end of the spectrum.

It is thought that certain of the components of the soil fumigant mixture may be entering into the biogenesis of the leaf pigments, in place of their normal precursors.

The precise environmental conditions necessary to produce tainting and the effect of such tainting on the metabolism of the tobacco plant are, as yet, unknown. The problem is receiving further attention and the work will be published in more detail elsewhere.

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A Growth Interaction between β-Indolylacetic Acid and Thiourea (Thiocarbamide)

In experiments designed to explain the activities of 3-indolylacetonitrile recently isolated by Jones, Henbest, Smith and Bentley[1] from brussels sprouts, Osborne[2] has shown evidence for synergism between this compound and heteroauxin (β-indolylacetic acid). The experiments were carried out on pea tissue, and the degree of curvature of split pea cotyledons measured in accordance with the standard Went pea curvature test[3].

Experiments carried out in this department show that thiourea also can interact synergistically with β-indolylacetic acid when both are applied simultaneously in aqueous solutions to germinating *Avena sativa* seedlings. The effects are shown in root-growth following a 48-hr. treatment and during subsequent shoot-growth following defoliation (100 plants per treatment).

The concentration of thiourea was of the same order as that tested by Amlong[4], namely, 2,000 mgm./litre, and that for β-indolylacetic acid of the order of 50 mgm./litre. Table 1 shows the effect on root-length following the 2-day treatment.

Table 1. Length of Longest Root (Mean Length (cm.))

Distilled water	2·6
Thiourea	2·1
β-Indolylacetic acid	0·8
Thiourea and β-indolylacetic acid	0·5

The inhibitory effects are greater in the case of treatment with β-indolylacetic acid than those with thiourea; but both treatments when compared with the controls treated with distilled water are statistically very significant. When both treatments are applied simultaneously the inhibition is greater than when the treatments are applied independently. This interaction proved to be highly significant, its variance ratio (*F*) having a probability less than 0·001.

Following this initial treatment, the seedlings were transferred to sand watered with a complete nutrient solution. Nine days after planting, the seedlings were defoliated, the region of defoliation being approximately 1 cm. above the growing-point. Table 2 shows the effect on shoot-height for the first month of the regeneration period.

Table 2. Mean Shoot Height per Treatment (cm.)

	Oct. 16	Oct. 23	Oct. 30	Nov. 6
Distilled water	1·6	2·6	4·6	5·4
Thiourea	1·6	3·9	4·6	6·3
β-Indolylacetic acid	1·5	2·9	4·6	5·5
Thiourea and β-indolylacetic acid	1·9	4·7	5·2	7·1

The interaction effects are statistically significant on October 16 and October 30, while on October 23 and November 6 both thiourea and β-indolylacetic acid, acting independently, produce differences which are also statistically significant. The increased rates of regeneration from both treatments are reflected in the dry-weight estimations of the shoots and leaves shown in Table 3, although the interaction effect fails to reach significance.

Table 3. Mean Dry-weight per Plant (gm.)

Distilled water	0·59
Thiourea	0·71
β-Indolylacetic acid	0·66
Thiourea and β-indolylacetic acid	0·80

Both thiourea and β-indolylacetic acid, acting independently, produce dry-weight increases which are significant.

Work of a fundamental nature similar to that carried out with auxins has not been attempted on a large scale with thiourea. It appears, however, from the work of Denny[5] that in the potato this substance stimulates a greater number of buds to develop from a single eye, and prevents the apical buds from inhibiting the growth of the basal buds. If it is assumed that this apical dominance is caused by auxin, then it appears that thiourea can destroy its action, or even prevent its formation. The above experiment, however, indicates that thiourea can react in a way different from this. When applied simultaneously with β-indolylacetic acid to germinating *Avena* seedlings, a greater inhibition of early root-growth, and a greater regeneration of shoot-growth after defoliation, is produced than that which is obtained when both substances act independently of each other. Thus, there is some evidence for synergism between these compounds in their effects on early growth of *Avena* seedlings.

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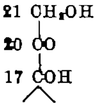
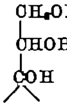
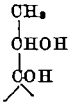
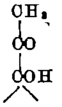
Determination of Urinary Corticosteroids

A major difficulty in the estimation of urinary corticosteroids arises from their destruction under conditions necessary for the complete hydrolysis of steroid conjugates. Extraction of corticosteroids from non-hydrolysed or partly hydrolysed urine yields only a small fraction of the amount released by enzymatic hydrolysis with β-glucuronidase[1]. The existing procedures have been authoritatively discussed and their inadequacy pointed out by Marrian[2].

As reported elsewhere[3], 17-hydroxylated corticosteroids of types I, II and III (see table) yield 17-ketosteroids on oxidation with sodium bismuthate. The application of this finding to the oxidation *in situ* of urinary corticosteroids has now been studied with the object of converting steroids bearing any of the three side-chains I–III into a group of sub-

Substance added to urine (10 mgm./l.)	Type of side-chain	Increase of 17-keto-steroids (mgm./l.)	Increase of 17-ketogenic steroids (mgm./l.)	
		Found*	Found*	Expected
17α-Hydroxy-11-dehydro-corticosterone	 (I)	0·3	4 9	8 1†
17α : 20β : 21-Trihydroxy-pregn-4-en-3-one	 (II)	0 4	8·9	7·9†
3α : 17α · 20β-Trihydroxy-pregnan-11-one	 (III)	0 5	6·0	8·2†
3α : 17α-Di-hydroxy-pregnane-11 : 20-dione	 (IV)	2·3	0·4	6·4† 0‡
Dehydroepi-androsterone	(V)	9·3	0·3	0

* Colour equivalent after correction for non-specific absorption (ref. 8) in terms of mgm. dehydroepiandrosterone as standard; the figures represent averages of four to seven estimations.

† Assuming quantitative conversion to a 17-ketosteroid and colour equivalency with dehydroepiandrosterone.

‡ Assuming no oxidation occurred.

stances (17-ketosteroids) more resistant to acid hydrolysis and assayable by well-established methods. The difference between 17-ketosteroids found before and after oxidation of urine affords a measure of '17-ketogenic steroids' which represent an important group of corticosteroids. That certain urinary corticosteroids may be determined by their conversion into 17-ketosteroids has been previously shown by Talbot and Eitingon[4]. These workers used periodic acid as oxidizing agent, the oxidation being preceded by isolation of the steroid conjugates, their mild hydrolysis, and separation of the non-ketonic fraction from the hydrolysate.

The procedure for the direct oxidation of urine with sodium bismuthate is simple and rapid: 10 ml. urine and 10 ml. glacial acetic acid are mixed and shaken for ½ hr. with 2 gm. sodium bismuthate, the mixture is centrifuged and a suitable aliquot of the supernatant diluted with an equal volume of water; the subsequent hydrolysis, extraction and determination of 17-ketosteroids can be carried out by any of the numerous existing methods. In the present investigation the procedure of Drekter *et al.*[5] has been adopted for hydrolysis and extraction, and a modification[6] of the Callow–Zimmermann reaction[7] for the colorimetric estimation. The 17-ketosteroid content of untreated urine is estimated concurrently.

By the method outlined above, the urines of two normal males were found to contain, respectively, 7·0 and 7·6 mgm. of 17-ketogenic steroids in 24-hr. specimens. The value found for the urine of a rheumatic patient following administration of 300 mgm. cortisone acetate was 125 mgm. per 24 hr.; the latter urine, when adjusted to *p*H 1 and extracted with chloroform, yielded only 2·5 mgm. of formaldehydogenic steroids per 24 hr.

In a series of experiments the 17-ketosteroids and the 17-ketogenic steroids of a urine specimen were estimated before and after addition of various steroids. The results (see table) clearly show that steroids bearing the side-chains I–III significantly increase the estimated 17-ketogenic steroids, while their effect on the 17-ketosteroid values is negligible.

The amount of urinary corticosteroids estimated by the bismuthate method is of a much higher order than that estimated by the usual procedures, and is only comparable with the amount of formaldehydogenic steroids released by enzymatic hydrolysis. It should, however, be emphasized that determinations of formaldehydogenic, reducing and 17-ketogenic steroids estimate different, though overlapping, groups of corticosteroids[8].

The present method is well suited for routine estimations. A more detailed account of this work will be published elsewhere.

I am greatly indebted to Dr. H. F. West for his interest in this work. My thanks are also due to Mr. R. D. Stubbs for valuable technical assistance. Specimens of steroids were kindly provided by Messrs. British Schering, Ltd., and N.V. Organon (Oss).

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Irradiation of Linear High Polymers

A VARIETY of polymers have been subjected to irradiation in the Harwell pile, and electrons from a Van de Graaff generator, the results being followed mainly by X-ray diffraction. The initial effect is to break down bonds, some ionic, the majority covalent. The radicals formed can react in a number of ways. In the presence of oxygen they can form low-molecular weight compounds and carboxyl end-groups; different end-groups and low-molecular weight compounds can be formed in the absence of oxygen; they can reform the original bonds; or they can recombine in other ways.

The proportions in which these reactions occur depend on three main factors:

(*a*) Presence or absence of air or other reacting medium. Two examples may be quoted to illustrate this. Many workers with the electron microscope have noticed that thin films or small particles of polymeric material are 'stabilized' by beams of moderate intensity, becoming more resistant to the effects of both heat and their normal solvents. In the process specimens often darken. In the present work, samples have been exposed to electrons in the presence of air, and quickly broken down. In vacuum, reactions between the free ends have resulted in the formation of covalent or dipolar bonds to produce a polymer of greater stability; while in air, interaction with oxygen has resulted in a loss of radicals as volatile compounds. It has been noted that, even after considerable breakdown, X-ray diffraction frequently gives the characteristic patterns of the original polymer; while in one instance—nucleic acid—a product which presented a black and charred appearance was analysed chemically and showed remarkably little evidence of drastic breakdown. The second example is that of polyethylene. On pile irradiation the surface rapidly becomes sticky, but polyethylene containing carbon black does not produce this oxidation reaction for several days, since oxygen reacts more readily with carbon.

(*b*) Intensity of irradiation. When allowance is made for the heating effect of the electron beams, differences between the effects of the pile and the Van de Graaff generator can be interpreted as differences of degree rather than of kind. Similarly, with a single type of irradiation, in certain instances, it appears that a different dose-rate can produce somewhat different effects.

(*c*) Chemical nature of the polymers. Effects noticed after irradiation, and the rate and type of breakdown, can to a large extent be correlated with chemical groups within the polymers and with the nature of the crystallites which are present, and the polymers can be classified accordingly. In general, the factors considered by Hill and Walker[1] in their work on the relation between polymer constitution and the ability to assume a polycrystalline form with adequate thermal stability apply in this case also. Polymers which on irradiation retain their strength the longest are those which are able to form a 'close-packed' type of crystallite—linear high polymers without side-chains—the crystallites being more resistant to breakdown by radiation than the non-crystalline regions.

When exposed in the presence of air, the non-crystalline regions in fibres of polyamides or polyethylene eventually become fluid, with the solid crystallites (as shown by sharp reflexions in X-ray diffraction patterns) remaining in the viscous medium. In the absence of air, the effect on the non-crystalline regions is different. In many instances an initial increase in strength has been reported[2]. It may be assumed that the free radicals recombine to form more stable groupings, possibly with bridges between one chain and another, and possibly with linkages of a different ionic character. Infra-red and thermal measurements will be necessary to estimate the relative importance of these. Almost certainly the formation of unsaturated rings is an important factor in preventing the rapid break-down that might be expected from the total energy received. Polystyrene is more resistant to irradiation than polyethylene[2], and polyethylene terephthalate than the aliphatic polyesters. Similarly, the purine and pyrimidine groups in the nucleic acids seem able to protect the sugar portion of the molecule. In the case of polyethylene terephthalate, with oxygen atoms in the main chains, further condensation would be difficult, and the polymer is observed to become brittle at quite an early stage.

With long-chain polymers containing aliphatic rings, diffraction results indicate that the crystalline regions break down almost as readily as the non-crystalline—the diffraction rings become diffuse before the specimens have lost their strength. However, physical properties such as solubilities and melting points are affected in a similar manner to other polymers. In this group are cotton-wool and the various cellulose derivatives, and also collagen.

Another group of compounds requiring mention are those containing atoms or radicals which are readily and permanently lost, as, for example, those attached by an ester link—loss of the acetate radical causes cellulose acetate to break down more rapidly than viscose.

Naturally occurring complex polymers are more difficult to classify than the synthetic polymers in that more than one effect may be operative. Thus the basic portion of the nucleic acid molecule contains both a stable ring system and the readily detachable amide groups. In this polymer it is possible to account for the decreased solubility which is observed without postulating carbon-containing bridges.

This work is to be published more fully elsewhere. I wish to thank the firms or individuals who have provided samples of polymers, Dr. P. Kent of the Biochemistry Department, Oxford, for analysis of nucleic acids, and the Director of the Atomic Energy Research Establishment for permission to publish this communication.

K. LITTLE

Atomic Energy Research Establishment,
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Oct. 3.

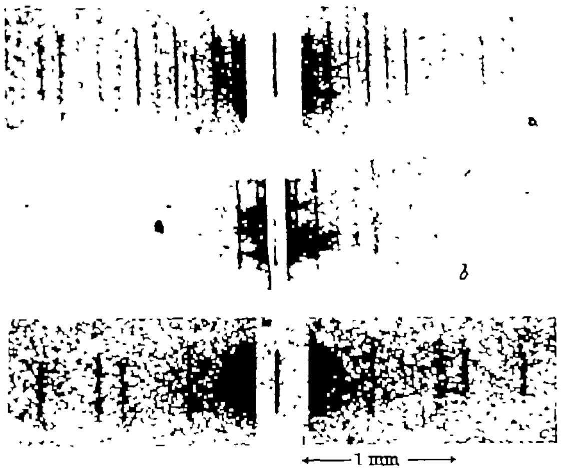
[1] Hill, R., and Walker, E. E., *J. Polymer Sci.*, 3, 609 (1948).
[2] Sisman, O., and Bopp, C. D., ORNL 928 (1951).

Small-Angle X-Ray Scattering

THE large lattice spacings occurring in such organic matter as fibres or crystalline viruses give rise to X-ray diffraction patterns with Bragg angles of minutes of arc rather than of degrees. The neighbourhood of the direct beam is, however, for a variety of reasons, easily obscured by scattered radiation and insufficient collimation, so that special measures such as very long film-specimen distances[1] or focusing crystal monochromators[2] have been used for obtaining satisfactory photographs. In particular, Furnas[3] has recently made an important contribution to the latter method.

We have now succeeded in obtaining, comparatively rapidly, clear photographs of small-angle patterns, by making use of a concave mirror in combination with a fine-focus X-ray tube[4,5]. A bent optical flat forms an image of the foreshortened X-ray focus ($5\,\mu \times 50\,\mu$) on a photographic film. The specimen is placed in the convergent beam in front of the film. Slits near the X-ray tube and near the specimen minimize unwanted radiation: the widths and positions of the slits are critical. Beyond about 20′ from the origin, the resolution is determined by the size of the focus and the specimen-to-film distance. Nearer the origin, stray radiation, mainly from the reflector, tends to obscure the pattern. The stray radiation depends on the dimensions of the components of the camera. A reduction in the width of this radiation is accompanied by a decrease in the intensity of the main beam. The effect of air scattering and incoherent scattering from the specimen is negligible, because the reflector is set near the critical angle of the characteristic radiation employed and thus hard radiation is suppressed.

The photographs shown herewith are produced with copper *K* radiation and a camera with mirror 4 cm. long, focus-to-film distance 30 cm. and specimen-to-film distance 5 cm. With this camera a spacing of 350 A. can normally be detected (Fig. *a*), the first



Enlargements of low-angle X-ray diffraction photographs. (*a*) Collagen from kangaroo tail tendon, 8 hr. exposure at 50 kV., 450 μamp The repeat distance is 640 A.; the second order (17′ deflexion) is clearly visible. (*b*) Collagen from stained rat tail, 30 min. exposure at 50 kV., 450 μA. The first order (8·5′ deflexion) is visible and corresponds to a spacing of 640 A. (*c*) Tobacco mosaic virus gel, 8 hr. exposure at 50 kV., 450 μamp. The lines nearest to the origin (41′ deflexion) correspond to a spacing of 130 A

few orders appearing within 30 min. With favourable specimens such as collagen stained with phosphotungstic acid, the range of visibility goes up to twice this figure, because the exposure times are short, the first few orders appearing within 5 min. Fig. *b* is not fully representative, as it has been obtained with the width of the slit near the specimen below its optimum value. This increases the first-order visibility somewhat and the exposure-time by about a factor 3.

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Aug. 28.

[1] Bear, J , *J. Amer. Chem. Soc.*, 66, 1297 (1944).
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[4] Ehrenberg, W., *J. Opt Soc. Amer* , 39, 741 (1949).
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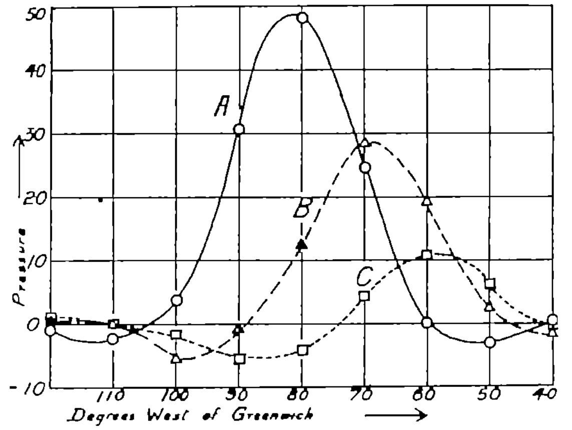
Behaviour of Atmospheric Pressure Systems

A method for studying the behaviour of atmospheric pressure systems has lately been developed at the local weather bureau at Pretoria. The general method, which can be applied in a number of different ways, can best be explained by a concrete example.

The departures (at a fixed hour) of daily pressure from the appropriate means were tabulated for 10-deg. grid points and expressed as percentages of the respective standard deviations. A grid point *P*, at 80° W., 50° N., was selected, and whenever the departure exceeded the standard deviation and formed a point of inflexion, the departure being greater than on the day before and on the day after, the date was written down. This occurred on 380 days during a period of ten years, 1929–38. The mean pressure for these 380 days was computed at *P* and at a large number of neighbouring grid points. The resulting mean isobars reveal an extremely simple pattern, since at all points sufficiently remote from *P*, the mean departure of pressure is practically zero.

The behaviour of this simplified isobaric pattern with the passage of time can now be readily studied. If one day be added to all the listed dates and the average pressure found for the new set of 380 dates, we obtain a chart of the mean isobars 24 hr. later.

In order further to simplify the picture of what actually happens, the pressures are shown graphically only for the 50th parallel north. Curve *A* was drawn to fit the original pressures as computed and shown in the accompanying figure. Curves *B* and *C* represent the distribution after one and two days respectively, the units of pressure used being quite arbitrary.



As one would expect, the isobaric pattern moves from west to east due to the prevailing westerlies In this case careful calculation indicates a displacement of 10·7 deg. or 413 nautical miles in 24 hr., equivalent to a speed of 17·2 knots, in close agreement with the known rate of travel of pressure systems.

The curves presented here show several other features, only one of which need be discussed at the moment. When the temperature distribution curves in a conducting rod, resulting from an instantaneous point source of heat, are graphically represented after fixed intervals of time, they show a striking similarity with curves *A*, *B* and *C*, except that the latter are displaced eastwards with the passage of time. It would therefore appear to be quite legitimate to introduce the concept of the 'diffusion of atmospheric pressure', and it should not be impossible to derive the laws of pressure diffusion even though they are bound to be appreciably more complicated than the analogous law of diffusion of heat. If these laws are reasonably well known, they could be applied to determine to a first approximation to-morrow's pressure at any point on the basis of to-day's pressure distribution. The preparation of prebaratic charts, as currently drawn at most forecasting centres, should thus be facilitated.

Research on the lines indicated is being continued at Pretoria and the results will be published in due course.

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(Director)

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June 5.

Apparent Absence of Low-Energy Primary Cosmic Radiation

The form of the energy spectrum of primary cosmic rays is still uncertain at the low-energy end. The work of Carmichael and Dymond[1] and of Bowen, Millikan and Neher[2] suggested that there was a lower limit at about 2,000 MeV., but this has not been confirmed by Pomerantz[3], who has come to the conclusion that the spectrum continues down to low energies. The matter is of importance owing to its cosmological implications. If the existence of a cut-off in the spectrum be established, some mechanism must be found either for removing the slower particles as they travel through space, or for their initial acceleration with a sharp low-energy limit. The suggestion of Jánossy that a solar magnetic dipole field might be responsible is not now supported by the astronomical evidence.

In a recent communication, Van Allen and Singer[4] have reaffirmed the existence of a lower limit in the energy spectrum, placing it at about 500 MeV. They have compared the vertical intensity of the radiation above the atmosphere, as measured in rockets at geomagnetic latitude 58°, with that determined by Pomerantz in balloon flights at 69°. The equality of the two intensities thus found leads to the conclusion that there are no primary protons in the range 130–560 MeV. It is reasonable to assume also that there are no protons below 130 MeV.

Some doubt must always arise about results drawn from comparisons of absolute intensities measured by different counter systems, owing to the difficulty of determining accurately the absolute flux from the observed counting rates and counter dimensions. But Pomerantz and McClure[5] have recently published some observations made with identical counter telescopes at 52° and 69°, so that the difficulty of comparison does not arise. They find that the hard component increases by a factor of about 1·4 near the top of the atmosphere between these two latitudes. This observation can be interpreted as showing a sharp cut-off in the energy spectrum. This spectrum has been reasonably well established in the region of higher energies by measurements at lower latitudes[1]. Using this and assuming the usual $\cos^4 \lambda$ relation between minimum particle momentum in the vertical direction and geomagnetic latitude λ, we can calculate the expected latitude farther north. We find that the intensity should rise by a factor 1·35 between 52° and 56°. As this is close to the factor found by Pomerantz and McClure between 52° and 69°, we conclude that the intensity must remain constant above about 56°, in approximate agreement with the statement of Van Allen and Singer. The argument is unaffected by the fact that Pomerantz and McClure have made their measurements on the hard component only, as the minimum proton energy required to penetrate the 7·5 cm. of lead absorber in their counter telescope is 260 MeV., which is well below the cut-off energy of the primary spectrum which their observations reveal.

The precise energy at which cut-off occurs must await more extended observations, particularly in the interesting region between 50° and 60°. One difficulty in fixing this energy-limit arises from the geomagnetic field itself. It is usual to calculate geomagnetic latitudes from geographical position by assuming that the field is that of a centred dipole, with axis pole at 78·5° N., 69° W. That this assumption is insufficiently accurate is shown by the existence of the longitude effect. A better approximation is given by an eccentric dipole, with axis cutting the earth's surface at 80·1° N., 82·7° W. For some stations the difference in geomagnetic latitude is not trivial, so the cut-off momentum, which varies as the fourth power of λ, is quite sensitive to the assumed position of the pole. For Edinburgh, for example, the minimum proton energy is 460 or 730 MeV., depending on the approximation used. A further element of doubt is introduced by our ignorance of how the dipole field behaves in relation to the known secular magnetic variations. It has been calculated only for the epoch 1922. More exact information on the terrestrial dipole field is required before cosmic ray data on energy limits can be accurately interpreted.

E. G. Dymond

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Sept. 16.

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Cross-polarization of the Radar Melting-Band

When plane-polarized radiation is scattered by meteorological precipitation particles other than spheres, a component of the back-scattered energy is polarized at right-angles to the plane of polarization of the incident wave. This component will be referred to as the 'cross-polarized' component in this communication. Recent observations at Cambridge and Malvern have shown that the melting particles found just below the freezing-level, which give rise to the well-known radar 'melting-band'[1], produce back-scattered radiation with a greater cross-polarized component than that given by the rain below and the snow above the freezing-level. These observations have been made using separate aerials for transmission and reception, by comparing the echo received when the aerials have their planes of polarization parallel with that received when the plane of polarization for reception is at right-angles to that for transmission.

A wave-length of 3·2 cm. was used at the Cavendish Laboratory and a wave-length in the 8-mm. band was used at the Telecommunications Research Establishment, Malvern. Let I_1 denote the echo intensity measured with parallel planes of polarization and I_2 that measured with crossed planes of polarization; then Table 1 summarizes values of the ratio I_1/I_2 measured on several occasions at the two wave-lengths. Measurements were made of the intensity not only of the melting band echo, but also of the echoes from the rain below the freezing-level and the snow above.

Table 1 RATIOS OF THE INTENSITIES OF THE MAIN COMPONENT TO THE CROSS-POLARIZED COMPONENT

Wave-length (cm.)	I_1/I_2		
	Rain	Melting region	Snow
0·8	15±1 db.	7±1 db.	12±2 db.
3·2	21·8±0·4 db.	16·9±0·3 db	19·9±0·6 db.

When the transmitting and receiving planes of polarization are crossed, the maximum echo intensity is received from the same range as when the planes are parallel.

Because the echoes from the snow above the freezing-level are weak, there is some uncertainty about the figures in the last column in Table 1.

The ratio I_1/I_2 in Table 1 for rain is not reliable, but probably indicates that the aerial system used introduced a cross-polarized component almost as great as that measured for rain. This suggestion is supported by direct measurements made at Malvern of the characteristics of the 8-mm. aerial.

The results might be explained in two ways. First, the cross-polarized component might be introduced by multiple scattering, in which the energy arriving back at the receiver has undergone scattering by more than one precipitation particle. Although the ratio of secondary to primary scattered field should be greater by about 12 db. for the melting-band echo than for the rain echo, because of the greater concentration of particles in the melting region, preliminary calculations for a wave-length of 8 mm. have indicated that the secondary scattered field for rain of the appropriate precipitation-rate will be about 60 db. less intense than the primary scattered field, while the tertiary scattering will be even weaker. Thus the secondary scattered field can give only a negligible contribution to the cross-polarized component measured in the echo.

Secondly, the cross-polarized component might be directly introduced by the scattering particles. There are three types of particle to be considered: raindrops, dry snowflakes, and the wet snowflakes found in the melting region. Raindrops, which can be considered as spheres, introduce no cross-polarized component[2]. The cross-polarization introduced by non-spherical particles has not been worked out in detail, though Cabannes[3] has investigated Rayleigh scattering (in which only the induced electric dipole is taken into account) by randomly orientated isotropic ellipsoids, the principal polarizabilities of which will usually be unequal. Maxwell[4] gives an expression for the three principal polarizabilities of an ellipsoid, and Stoner[5] has used this expression to compute 'demagnetization factors' for ellipsoids of revolution. From the work of Cabannes and Stoner, it is simple to compute the cross-polarization that would be introduced by ellipsoids of revolution. The cross-polarization increases with the dielectric constant of the particle, so that, if snowflakes be regarded as spheroids, the theory predicts a greater cross-polarized component from the wet snowflakes (of dielectric constant 70) in the melting region than from the dry snowflakes (of dielectric constant 3) above. Table 2 shows some values of I_1/I_2 for several values of m, the ratio of the lengths of the polar and equatorial axes. It is hoped to extend these calculations to include scattering by spheroids which, like falling snowflakes, are not randomly orientated.

Table 2. PREDICTED RATIOS OF THE MAIN COMPONENT TO THE CROSS-POLARIZED COMPONENT

m	I_1/I_2 (melting snow)	I_1/I_2 (dry snow)
0·10	10·2 db.	14·7 db.
0·33	14·6 db.	18·2 db
0·67	18·5 db.	25·8 db.
1·00	∞ db.	∞ db.
1·50	16·0 db.	24·6 db.
3·00	9·0 db.	18·2 db.
10·0	5·8 db	15·2 db

If this explanation be correct, it follows that the particles in the melting-region must preserve their non-spherical shape until melting is almost completed.

These observations of a strong cross-polarized component in the melting-band have considerable meteorological interest in that they indicate a method of detecting the presence and, perhaps, determining the shape, of small quantities of ice in rain-clouds. On occasions, a melting-band which could not be detected by a conventional radar has been revealed by using one of the radars described here, in which the plane of polarization for reception was perpendicular to that for transmission.

Acknowledgment is made by one of us (N. P. R.) to the Chief Scientist, Ministry of Supply, for permission to publish this communication, and by the other (I. C. B.) to the Master and Fellows of Trinity College for the award of a Twisden Studentship.

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N. P. ROBINSON

Telecommunications Research Establishment
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Sept. 12.

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Delayed Brittle Fracture of Alloy Steel at Low Stress Levels

THE recent publication by Petch and Stables[1] dealing with the delayed fracture of metals under static load has been read with interest. Work of a similar nature, to investigate the liability of an alloy steel to crack in the heat-affected zone when it is metal-arc welded under certain conditions, has been in progress in the laboratories of the British Welding Research Association since December 1951.

The effects which occur in the heat-affected zone of a weld have been imitated, so far as possible, in mechanical test pieces. The specimens were tubular in form with screwed ends and a gauge-length of 0·2 in. Each specimen was notched circumferentially to a depth of 0·019 in. The notch had a 45° included angle and a 0·005-in. root radius. The area of cross-section under the notch was 1/50 sq. in. and the wall thickness was 0·039 in.

The treatment of the specimens comprised supersaturation with hydrogen, rapid heating to a peak temperature in the region of 1,250° C. followed by cooling at selected welding-rates. The specimens were then examined by each of the following tests: (*a*) impact tensile test, at a velocity of impact of 22 ft. per sec.; (*b*) slow tensile test, at a strain-rate of 0·1 in. per min.; (*c*) dead-load tensile test, giving rupture after a period varying from 1 min. to several hours.

Some results of these tests on a low-alloy steel containing 0·19 per cent carbon, 1·3 per cent manganese and 0·25 per cent molybdenum are given in

Condition of specimen	Impact tensile test: energy to fracture (ft. lb.)	Slow tensile test: U.T.S. (tons per sq. in.)	Dead-load tensile test. stress just producing rupture (over notched area) (tons per sq. in.)
1. As-rolled	4·1	49·5	47
2. Untreated, high cooling-rate simulated	8·1	111	93
3. Hydrogen-treated, high cooling-rate simulated	6·7	63	27
4. Hydrogen-treated, low cooling-rate simulated	4·7	64	57

the accompanying table. The results show the increased influence of hydrogen on the strength as the rate of straining is decreased; Petch and Stables observed a corresponding effect on ductility. The results are mainly for duplicate tests.

These results give a better understanding of the factors affecting the formation of brittle hard-zone cracks during the welding of this type of alloy steel. We have observed that cracks occur in welding this steel only when relatively high hydrogen contents and high cooling-rates occur in the weld zone together[2], that is, condition 3 in the table. This observation is based on tests made on a structure, in addition to laboratory tests.

The impact tensile test results do not show any deterioration in properties in any of the conditions 2, 3 or 4 when compared with the as-rolled plate material (condition 1). Therefore, formation of hard-zone cracks is not related to this property of the steel. In this rapid test there is probably no time for the diffusion of hydrogen to take place during testing and so to cause embrittlement.

The slow tensile test is also quite rapid, and the time available for the diffusion of hydrogen is limited. The strength of the material is, however, reduced considerably by the presence of hydrogen, as shown by a comparison of conditions 2 and 3. Similar tests with specimen of condition 3 on un-notched specimens gave a value of reduction in area of only 5 per cent, which indicates that considerable embrittlement is produced in the steel in this condition. In spite of this reduction in ductility, the slow-tensile strength in condition 3 is greater than that of the as-rolled material, and, therefore, this property also is not a direct index of the tendency to form hard-zone cracks.

The dead-load test gives a good indication of the liability to crack formation, since brittle cracks might be expected only when the minimum rupture stress of the heat-affected zone falls below that of the background plate material, namely, 47 tons per sq. in., which occurs in condition 3, combined also with the low reduction of area of 5 per cent mentioned above. With this condition, the fracture produced is completely brittle, and there is ample time for diffusion of hydrogen to occur during the test.

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Sept. 30.

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[1] Petch, N. J., and Stables, P., *Nature*, 169, 842 (1952).

[2] Cottrell, C. L. M., Jackson, M. D., and Purchas, J. G., *Welding Research*, 6, 50 (1952)

Edmond About and the Technique of Freezing and Drying Tissues

In *Nature* of September 27, p. 547, Dr. L. G. E. Bell asks for the source of Edmond About's information on the technique of the preservation of tissues described in 1862 in About's scientific novel "L'homme à l'oreille cassée". The material that I am actually collecting for the purpose of writing the history, which covers nearly a century, of the Marine Laboratory at Concarneau, enables me, I believe, to reply.

Coste created this Laboratory in 1858 for the purpose of "la mise en culture des mers". In 1873, after his death, the work was continued by Charles Robin and Georges Pouchet, interesting scientific personalities who had strong links with the literary world.

Robin (1821–85) was professor of histology in the Faculty of Medicine in Paris, holding a chair created for him; he was a member of the Institut de France and of the Senate. The Goncourts have described him as "au cerveau tout à la fois nuageux et plein d'éclairs, et à la langue brouillée". He had been taken by Littré to the lectures of August Comte, had become a positivist and published with Littré the "Dictionnaire de Médecine", which ran to many editions. Robin carried out a considerable amount of work, chiefly in anatomy and cellular physiology. He had a number of followers, one of the more celebrated of whom was without doubt Clemenceau, who dedicated his thesis to him. His influence made its mark on a number of writers, as did that of Pouchet, of whom it was said that he was the scientific consultant of one literary generation.

Robin practised medicine at Mérimée; he documented Michelet's "L'oiseau", "L'insecte" and "La mer"; he was the friend of Taine and Sainte-Beuve, who like him had studied medicine at first. During these years, Sainte-Beuve, Robin and Pouchet met each week at Princess Mathilde's house, and then dined at Magny's, where they were frequently joined by Flaubert (he stayed with Pouchet one summer at the Concarneau Laboratory), the brothers Goncourt, Viollet-le-Duc, Théophile Gautier, Berthelot, Renan and many others. The "Journal" of the Goncourts is strewn with table-talk of Robin.

Among the convivial figures was Edmond About, who could thus have heard about topics which Robin was familiar with, such as the desiccation and the revival of the guinea worm which Robin studied in 1855, or the echo of discussions on the Tardigrades between Doyère and Pouchet's father, who was a partisan of spontaneous generation and against Pasteur. Further, the source of About's information is apparent: one of the principal characters of "L'homme à l'oreille cassée" is Dr. Nibor, an anagram of Robin, and they resembled each other. Also, the novel did not please Clemenceau, who criticized it. Another novel by About, "Le nez d'un notaire", is one story of van Helmont as recounted by Robin.

Further information can be found from the following works: G. Pouchet, "Charles Robin, sa vie et son œuvre", p. 195 (Paris, 1887); V. Genty, "Un grand biologiste, Charles Robin; sa vie, ses amitiés philosophiques et littéraires" (Lyon, 1931); and, concerning Pouchet, in C. Chassé, "Le biologiste consultant d'une génération littéraire: Georges Pouchet (1833–1894)", *La Grande Revue*, 28, 295 (1924).

R. Legendre

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FORTHCOMING EVENTS

Monday, December 22

Royal Geographical Society (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Eric Shipton: "Expedition to Cho-Oyu".

Saturday, December 27

Royal Institution (at 21 Albemarle Street, London, W.1), at 3 p.m.—Dr. F. Sherwood Taylor: "How Science has Grown". (Christmas Lectures adapted to a Juvenile Auditory.) (Further Lectures on December 30, January 1, 3, 6 and 8.)

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Experimental Officers and Assistant Experimental Officers in various Government Departments, for posts in (*a*) mathematical and physical sciences, (*b*) chemistry and metallurgy, (*c*) biological sciences (biological research and infestation control), (*d*) engineering subjects, and (*e*) miscellaneous, including geology, library and technical information services—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.94–95/52 (December 31).

Lecturer in Clinical Pathology at the University Veterinary Laboratories, Langford—The Registrar and Secretary, The University, Bristol (December 31).

Senior Scientific Officers (Ref. S.53/52) and Scientific Officers (Ref. S.52/52 and S.128/52) (Patent Examiner and Patent Officer classes) in various Government Departments covering a wide range of scientific research and development in most of the major fields of fundamental and applied science—The Civil Service Commission, Scientific Officer Branch, Trinidad House, Old Burlington Street, London, W.1, quoting the appropriate Ref. No. (December 31).

Lecturer in the Department of Geology (knowledge of petrology and mineralogy is essential)—The Registrar, Queen Mary College, Mile End Road, London, E.1 (January 1).

Senior Lecturer or Lecturer in Physics at the Nigerian College of Arts, Science and Technology—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (January 1).

Principal Scientific Officer, Senior Scientific Officer, Scientific Officer (Grade 3), Scientific Officer (Grade 1), Senior Experimental Officer, Experimental Officers (Grade 3), and Experimental Officers (Grade 1), for research, design and development on electronic defence problems, at the Electronics Research Laboratory, Salisbury, Australia—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (January 3).

Lecturer in Chemistry (with an interest in inorganic chemistry)—The Secretary, The University, Aberdeen (January 5).

Research Officer (Mycologist) (with university honours degree in science or agricultural science, including research experience, or equivalent qualifications) in the Division of Food Preservation and Transport, Homebush, New South Wales, to undertake investigations on problems of mould wastage in stored fruits—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (January 9).

Civil Engineers (40) and Mechanical and Electrical Engineers (30) in connexion with the Bhakra Nangal Project—The Chief Engineer, Irrigation Works Punjab, Ellerslie, Simla 2, India, endorsed 'Specialist Officers' (January 15).

Science Graduate as Assistant Librarian—The Librarian, University College, Gower Street, London, W.C.1 (January 15).

Readership in Physiology at St. Bartholomew's Hospital Medical College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 22).

Readership in Anatomy at St. Mary's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 26).

Readership in Geography at Queen Mary College—The Academic Registrar, University of London, Senate House, London, W.C.1 (January 29).

Senior Lecturer in Soil Conservation and Irrigation in the Department of Agriculture, University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (January 31).

Chair of Geography—The Secretary of University Court, The University, Glasgow (February 14).

Senior Lecturer in Pure Mathematics at the University of Otago, Dunedin—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (February 15).

Assistant Lecturer in Bacteriology (qualified to specialize in Dairy Bacteriology) in the Department of Agricultural Sciences at the School of Agriculture, Sutton Bonington—The Registrar, The University, Nottingham.

Lecturer in Metallurgy (a degree or equivalent qualification in metallurgy is essential)—The Principal, Technical College, Cole Street, Scunthorpe, Lincs.

Physicists (with a first- or second-class honours degree or equivalent in physics) at the Ministry of Supply Establishment, Aldermaston: Principal Scientific Officer to supervise a group engaged on research and development work in relation to problems involving radioactive materials (Ref. A.324/52A), Senior Scientific Officer or Scientific Officer to take charge of a group and for research on application of a 3 M.E.V. linear accelerator (Ref. A.325/52A), and Scientific Officers to work with a group engaged in research on certain aspects of physical properties of radioactive materials (Ref. A.326/52A)—The Ministry of Labour and National Service, Technica and Scientific Register (K), Almack House, 26 King Street, London S.W.1, quoting the appropriate Ref. No.

Research Engineer (with honours degree in engineering o science)—The Secretary, British Internal Combustion Engine Researc Association, 111–112 Buckingham Avenue, Slough, Bucks.

Science Graduates and Rubber Technologists (preferably wit experience of rubber technology in either a laboratory or factory) a the Rubber Research Institute of Malaya, Kuala Lumpur—Th Secretary, London Advisory Committee for Rubber Research (Ceylo and Malaya), Imperial Institute, South Kensington, London, S.W.7

Scientific Officers (with a first- or second-class honours degre in physics with mathematics, or equivalent, and a leaning toward experimental rather than theoretical work) in the Radio Divisio Royal Aircraft Establishment, Farnborough, for investigations in th field of radio frequency measurement, especially at V.H.F. and centi metric frequencies—The Ministry of Labour and National Service Technical and Scientific Register (K), Almack House, 26 King Street London, S.W.1, quoting A.314/52A.

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SHORTAGE OF SCHOO[illegible] TEACHERS

THE Barlow Committee asked the uni[illegible] Great Britain to double their pre-war [illegible] science graduates by 1955, and they had almost [illegible] so by 1952. But in spite of this, there is a grave shortage of science teachers in schools and a serious decline in the academic quality of those presenting themselves, suggesting that the foundations of the educational structure for training science graduates are unsound.

The Incorporated Association of Head Masters, consisting of the heads of all boys' or mixed public and grammar schools in England and Wales, asked its members for particulars of their science staffs in July 1950. It received replies from four-fifths of their schools, employing 3,065 science teachers. In these schools, 193 science posts were unfilled; in 48 schools a science subject had been dropped from the curriculum because it had been impossible to find anyone to teach it. Perhaps the shortage of science teachers might have been at its worst in 1950, because 'sixth forms' were already twice their 1939 size, while the additional number of teachers expected from the increase in numbers at the universities had not yet reached the schools. But the experience of head masters in the next two years suggested that the position was getting worse rather than better; so, in July 1952, the Joint Four, which is the name given to the association of heads and assistants of public and grammar schools in England and Wales, undertook another survey. Three-quarters of the schools replied; 49 posts in boys' and mixed schools and 116 in girls' schools were unfilled. Again, 145 science posts for men and 128 for women vacant in September 1952 were advertised between May 30 and July 25. It is unlikely that any of these vacancies has been filled; no teacher already in a post could apply, as notice must be given by May 31 to be free to go to a new school in September; and the few scientists at the university seeking their first teaching posts in September would have been engaged before the previous June. Thus some two hundred and fifty posts for science teachers in Britain will remain vacant for the whole of the present school year; for if any of the above September vacancies are filled in January 1953, it will only be by creating a vacancy in another school. So some 190 vacant posts in boys' and mixed schools in 1950 has become between 50 and 140 in 1952. The shortage of science teachers in these schools persists, and it is pertinent to add that it leads to a continuous movement of science staff from one school to a better post in another. Nowadays, it is common for five out of a science staff of six to leave a school in the course of five years, so that even when no post is unfilled there is little continuity in the science teaching in the school. The position in girls' schools in Britain is even more serious, for 120 posts remain unfilled, which is one-fifth of their vacancies. Also it is well-nigh impossible to get teachers for girls' schools qualified to teach the 'science sixth', and university departments of [illegible] receiving women science students [illegible] ainments. So the cessation of the [illegible] men science graduates is within sight, [illegible] schools will shortly be unable to train [illegible] the standard for admission to the science [illegible] the universities.

[illegible] ere has also been a decline in the qualifications of science teachers since 1939. Here it should be pointed out that high scientific attainment at the university does not necessarily imply ability as a teacher. The survey conducted by the Incorporated Association of Head Masters in 1950 claimed that one-fifth of the science teachers in boys' and mixed schools in Britain were not properly qualified for the work they were doing. In 1952 the survey made by the Joint Four, when the increased size of the universities had had time to increase the supply of science teachers, reveals a similar state of affairs: only 39 per cent of the science teachers taking up their first posts in September 1952 had first- or second-class honours degrees, compared with an average of 55 per cent in the schools before the War. In 1949, the Cambridge University Appointments Board was told of 400 vacant science posts. Before the War it would have filled 100; probably another 50 would be filled by Oxford and the remaining 250 by the other universities of Britain. But in 1949 Cambridge could fill only 59 of these science posts, and in 1950 only 11 Oxford science graduates out of a possible 213 took up teaching; none of them had a first-class honours degree and only three had seconds. It is clear that the schools are not getting back as teachers anything like as many of the abler boys and girls as they did before the War—and certainly not a fair share of them, if the schools are to do the work the nation expects of them.

This decline in scientific quality of science teachers is confirmed by the facts at individual schools. One leading State grammar school, with a distinguished list of academic successes making its vacancies very attractive, has had five chief science masters since 1942 The same school lost its second chemistry master, who went to another well-known grammar school as chief science master. His post was advertised three times; there was no applicant. The vacancy was temporarily filled by a pass-graduate who was giving up industrial chemistry at the age of forty-five and taking up teaching; after three years he is still holding the post. Of course, if good results are being obtained, then the authorities must congratulate themselves on having a good teacher—pass degree notwithstanding. In 1950 a well-known grammar school in a large city in the south of England had four first-class honours graduates on its science staff; in 1952 there is only one left, the chief science master, who is receiving a special responsibility allowance. These facts illustrate the drop in academic standing of science teachers in Britain since 1939. This decline in quality might well lead to a drop in the level of attainment of science specialists in the schools, so that fewer will gain admission to the universities. The universities in turn will produce fewer science graduates, and fewer science teachers than ever will enter the schools. We shall then have slipped back to the position which existed in 1900, when most science graduates started their science at the university, and the fruits of forty-five years hard work, by which the schools laid the foundations and the universities concentrated on the advanced work, will have been thrown away One further fact underlines the precarious condition of school science. Too great a proportion of the good science teachers are more than fifty years old, so that the schools will lose most of them in the next ten to fifteen years.

What are the causes of this deplorable state of affairs? First, since the War we have tried to enlarge the universities, the Scientific Civil Service, the industrial research laboratories, the medical services, and the schools. Is it not possible, and even likely, that we are not producing, and never can produce, enough scientists to meet all these needs? Secondly, the salary of science teachers is too low. Before the War, a science teacher got £480 per annum—about the same as a university lecturer (£500 per annum) and about the same as he could get in the Scientific Civil Service or industry. To-day a science teacher gets £706 per annum, while a university lecturer gets £1,100 per annum and family allowances; and the Scientific Civil Service and industry are on similar scales. The science teacher's salary has not increased at the same rate as salaries in other occupations open to him. Before the War, the salaries of science teachers were determined by a separate Grammar School Burnham Committee, where the particular interests of all grammar school teachers received proper consideration. This separate Committee was abolished by the 1944 Education Act, and now the salaries of teachers in all types of school—nursery, primary, secondary modern, secondary technical and grammar—are settled by one Burnham Committee, in which grammar school teachers are in a minority. Their interests have received insufficient attention, because the majority of teachers on the Burnham Committee have failed to appreciate the importance of the grammar school in the national system of education. Finally, before the 1944 Education Act, there were two types of school, namely, elementary schools and grammar schools, and they were administered quite differently. Now all schools are administered in the same way; and unfortunately most local education authorities are administering all schools as they formerly administered elementary schools, in which the seat of authority was at the education office. Head masters and assistant masters feel that they have no longer the authority and freedom to do their work efficiently. They resent this loss of freedom, which is against the interests of their pupils and produces a sense of frustration, and is causing teachers to leave State grammar schools for independent schools, where both the salaries and working conditions are better.

The shortage of science teachers and the decline in their quality must be given careful consideration at the highest government level. The resources of scientific man-power and their most effective use require reconsideration, with full recognition of the claims of the public and grammar schools. It cannot be too strongly emphasized that these schools occupy the key position in the professional life of Britain. They are the source from which the nation recruits not only its university students, but also the majority of other professional men and women, including the teachers in the primary and secondary modern schools. If the standards in the public and grammar schools be allowed to fall, this will in due course be reflected in the whole professional and industrial life of the community, with all this means for our standard of life.

The present position is that the number of suitably qualified graduates in science is strictly limited, and one profession, namely teaching, which occupies a fundamental place in the supply line of scientific men and women, is experiencing a serious shortage. If the work of technical colleges is expanded and a new technological university is opened, where will the additional staff come from? Some school science teachers are already being attracted to the technical colleges by improved salaries. It is therefore pertinent to ask whether the Scientific Civil Service and industry could economize in their use of scientific workers.

Secondly, the salaries of science teachers (and that of all grammar school teachers) should be made comparable with those offered by the universities, the Scientific Civil Service and industry. The present Burnham salary scale continues until March 31, 1954. If by that time the salary position in such schools has not improved, the present system of one Burnham Committee for all types of schools will have failed, and a separate Burnham Committee for grammar schools should be re-instituted, parallel with the separate committees both for technical colleges and for teachers' training colleges already in existence. Finally, every effort should be made by the Ministry of Education, by professional associations of administrators and of teachers, and by public opinion to induce local education authorities to restore to the grammar schools the working conditions they enjoyed before the War,

To sum up, there is at present in Britain a shortage of grammar school science teachers, and their scientific qualifications are below pre-war standard. The situation will get progressively worse and lead to a lowering of our standard of life unless prompt measures are taken. In its post-war schemes of expansion, Great Britain over-strained its resources of scientific man[illegible]wer, with the result that science in the grammar school is suffering. The position warrants a survey at the highest level of the utilization of science graduates in Britain.

A PHILOSOPHY FOR MODERN MAN

The Conduct of Life

By Lewis Mumford. Pp. ix+342. (London: Secker and Warburg, Ltd., 1952.) 21*s*. net.

THIS book completes the series which Mr. Lewis Mumford commenced with the publication of "Technics and Civilisation" and continued in "The Culture of Cities" in 1938, and in "The Condition of Man" in 1944. In this final volume the reader is given the philosophy which inspired the earlier trilogy and which gives unity to the whole ambitious project. For two decades Mr. Mumford's thought has matured, as may well be seen by comparing the final volume with two other slighter books, "Faith for Living", written in response to the challenge of the early summer of 1940, and "Programme for Survival", provoked in 1946 by the menace of the atomic bomb. These two books contain, indeed, the core of Mr. Mumford's thesis and argument expounded at greater length and more maturely in the present volume. Mr. Mumford's claim that "The Conduct of Life" is, in fact, a preface to the earlier volumes of the series thus seems a little thin, but there is justice as well as logic in his contention that the full import of any one book cannot be grasped without an understanding of the other three. To some extent they overlap and are interdependent, and the admirable bibliographies are planned to be complementary so as to avoid overlapping.

Like "Faith for Living", "The Conduct of Life" is a confession of faith and a tract for the times. As such it is acceptable, where from a strictly philosophical point of view it might be found deficient. Even from that point of view it is a better and more mature book than "The Condition of Man". It is free from the tendency to dramatize and over-simplify the issues which in earlier books in the series masked the historical continuity and, especially with his predilection for dramatic captions and juxtapositions, frequently distracted or irritated the reader. The pattern of life clearly to be traced in those earlier books is here set forth in the context of some discussion, comprehensive but not exhaustive, of the final problems of man's nature, destiny and purpose, and the measures required to further that pattern are argued afresh in the light of the changes for the worse which have occurred throughout the world since Mumford began to write these books.

Mumford opens with a revolt against the idea of automatic progress through scientific advance and of the mechanical conception of life with its disregard for human personality. This seems to flow naturally from two brilliant chapters in "Technics and Civilisation" in which he discussed the assimilation of the machine and the reorientation of life on lines which gave full expression to human personality and made man once more the master and not the servant of the machine. Once again he diagnoses the present situation to show the challenge it offers to renewal, insisting on the need to concentrate all the resources our society possesses, all its present energies and vitality, and its funded values and ideas on the upbuilding and regenerative functions, in both the personality and the community. Such a process of renewal, he argues, holds our only hope of escaping catastrophe, and he then proceeds to analyse what is involved in such a reorientation to life. That analysis leads him to a discussion of man and his nature and the transformation of man, in which Mumford sets forth his ideas on ethics and religion much as he did in "Faith for Living". Philosophically, his argument seems somewhat superficial, but his plea for self-understanding and for a moral foundation is argued with a sincerity that commands respect even when agreement is only partial, and he gains strength as he goes on to delineate the basis for human development and to diagnose the obstacles which have to be removed or surmounted. On the fulfilment of man and the drama of renewal he writes with an assurance that is never more fluent and convincing than when he expands his views on the need for balance and discipline—views which are similar to those Dr. K. E. Barlow set forth in "The Discipline of Peace". Here, even more than in his earlier books, Mumford reveals how much his thought has in common with Smuts's conception of holism, and his discipleship of Geddes is as marked as in a much slighter tract for the times, "The Social Foundations of Post-war Building", in which he expounded views which are set forth more fully here and in "The Culture of Cities". Mumford is never happier, too, than when he touches on the world of science: his book is supremely a sermon against extremism and rigid institutions in systems. He denounces as folly both the effort to increase productivity or output without regard to the effect on human personality, and a blind trust in the wisdom of the masses. The first step towards freedom, he argues, will be a new respect for the symbol, a purification and clarification of language itself, an abstention from the unclean slogans which are so cunningly employed by totalitarian regimes. "The death of the advertising agency and the propaganda bureau will be one of the surest signs of the birth of a new society."

Mumford pleads for thought, for the will and the means to direct the instruments we have created in the interests of life, so that we can contract them and bring them to a halt when they threaten that life. Discrimination and selection are essential elements in his programme, and he places in the forefront the cultivation of a sensitivity and a tenderness to human needs and personality to which the welfare State, no less than the totalitarian, is markedly indifferent. That is one reason for his sternness to those who reduce life to a rigid system: planning has its place, but strictly as the servant of man, and Mumford raises his voice against the barriers that have been erected in these years against the free interchange of opinions, the free rivalry of opposing beliefs, the free flow of ideas, as he does against subservience to all anodynes that impair our power of choice and judgment, whether the cinema, the television set, alcohol, tobacco or drug addiction. "The majority is probably wrong" might well be his reply to some of the slogans of to-day or to those who think modern man can do no wrong.

The development of evaluation and selection, of a constant discrimination between good and bad, as an inherent need of human life, is one of Mumford's three main criteria for an ethics of human development. Reverence for human life in all its manifestations is another: he examines at some length Dr. Albert Schweitzer's principle, which he commends without unreservedly accepting its theological connotation. Third is the acknowledgment of the purposive nature of all living processes and the conscious formulation of ideals, goals and plans as an essential transition of natural teleology into the development of man.

Mumford's distrust of rigid systems is a basic thesis of the book; more positively this is the affirmation of organic life in what he calls the principle of balance—a balance and harmony, sufficiently dynamic and comprehensive to nourish every kind of nature, to create the fullest variety in unity and to do justice to every occasion. It is this principle he finds incarnate in Schweitzer, and, following the latter's argument that no present form of science or political or religious organization can avert the disintegration of civilization, Mumford postulates, as the first condition of renewal, a withdrawal from society to gain the self-knowledge and concentration which are the prelude to effective action and to a balanced life characterized by health, poise and sanity, and renewed faith in the creative processes and in values and purposes that transcend past achievements and forms. What he advocates here is not asceticism as such but rather something akin to the wise administrator's practice of making time for creative thinking, free from routine duties.

In this way, Mumford suggests that the individual will regain the vision and initiative to make him an active and effective member on rejoining his group. Confidence in this prescription is derived by Mumford essentially from Clerk Maxwell's doctrine of singular points. "At these points, influences whose physical magnitude is too small to be taken account of by a finite being may produce results of the greatest importance. All great results produced by human endeavour depend on taking advantage of these singular states when they occur." Mumford believes in the possibility of the singular point, though he gives no indication as to how these points can be fostered.

In that possibility he finds the first reason for the faith and sense of purpose that he considers as essential for the development of man and the regaining of control over events. His second reason is in the sense of historic continuity to which his mature thought has led him. He starts with human life in its historic manifoldness and purposefulness: "Before every attempt to describe the world and life and time there stands an unspoken prologue: human history itself. . . . To understand the nature of man, accordingly, we must first of all understand this prologue". Mr. Mumford has now discovered not merely that man needs a religious as well as a moral view of the universe, but also that there are more primordial elements of human experience than matter or motion. Man lives in history and through history —in a sense he lives for history; and from this Mr. Mumford derives the faith that enables him to face the task of renewing civilization, even if, while recognizing the noble elements in the great world religions, he cannot entirely accept any of them. For him God is still in the making. There are occasional lapses in balance or judgment—as, for example, in the reference to Neville Chamberlain or the apparent bracketing of Schweitzer with Weston—but these do not impair the dignity of a courageous and inspiring book, a book which stimulates reflexion and self-examination and which, as a subsidiary merit, includes a select bibliography forming a reliable guide to representative books for further reading.

R. Brightman

HORMONES, CHEMOTHERAPY AND ANTIBIOTICS

Medicinal Chemistry

Chemistry, Biochemistry, Therapeutic and Pharmacological Action of Natural and Synthetic Drugs. By Prof. Alfred Burger. Vol. 2. Pp. xv+579–1084. (New York and London: Interscience Publishers, Inc., 1951.) 10 dollars.

This second and final volume of Prof. Alfred Burger's treatise follows the same pattern as the earlier volume, the review of which (*Nature*, 168, 438; 1951) contains general comments which are applicable here also. In the main, this volume is concerned with synthetic drugs used in the chemotherapy of diseases caused by pathogenic organisms and with antibiotics. The author evidently wished his treatise to be fairly comprehensive and has included a description of vitamins and hormones; but he seems to have had difficulty in fitting these into his scheme. The vitamins were discussed in the first volume, although they have little relationship to the other classes of drugs dealt with there, whereas the present volume contains a chapter on hormones (mainly steroid) which seems a little out of place in relation to the other contents.

In his preface the author comments on the increasing activity in several fields during the year of publication, and he found it difficult to incorporate all the latest developments. This is inevitable with a rapidly advancing subject, and in the period which has elapsed since publication there have been further important developments. This applies especially to the adreno-cortical hormones, in connexion with which the past two years have witnessed much feverish activity culminating in their total synthesis; in improved methods of partial synthesis from more abundant plant and animal steroids; and in elucidation of some of the likely stages in their biosynthesis. In the field of antibiotics also there have been important advances, of which perhaps the most interesting is the recent claim to have established the structures of aureomycin and terramycin as hydronaphthacene derivatives (Woodward *et al.*, *J. Amer. Chem. Soc.*, 74, 3708, 4976; 1952). The quest for new antibiotics seems to attract the big battalions. One learns from Prof. Burger's book that the first announcement of the discovery of aureomycin was made by forty-three authors, and that one of the earliest papers on terramycin appeared under the names of no less than eighty-five authors.

It is unfortunate that the discovery of valuable new therapeutic agents tends to be over-publicized, with exaggerated claims which lead to inevitable disappointment. This has happened many times in the history of therapeutics. Cortisone has been shown to be less generally efficacious in the treatment of rheumatoid arthritis than was originally thought; this and its undesirable side-effects have now led to the situation that the supply seems to have outstripped the demand. Recently the Americans have been considering imposing a ban on the use of chloramphenicol (chloromycetin), for although it has been used successfully in the treatment of rickettsial diseases, there have been indications that it may produce a dangerous condition of aplastic anæmia. In spite of such disappointments, there is probably every justification for Prof. Burger's statement (p. 658) that "the last fifty years of chemotherapeutic research have helped medicine more than the efforts of all scientists in the preceding 5000 years".

In addition to the chapters on hormones and antibiotics, the present volume contains chapters on essential amino-acids and fatty acids, dyestuffs used in chemotherapy, sulphonamide drugs, antimalarials, antitubercular and antileprotic agents (in both of which fields there have been subsequent developments), trypanocidal, amœbicidal and antifilarial drugs, organometallic compounds of arsenic, antimony, and bismuth, and antiseptics. There are available more extensive works on most of these subjects, but it is useful to have an excellent account of them all in one volume. An attempt has been made to present the views which have been advanced as to the mode of action of the drugs, and there is, for example, a chapter devoted to a discussion of theories of metabolite antagonism.

In its production this volume reaches the excellent standard set by Vol. 1, and there is a good index covering both volumes. There are a few misprints, such as "typtophan" (p. 581), and "persued" (p. 699). It is questionable whether "stereoisomerize" should be used as a verb (p. 627), but "grignardize" (p. 622) is an abomination. Exception could be taken to other points of detail; but as a whole the book is very readable and contains a wealth of useful information.

J. W. Cook

PLANT VIRUSES, OLD AND NEW

Plant Viruses and Virus Diseases

By F. C. Bawden. (Plant Science Books, Vol. 23.) Third, entirely revised edition. Pp. xvi+336. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1950.) 6 dollars.

THE modern study of plant viruses involves the use of varied techniques and ramifies through much of the whole field of natural science. It is therefore a formidable task for any one investigator to collect together all the relevant information from such a wide field and present it in an intelligible and readable form. That Mr. F. C. Bawden has succeeded so well in his task speaks well for his grasp of the subject. During the past decade, with the development of new techniques and methods of approach to the problem, our knowledge of the plant viruses has expanded so rapidly that any books on the subject become quickly out of date. The author has realized this and in consequence has virtually rewritten the third edition of his book, adding a new chapter on quantitative methods of virus assay. There are now seventeen chapters, and they deal with external and internal symptoms of infected plants, methods of transmission, relations between viruses and vectors, mutation and interference between strains, serological relations, quantitative methods of assaying for viruses, their purification and chemical and physical properties, crystallinity, estimation of particle size, types of inactivation, taxonomy of viruses, physiology of host plants, control measures and speculations on the origins of viruses.

This list of contents shows how completely the subject is covered, though perhaps, by the time the next edition is called for, knowledge will have progressed far enough for a chapter on the multiplication of viruses to be added. One of the most interesting chapters is the last, in which the author discusses the origin of viruses. Like most plant-virus workers, he is struck with the appearance of new virus diseases which "are being described with an almost frightening frequency". On p. 321 he says: "it is probably to tolerant organisms we should look for the origin of our current pathogens". This brings up the question of the origin of these 'new' viruses, which is fundamental to the whole problem. It may not be too revolutionary, in view of the modern trend of virus work, to suggest that one explanation may be the transfer, usually but probably not always by insect agency, of cellular constituents from one organism in which they are not pathogenic to another one in which they are. We do not know how many instances of such "cellular constituents" exist, whether we regard them as 'latent viruses' or merely as normal cell components of that particular host. The inference is that they are very numerous. The newly described latent virus of sugar-beet is a case in point. Transfer of this to the cowpea produces in outdoor plants a virulent disease. Other instances are the paracrinkle virus of King Edward potatoes and the latent virus of dodder.

Methods of detecting the presence of such latent or potential viruses are at present very crude and consist mainly of hit-or-miss trials with indicator plants. It is possible that the electron microscope will aid in this search, although the difficulties in interpreting the many virus-like particles seen in cells of apparently healthy plants are very great.

Mr. Bawden is to be congratulated on his book, which is clearly printed and illustrated with many excellent photographs. K. M. SMITH

FUNGI FOR EVERYONE

The Molds and Man

An Introduction to the Fungi. By Prof. Clyde M. Christensen. Pp. viii+244. (Minneapolis: University of Minnesota Press; London: Oxford University Press, 1951.) 21*s*. net.

THIS book is written for "beginning students in mycology, whether amateur or professional". It would certainly be most useful for such people, but it may prove to be one of the few books which present scientific facts without strain to the non-scientific reader. The language is clear and the text most interesting of itself; many narrative novels have less power to hold the attention.

There are chapters on what fungi do and how they grow, on their reproduction and dissemination, and an appendix on their classification. Discussion of fungus partnerships with other plants includes lichens and mycorrhizas of orchids and forest trees. Partnerships with animals bring descriptions of scale insects and their fungus houses, ants and fungi, ambrosia beetles, the nitrogen cycle, and the fascinating behaviour of *Pilobolus* on horse dung. Plant diseases are treated with the importance they deserve, for Dr. C. M. Christensen himself lived mainly on corn-meal mush in the winter of 1916–17, when stem rust of wheat "emptied the breadbasket of North Dakota". Typical rust diseases of various food plants and fungi which cause heart rot in trees are the two subjects chosen to illustrate the whole. Fungi also destroy stored food-products—grain, butter, meat and eggs—and they rot wood, paint, fabrics and other materials. The section on parasites of micro-organisms and insects includes an account of 'snaring' mechanisms on some fungi which trap and feed on nematodes. It also describes several entomogenous species, and considers the possibilities of biological control of insect pests. Fungal parasites of fish, land animals and man expand the total of our awareness of fungi as enemies. On the credit side, fungi add to our food, either directly, as in the cultivation of mushrooms, or indirectly, to flavour, as in Roquefort or Camembert cheese. Enzymes and acids are now produced by mycological methods, while the fascinating development of penicillin and streptomycin is discussed in the text.

Dr. Christensen is an artist with words, and his book should bring mycology much more within the orbit of an increasing body of non-specialist but discriminating readers. Why, however, does he ration his book so sparsely of illustration? The few pictorial representations which do occur suggest that he may have a wit of delineation in addition to an ease of language. J. GRAINGER

TOWARDS THE ABSOLUTE ZERO

Low Temperature Physics

Four Lectures. By F. E. Simon, N. Kurti, J. F. Allen, K. Mendelssohn. Pp. vi+132. (London: Pergamon Press, Ltd., 1952.) 21*s*.

THE four lectures in this volume were delivered at the Royal Institution, London, in February and March 1950, but the opportunity has been taken during the interval to revise the text and to bring the subject-matter up to date. The references include papers published as late as the first quarter of 1952. Three of the lectures are by leading members of the low-temperature school at the Clarendon Laboratory, Oxford, and the fourth by Prof. J. F. Allen, of the University of St. Andrews.

Prof. F. E. Simon in his introductory lecture describes low-temperature physics as one of the most flourishing parts of modern science and gives a masterly general survey of the characteristic features, with particular reference to the guiding principle of the third law of thermodynamics and the fact that quantum laws cause all systems to approach a state of perfect order. Dr. N. Kurti discusses the temperature-range below 1° K., a region which has been explored for about ten years only and for the attainment of which, being below the lowest temperature obtainable with liquid helium, methods other than that of the standard method of gas liquefaction have been devised. The magnetic cooling method is fully dealt with, and nuclear paramagnetism, which is a very recent development, is shown to be a fruitful field of investigation for the application of extremely low temperatures.

The peculiar and most interesting properties of liquid helium, many of which are still not understood, are described by Prof. Allen, and finally Dr. K. Mendelssohn deals with that equally puzzling and perhaps in some ways related phenomenon, superconductivity. Discovered forty years ago and investigated both theoretically and experimentally in great detail since, a wealth of information has been collected; but there are grave difficulties in the way of a satisfactory explanation of the phenomenon. Dr. Mendelssohn suggests that what is missing is a new concept in physics, a new form in which the particles of matter can associate. He emphasizes the curious analogy between superfluidity in liquid helium and superconductivity, in both of which, at a certain temperature, the degree of order in the system suddenly increases; and he advances the idea of a fourth state of aggregation of matter, an ordering or condensation with respect to the momenta, in addition to the three states of aggregation of positional order.

The volume should prove most useful to honours students, to those intending to specialize in low-temperature physics and to more advanced physicists who wish to obtain a clear, authoritative picture of the present position of knowledge of low-temperature phenomena. S. WEINTROUB

Introduction to the Transfer of Heat and Mass

By E. R. G. Eckert; with an Appendix on Property Values, by Robert M. Drake, Jr. Pp. xiii+284. (London: McGraw-Hill Publishing Co., Ltd., 1950.) 34*s*.

THE American edition of Dr. E. R. G. Eckert's excellent German text, enriched as it is by new sections and some fine interference photographs, is most welcome. The literature of the subject is so vast that there is need for a work such as this, which presents basic theory and established data but is chiefly concerned with depth of understanding.

The largest part of the book deals with heat transfer by convection. The starting-point is the flat plate in longitudinal flow, so that the student is immediately introduced to velocity and thermal boundary layers and acquainted with the factors which govern them. Extensive use is made of the approximate methods associated with the names of von Kármán, Pohlhausen and Kroujiline, which are simple and sufficiently accurate and which have the great advantage for the student of using physical, rather than exclusively mathematical, reasoning. Flow in ducts is treated later, as a case where the stream is all boundary layer. There is a good account of recent work on the analogy between heat transfer and friction.

Mass transfer is given less attention than heat transfer. The only case considered in detail is the transfer of water vapour between an air stream and a flat plate. A few pages devoted to generalizing the results so obtained would be a worth-while addition, contributing to the student's confidence in tackling other cases.

The treatment of radiation and radiative heat-exchange is concise and benefits from the fact that the author's own research has made important contributions to our knowledge of this aspect of heat transfer.

D. B. Spalding

Tables of the Error Function and of its First Twenty Derivatives

By the Staff of the Computation Laboratory. (Annals of the Computation Laboratory of Harvard University, Vol. 23.) Pp. xxviii+276. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1952.) 8 dollars.

IN various forms, at various intervals, and with various degrees of accuracy, integrals of the 'normal' (Gaussian) distribution function have been tabulated, mainly on account of its fundamental importance in statistical calculations. Nothing like the same attention has been given to the derivatives, although the demand for them has been increasing. They also enter into statistical calculations (for example, the Gram–Charlier series). They provide solutions of the equation of heat conduction or diffusion, are closely associated with the Hermite polynomials, and possess valuable orthogonal properties. After requests from various quarters these tables were prepared in the Harvard Computational Laboratory, under contract with the United States Air Force. It is claimed that, at any point, they give more derivatives or more decimals, or use a smaller interval, than other published tables.

Table 1 gives $\varphi_0(x) = \sqrt{(1/2\pi)}\,\exp(-\tfrac{1}{2}x^2)$, its integral (for completeness) and its first four derivatives. Table 2 gives derivatives from the fifth to the tenth. In these tables six decimals are given, at intervals of 0·004 in x, and tabulation proceeds until the values cease to be significant in the sixth decimal. Tables 3 and 4 give the succeeding derivatives, up to the twentieth. Here the larger values which occur for the smaller values of x are given to seven significant figures, but later values stop, as before, at the sixth decimal; the interval in these tables is 0·002. No reason is given for the rather unusual choice of intervals, and no special provision is made for interpolation, since the Taylor series is appropriate and not inconvenient.

An introduction gives an account of the main properties of the functions tabulated, an outline of the method of calculation, and an account of problems in which these functions have found application. Seven-decimal values of their zeros are also given.

W. G. Bickley

Copolymerization

By Turner Alfrey, Jr., John J. Bohrer and H. Mark. (High Polymers, Vol. 8.) Pp. x+269. (New York and London: Interscience Publishers, Inc., 1952.) 6.80 dollars.

COPOLYMERIZATION is the phenomenon of the synthesis of a macromolecule from two monomeric components, each of which is capable of polymerizing. Not all monomers exhibit this phenomenon, and in addition it is occasionally possible for copolymers to be formed when one of the components does not itself polymerize. Very occasionally it may happen that two molecules will form a copolymer and neither will polymerize separately. Copolymers are of great interest industrially—nearly all synthetic rubbers are copolymers because the necessary properties cannot be obtained with a homogeneous polymer made from one component only. But this volume is concerned almost wholly with the purely academic problems which arise in such processes. Most of the work on copolymerization has been induced by the addition of free radicals in the monomers, and the ionic mechanism of copolymerization has only been studied to a very limited extent.

The book presupposes some knowledge of polymerization mechanism, since this is dealt with in detail in other volumes in the series. The authors are so well known for their contribution to high-polymer chemistry that this whole book is a thoroughly critical and authoritative discussion of the reaction mechanism of copolymerization, the structures and reactivity of copolymers. The immense number of systems studied has added a very important chapter to our knowledge of relative reactivity radicals and thrown a new light on radical reactions. In spite of the specialist nature of the subject, the book will be of great interest to anyone interested in the mechanism of organic reactions. It is well produced, illustrated, printed and bound.

H. W. Melville

Geometry and the Imagination

By D. Hilbert and S. Cohn-Vossen. Translated by P. Nemenyi. Pp. ix+357. (New York: Chelsea Publishing Co., 1952.) 5 dollars.

THE original German edition of this book, "Anschauliche Geometrie", was reviewed in these columns in 1933 (see *Nature*, 132, 369; 1933). This English translation, by P. Nemenyi, retains the fascination and enthusiasm of the original work, and should provide stimulus and inspiration to every student and teacher of geometry.

CONDUCTIVITY OF THE IONOSPHERE*

By Dr. W. G. BAKER
Amalgamated Wireless (Australasia), Ltd.,
AND
Dr. D. F. MARTYN, F.R.S.
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MORE than seventy years ago, Balfour Stewart[1], and later Schuster[2], realized that the small regular daily oscillations of the compass needle were probably produced by electric currents in the upper atmosphere. The latter put forward a detailed quantitative theory, the 'dynamo theory', which attributed these currents to the regular daily (horizontal) tidal movement of conducting air across the magnetic field of the earth. Chapman[3] showed that the postulated conducting region should have a (height-integrated) conductivity $\int \sigma dh$ of $2{\cdot}5 \times 10^{-5}$ e.m.u.-cm. at the epoch of sunspot maximum, if the tidal speed in the conducting region was the same as that found at ground-levels.

When the ionosphere was experimentally discovered, about 1925, by Appleton, and by Breit and Tuve, it was reasonable to expect that the dynamo theory of magnetic variations would soon be confirmed. Unfortunately, as experimental knowledge of this region accumulated, it seemed clear that all the various ionized layers D, E, F, taken singly or together, had insufficient conductivity to give the necessary current intensities, if these were calculated according to Schuster's theory, which assumed that the velocities of the tidal winds in the ionosphere were the same as those measured at the ground. The calculated low conductivity of the ionosphere was due mainly to the earth's magnetic field, which impedes the horizontal flow of charged particles at the low pressures existing in the upper atmosphere, as first pointed out by Pedersen[4].

This deadlock in the application of the dynamo theory to the magnetic variations remained until 1936, when Taylor[5] and Pekeris[6] showed that the atmosphere could oscillate tidally in such a way that the wind velocities in the upper atmosphere were much larger than those at the ground. Previous investigators of atmospheric oscillations had assumed two special temperature gradients: (*a*) isothermal, with isothermal expansions (Laplace), and (*b*) fully adiabatic, with adiabatic expansions (Lamb). In these two special cases, chosen by Laplace and Lamb for mathematical convenience, the amplitude of the oscillations is independent of height; it is now clear, however, from Taylor's work, that these two cases are unique, for in the general case the amplitude tends to increase markedly with height. The fundamental physical principle involved in the general case appears to be that the horizontal *energy* flow tends to be uniform at all heights; this is proportional to ρu^2, where ρ is the air density, and u the speed of tidal motion. Thus u varies as $\rho^{-1/2}$, and may be expected to be some 1,000 times greater in the ionosphere than at the ground, if damping be negligible. In parallel with this theoretical development, the discovery of the large (1-km.) lunar oscillation of the E-region of the ionosphere by Appleton and Weekes[7] in 1939 appeared to provide an experimental vindication of the dynamo theory, since it could be interpreted as showing that the lunar oscillation at 120 km. was some 6,000 times that at the ground. However, Martyn[8] showed that this oscillation of the E-region was likely to be due, not to simple tidal rise and fall of the isobaric surfaces, but to the electrodynamic forces associated with the magnetic variations; this demanded much less amplification of tidal velocities—perhaps only 200. This view has been confirmed by Weekes[9], who finds no evidence of lunar tidal winds in the E-region of velocities greater than about 200 times those at the ground. It should be pointed out also that amplifications of 6,000 would lead, for the solar tide, to winds in the ionosphere of speeds approaching, or greater than, that of sound—an unlikely contingency, and one not envisaged in the theoretical work of Taylor and Pekeris.

Cowling[10] has made a careful study of ionospheric conductivity; his findings may be summarized by the statement that a tidal amplification of several thousands is required if the dynamo theory be valid, unless there are large numbers of negative ions in the E- and F_1-regions. More recently, Bates and Massey[11] have put forward strong arguments against the existence of negative ions in appreciable numbers in these regions. They conclude that the theoretical calculated conductivity of the ionosphere is less than 4×10^{-9} e.m.u.-cm., so demanding a tidal amplification of about 6,000.

In recent years, Martyn[12] has studied the observed amplitudes and phases of the lunar semi-diurnal oscillations in the heights and densities of the various ionospheric regions. He concluded that the phases were inconsistent with the view that the lunar magnetic variations were due to currents flowing in either the E-, F_1- or F_2-regions, if these currents flowed in the direction of the local electric fields. If this conclusion be accepted, then it must follow either that these currents flow in other regions, deficient in electron density but rich in negative ions, or that the currents flow in a direction markedly different from the electric fields. Bates and Massey (*loc. cit.*), after exhaustive investigation, have shown that it is extremely improbable that ions can exist at other levels, in numbers sufficient to give the necessary conductivity, so that the first-mentioned alternative is unlikely to be permissible.

Martyn[13] suggested in 1948 that the conductivity of the ionosphere may be enhanced if transverse (Hall) currents are prevented from flowing by polarization, along lines investigated first by Cowling[14] in connexion with the solar atmosphere. However, Cowling and Borger[15] considered that this suggestion would not account for the discrepancy, save perhaps in a narrow region near the magnetic equator.

It now seems clear that in spite of the early promise of Pekeris's theoretical calculations of high-level tidal amplitudes, and of Appleton and Weekes's measurements of E-region lunar oscillations, a major difficulty still exists, in that all the combined regions of the ionosphere have apparently insufficient conductivity (by the factor of 10 at least) to account for the observed geomagnetic daily variations according to the dynamo theory.

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* Substance of papers presented at the recent meetings of the International Scientific Radio Union and of the Mixed Commission on the Ionosphere, at Sydney and Canberra, Australia.

No satisfactory alternative to this theory exists, and it cannot be lightly abandoned, since it gives an excellent qualitative account of the magnetic variations. Moreover, an entirely different approach, by Ashour and Price[16], who have studied the induction of currents in the ionosphere, gives convincing support to the view that the average conductivity of the ionosphere is between 5 and 10×10^{-8} e.m.u.-cm., which would be adequate for the purposes of the dynamo theory.

Accordingly, we have examined afresh the fundamental principles involved in the production of electric currents in the ionosphere by tidal winds.

It is clear that the relevant conductivity cannot be σ_0, which is that appropriate for currents flowing parallel to the electric and magnetic fields, since horizontal currents must flow *across* the magnetic field in all but very limited portions of the globe. Another (lower) conductivity, σ_1, which is that appropriate for currents flowing parallel to the electric field, but transverse to the magnetic field, has been found inadequate quantitatively, as described above.

There exists another conductivity, σ_2, the Hall conductivity, which is relevant when the electric field, the current, and the magnetic field are all mutually at right angles, and when there is no hindrance (as by polarization) to the free flow of the direct (σ_1) current.

There is also still another effective conductivity, σ_3, that for currents flowing parallel to the electric field but transverse to the magnetic field, in circumstances where the Hall current is prevented from flowing by polarization.

Write

$$\omega_{e,i} = He/m_{e,i},$$

where H is the intensity of the geomagnetic field (gauss); $m_{e,i}$ are the masses of an electron and ion respectively; e is the electronic charge (taken as a positive number); $\nu_{e,i}$ are the collisional frequencies of an electron and ion with the air molecules, $\tan(\alpha,\beta) = \omega_{e,i}/\nu_{e,i}$; and N is the number of electrons (or ions) per cm.^{3}. Then the formulæ for these conductivities may be expressed in the following simple forms:

$$\sigma_0 = \frac{Ne}{H}(\tan\alpha + \tan\beta) = A(\tan\alpha + \tan\beta)$$

$$\sigma_1 = \frac{A}{2}(\sin 2\alpha + \sin 2\beta) = A\sin(\alpha+\beta)\cos(\alpha-\beta)$$

$$\sigma_2 = A(\sin^2\alpha - \sin^2\beta) = A\sin(\alpha+\beta)\sin(\alpha-\beta)$$

$$\sigma_3 = A\sin(\alpha+\beta)\sec(\alpha-\beta) \equiv \sigma_1 + \sigma_2^2/\sigma_1$$

(in the case of σ_2 it is necessary to specify the sense of the current by indicating that σ_2 is positive when H is directed along the positive x-axis and the electric field along the y-axis of right-handed axes).

Graphs of $\sigma_{1,2,3}$ (for $N = 1$) are shown in Fig. 1 at various ionospheric levels. In computing these, the atmospheric properties assumed were those adopted by Bates and Massey (*loc. cit.*); they incorporate the latest data derived from rocket measurements. In accordance with recent measurements by Shaw[17], ν_e was taken to be $2 \cdot 5 \times 10^5$ collisions per sec. at a height of 100 km. and $\tan\alpha/\tan\beta$ was taken as 1,650, in accordance with Tyndall's[18] measurements.

It is seen that σ_1 has two maxima, that at 140 km. due mainly to ions, at 75 km. to electrons. These maxima are relatively small, and they occur at heights where ionization is relatively sparse. σ_2 has one broad maximum, at 105 ± 35 km., so including all the ionization of the *E*-region; σ_3 has a pronounced sharp maximum at 100 ± 10 km. When account is taken of the known and probable electron densities at the relevant heights (Fig. 1, curve N) it is found that:

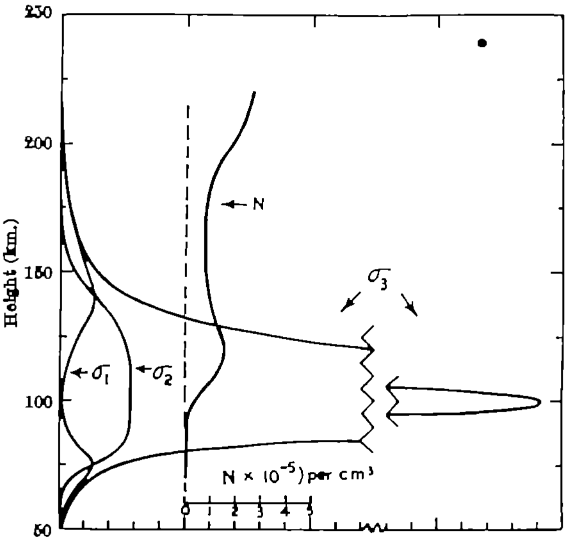

Fig. 1

$$\int \sigma_1\,dh = 4 \cdot 5 \times 10^{-9} \text{ e.m.u.-cm.},$$
$$\int \sigma_2\,dh = 1 \cdot 45 \times 10^{-8} \text{ e.m.u.-cm.},$$
$$\int \sigma_3\,dh = 1 \cdot 2 \times 10^{-7} \text{ e.m.u.-cm.}$$

Over the terrestrial sphere in general, the magnetic field is inclined to the horizontal, and to the 'dynamo'-generated electric fields. If we consider the ionosphere as a relatively thin sheet of conductive air enclosing the earth, and assume that *vertical* currents in the sheet are prohibited by polarization, then the important conductivities become σ_{xx}, σ_{yy}, σ_{xy} and σ_{yx}, the x- and y-axes running southward and eastward respectively. Here σ_{xx}, σ_{yy}, are the effective direct conductivities, and σ_{yx}, σ_{xy} the effective Hall conductivities, for horizontal electric fields in the south and east directions respectively. If χ be the magnetic dip angle, then:

$$\sigma_{xx} = \sigma_0\,\sigma_1/B, \qquad \{\to \sigma_0, \text{ as } \chi \to 0\}$$
$$\sigma_{yy} = (\sigma_0\,\sigma_1 \sin^2\chi + \sigma_1\,\sigma_3 \cos^2\chi)/B, \qquad \{\to \sigma_3, \text{ as } \chi \to 0\}$$
$$\sigma_{xy} = -\sigma_{yx} = \sigma_0\,\sigma_2 \sin\chi/B, \qquad \{\to 0, \text{ as } \chi \to 0\}$$

with $B = \sigma_0 \sin^2\chi + \sigma_1 \cos^2\chi$.

The variations of σ_{xx}, σ_{yy} and σ_{xy}, at the 100-km. level, are shown in Fig. 2 for latitudes (geomagnetic) from 0° to 90°. A logarithmic scale is used for the latitude Φ, since rapid changes take place near the equator. It will be noticed that at this height the horizontal Hall conductivity is some twenty times larger than the other horizontal conductivities over most of the earth. Within one or two hundred kilometres of the equator (magnetic), the Hall conductivity rapidly decreases, but the direct east–west and north–south conductivities rise to steep maxima.

It is readily found that a two-dimensional medium having direct conductivity σ_1, and transverse conductivity σ_2, has an effective conductivity $\sigma_1 + \sigma_2^2/\sigma_1$.

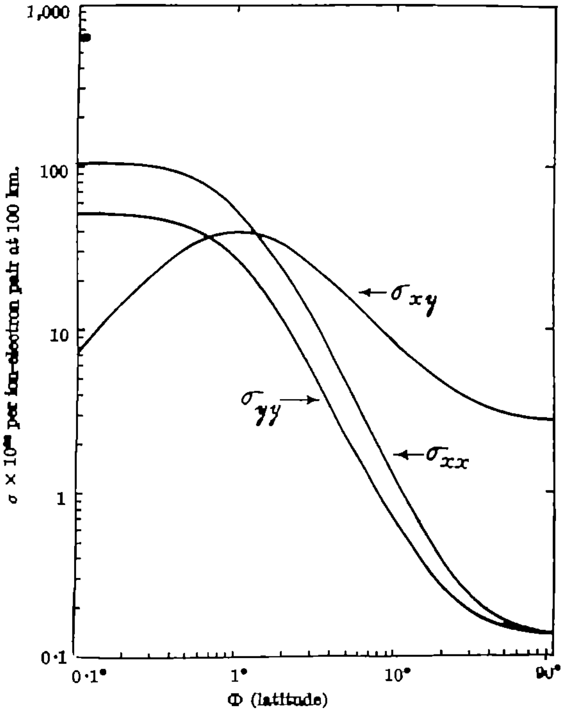

Fig. 2

In the case of the ionosphere, assuming for simplicity that $\sigma_{xx} = \sigma_{yy}$, the effective conductivity becomes $\sigma_{yy} + \sigma_{xy}^2/\sigma_{yy}$. However, although thin with respect to the earth, the ionosphere cannot be taken as infinitely thin, since σ_{xx} and σ_{xy} are variable within it. In order to assess its average conductivity, we assume that there is no height gradient of horizontal electric field; this assumption is justified by the high (σ_0) conductivity along the (nearly vertical) lines of magnetic force, which must be nearly equipotential lines. On this assumption the height-integrated effective conductivity becomes

$$\int \sigma \, dh = \int \sigma_{yy} \, dh \left\{ 1 + \left(\frac{\int \sigma_{xy} \, dh}{\int \sigma_{yy} \, dh} \right)^2 \right\}. \qquad (1)$$

At the magnetic equator, $\sigma_{xy} \rightarrow 0$ and $\sigma_{yy} \rightarrow \sigma_3$, so that:

$$\int \sigma \, dh \rightarrow \int \sigma_3 \, dh = \int \sigma_1 \, dh \left\{ 1 + \frac{\int \frac{\sigma_2^2}{\sigma_1} \, dh}{\int \sigma_1 \, dh} \right\}. \qquad (2)$$

(This expression is strictly accurate for the east–west conductivity at the equator; in this region the north–south conductivity degenerates to a somewhat higher value, namely, $\int \sigma_0 dh$ as shown above.)

In equations (1) and (2), the expressions in brackets have approximate numerical values of 12 and 29 respectively, with an uncertainty factor of about 2/1, depending on the unknown electron distribution between the E- and F_1- regions. Thus the effective conductivity of the ionosphere, over most of the earth, is some twelve times greater than that deduced by ignoring the Hall current, and near the magnetic equator is enhanced still further by an additional factor of 2·4.

Over most of the earth the currents are nearly perpendicular to the electric field, but are parallel to it near the magnetic equator. (There should therefore occur a rapid change in the phase of the daily electric field variations near this equator, a point which should have significance for the solar and lunar ionospheric variations.)

Equation (1) appears to account quantitatively for the high ionospheric conductivity necessary for the 'dynamo' theory, and would appear to justify the conclusion, after some seventy chequered years, that Balfour Stewart's 'dynamo theory' of the magnetic variations was well founded. Moreover, equation (2), which provides an additional enhancement of conductivity near the magnetic equator, is found to give a quantitative explanation of the anomalously large magnetic variations (the 'electro-jet') known to occur in these regions. (The latter conclusion has been tested by solving the dynamo equations for the spherical ionosphere, assuming the conductivity of equation (1) over most of the earth, and the narrow strip of higher conductivity at the equator.)

It appears that Martyn's earlier suggestion regarding the conductivity of the ionosphere is fully valid at the magnetic equator, and substantially valid over the rest of the earth; the earth's magnetic field reduces the conductivity by a factor much smaller than that deduced by Pedersen.

Over most of the earth, the current system should lie mainly between the 110- and 150-km. levels, the precise height distribution depending on the (relatively unknown) distribution of ionization and tidal velocities at these levels. However, near the magnetic equator the current system should be much more localized, Fig. 1 showing that it ought to flow in a shallow layer centred at 100 km. It is interesting to note that a rocket-borne magnetometer has recently been projected into the ionosphere near the magnetic equator by the U.S. Navy[19], and it is reported that the rocket passed completely through a current layer sufficiently intense to produce the observed diurnal magnetic variations at the ground; this layer was contained between the 93- and 105-km. levels.

We have discussed here the significance of our conclusions for the magnetic variations; if well founded, these conclusions are likely to have important application also to the theory of the regular solar and lunar ionospheric variations, and to the ionospheric variations associated with magnetic disturbance. These topics will be discussed elsewhere, in association with the detailed presentation of the above results.

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DYNAMO CURRENTS AND CONDUCTIVITIES IN THE EARTH'S UPPER ATMOSPHERE

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EXPERIMENTAL evidence has been obtained recently concerning magnetic discontinuities in the *E*-layer of the ionosphere near the magnetic equator[1]. This communication deals with the conclusions which can be drawn from these results about electric currents and D.C.-conductivities in the *D*- and *E*-layers of the ionosphere and their relation to ΔH, the diurnal variation of the magnetic field on the earth's surface.

Rocket measurements. With magnetometers mounted in 'Aerobee' high-altitude sounding rockets[1], we have made three separate measurements of the variation of the earth's magnetic field with altitude from sea-level up to 105 km.[1,3]. An electronic magnetometer of the saturable 'Permalloy'-core type was used in each of the three rocket flights; in order to make its reading independent of the orientation of the rocket, it was designed to measure the scalar value of the total field rather than any one component. The small magnetic influences of the rocket were carefully neutralized; the magnetometer sensitivity was determined periodically by means of in-flight calibrations; and the output of the instrument was telemetered by radio to ground receiving stations. A detailed description of the apparatus is given in references 1 and 3.

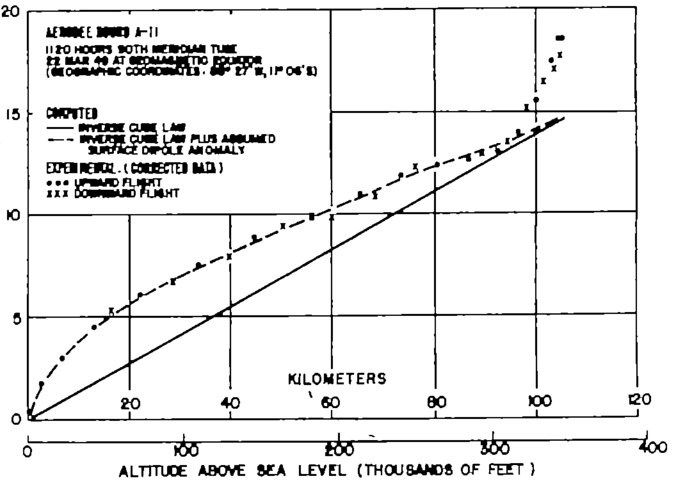
The initial attempt[3], conducted in April 1948 at the White Sands Proving Ground, New Mexico (geomagnetic latitude 41° N.), was designed mainly to test the instrumentation and the feasibility of the scheme. The decrease of the earth's field was found to be in excellent accord with the fall-off calculated from spherical harmonic analysis of the sea-level field[4]. No evidence either for or against a magnetic discontinuity could be established because of the smallness of the effect at this latitude.

Two further measurements were then carried out near the magnetic equator[1] (about 1,000 miles west of Huancayo, Peru) in rockets launched from the U.S. Navy seaplane-tender U.S.S. *Norton Sound*. The first rocket was fired on March 17, 1949, in the late afternoon, at which time ΔH is very small. Except for the effect of a small surface anomaly, the observed decrease of the magnetic field with altitude was in good accord with the inverse cube law; no detectable magnetic discontinuity was encountered.

The second rocket was fired near noon on March 22, 1949, close to the time of the maximum of ΔH, about 100 km. from the location of the first rocket launching. The deviation of the field from the inverse cube law (see graph) up to about 90 km. can be reproduced by means of a suitably *assumed*[2] surface anomaly. An interpretation in terms of a current—although this has an *a priori* possibility—does not appear justified.

Between 93 km. and 105 km. we observe a very rapid decrease in the magnetic field amounting to 4·0 ± 0·5 milligauss. The agreement of upward and downward points is within 0·5 milligauss or better. We interpret this decrease as produced by a current flowing from west to east in a sheet of large horizontal extension which commences at 93 km. and extends to an altitude of at least 105 km. in a rather uniform manner. (The accuracy of the measurements is not sufficient to obtain the detailed current distribution within this altitude interval.) We have no direct experimental knowledge of the strength or direction of the current *above* 105 km., the peak altitude reached by the rocket (but cf. 4 below).

Experimental deductions. These experimental results allow us to draw some conclusions about certain electrical properties of the earth's upper atmosphere.



(1) They establish by direct experiment the existence of a current system which is presumably responsible for the exceptionally large diurnal variation of the earth's field observed at Huancayo.

(2) The location of the current is found to be in the lower portion of the *E*-layer of the ionosphere; this fact lends further strong support to the dynamo theory[5] originally proposed by Balfour Stewart[6] in 1883 to account for the production of the current system which was inferred by him from the diurnal variation of the earth's magnetic field.

(3) The results do not bear out the existence of any appreciable current in the *D*-layer such as had been proposed by Martyn[7]. (A similar conclusion has been reached by Bates and Massey[8] in quite a different way, namely, by showing in detail that the maximum negative-ion concentration, and hence conductivity, in the *D*-layer would be too low.) Further measurements will be required to establish with certainty the distribution with altitude of the currents responsible for the exceptionally large lunar effect on the quiet-day solar (S_q) diurnal variation at Huancayo.

(4) It appears that the current must drop to zero rapidly just above 105 km. (unless we assume a counter-current to flow at a higher altitude). We

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reach this conclusion by comparing the amount of discontinuity—4 milligauss—with the sea-level variation of 2 milligauss observed at Huancayo. It is reasonable to suggest, therefore, that the electrical conductivity falls to zero rapidly above 105 km.

(5) The most striking feature of these results is the fact that the total current is confined to such a narrow range of altitude. We cannot account for this high value of current density ($2 \cdot 5 \times 10^{-16}$ e.m.u./cm.^{2}) if we assume in the conventional manner that the presence of a transverse magnetic field radically decreases the conductivity. At the magnetic equator the usual method of calculating the (west–east) D.C.-conductivity (parallel to the e.m.f. and transverse to the horizontal earth's magnetic field) leads to a value of 5×10^{-16} e.m.u. at the level of maximum electron density[8]. From the *observed* current, on the other hand, we can calculate an average conductivity of 10^{-13} e.m.u., using commonly accepted figures for high-altitude winds and the resulting e.m.f.'s.

(6) Thus the experimental value corresponds closely to 6×10^{-13} e.m.u., the value of conductivity calculated for the level of maximum electron density ($1 \cdot 5 \times 10^5$ per c.c.) in the absence of a magnetic field.

Hall effect. This discrepancy of almost a factor 1,000 between the observed and conventionally calculated conductivities can therefore be removed by ignoring the magnetic field.

It is well known[10] that this procedure is justified under suitable boundary conditions. In crossed electric and magnetic fields both ions and electrons will drift in the same direction (perpendicular to both fields), the electrons at a much higher speed. The resultant Hall current may set up a polarization sufficiently large to stop further current flow; once this transient Hall current ends and the polarization is established, any influence of the magnetic field on the conductivity parallel to the applied electric field is removed. Martyn[11] has suggested that this effect should be considered in calculating the conductivity of the ionospheric layers (although in the case of the D-layer at 75 km. the increase brought about by neglecting the magnetic field will be quite small). Cowling and Borger[12] have pointed out that, due to leakage, the polarization field may not build up sufficiently to keep a substantial steady-state Hall current from flowing and so result in only partial cancellation of the effect of the magnetic field. However, at the equator conditions may be favourable for almost complete cancellation, since the Hall current there flows perpendicularly to a horizontal magnetic field; hence a vertical polarization could be set up along a narrow equatorial strip where it would leak away only very slowly.

Conclusions. The results of the equatorial rocket measurements thus support the existence near an altitude of 100 km. of a layer of greatly increased conductivity, probably produced by Hall polarization. This finding is in accord with Hirono's[13] prediction of a narrow, highly conducting region at the equator; it may thus account for a substantial part of the so-called anomalous S_q variation at Huancayo.

Recent detailed measurements by Giesecke[14] of the latitude-dependence of the range of the diurnal variation ΔH have established the existence of a curve with maximum near Huancayo which is much more narrowly peaked (half-width 7°) than hitherto supposed; the main features of the curve probably persist all along the magnetic equator independent of longitude. Chapman has represented this 'abnormal' peak in a phenomenological way by superimposing on the normal dynamo current system (deduced from non-equatorial stations) an additional high-intensity current of small horizontal extension flowing only at the equator, which he terms 'electrojet'. So far no certain deductions have been possible about the dimensions, and particularly about the height, of the electrojet from sea-level observations of the magnetic elements. We cannot, therefore, exclude the possibility of interpreting Giesecke's data in terms of increased equatorial current produced by the increase in conductivity, plus the Hall polarization leakage currents. Hence the electrojet may not require any special physical mechanism, but may be understood purely on the basis of the dynamo theory.

It should be pointed out that the conclusions presented here are based on a single rocket flight, at only one location, on a disturbed day (C-index 1·8). It would be very desirable to repeat and extend these measurements of the Balfour Stewart currents in a series of rocket flights to higher altitudes, both on magnetically quiet and disturbed days, and also at various phases of the moon in order to establish the distribution of the lunar portion of the currents. The instrumentation has now been improved sufficiently to make it possible to obtain the detailed distribution of the current with altitude with considerable accuracy.

We wish to thank Prof. H. Alfvén, Prof. T. G. Cowling, Mr. W. R. Piggott, and in particular Dr. M. H. Johnson for valuable discussions. [Aug. 15.

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COLOUR TELEVISION

THE sixty-seventh science meeting of the Physical Society Colour Group, held on May 14, was devoted to a discussion on visual problems in colour television. Fortunately this followed immediately on Prof. W. D. Wright's return from the United States, where among his other commitments he had discussed and witnessed demonstrations of various American colour television systems. He was therefore able to give the meeting first-hand impressions of the very considerable developments in this field on the western side of the Atlantic.

The proceedings were opened by Mr. R. G. Horner, who gave a comprehensive survey of the more feasible methods at present available for producing a colour television picture. All these are based on the conventional system of interlaced scanning, the main differences between the systems at present under discussion being in their colour scanning sequences, which fall broadly under three headings: (a) field sequential systems, (b) line sequential systems, (c) dot sequential systems. Of these, the first and third are actively in competition in the United States; so far, there has been no real evidence of success with the second system, which appears to embody the disadvantages of the first one without the compensating advantages of the third.

In the field sequential system the picture is scanned in a succession of red, green and blue fields, and, in order to reduce flicker, it is necessary to increase the field scanning-rate by approximately three times. As the colour-changes in this system take place at relatively low speeds, it is possible to produce them by the simple and cheap expedient of revolving synchronous disks containing red, green and blue colour filters in front of the television camera and receiver cathode-ray tube. However, due to the increase in field scanning frequency, an existing monochrome receiver would be unable to receive a colour transmission even in monochrome without considerable modification to its scanning circuits.

The dot sequential system involves the most rapid rate of change of colours, so rapid, in fact, that one school of thought considers the latest form to be a truly 'simultaneous' transmission of the three primary-colour signals. While this system involves the very difficult technical problem of colour-changing at a rate of several millions per second, it offers the great advantage of requiring no change in scanning-standards, and could therefore be grafted on to an existing black-and-white system and be received in monochrome on existing receivers. Mr. Horner explained that this 'compatibility' feature is very important in the United States, where more than ten million receivers are already in the hands of the public, and programme sponsors have to be assured of the continuance of their audience when changing over to colour.

At first sight it would appear necessary to transmit about three times as much information per second for a colour picture as for a monochrome one of the same sharpness. The amount of fine detail in the picture can obviously be reduced and exchanged for colour if it is desired to keep the rate of transmission of information (band-width) constant. To a certain extent this has been the procedure adopted for recent demonstrations of the field sequential system in the United States by the Columbia Broadcasting System. The loss of sharpness incurred has been partially recovered by a new receiver circuit development known as 'crispening', and very satisfactory colour pictures have been demonstrated.

In the latest form of the dot sequential system demonstrated by the Radio Corporation of America and Hazeltine, it has been found possible to recode the three electronic primary-colour signals to give a brightness component similar to that transmitted in existing monochrome systems, the colour information being transmitted by two 'colour-difference' signals which are analogous to the familiar two dimensions of the C.I.E. colour triangle. This has been called the 'by-passed monochrome' system. As the eye is insensitive to colour in fine detail, it is therefore possible to reduce the band-width (sharpness) of the two colour-difference signals. This manœuvre is one method of achieving what is known as 'the principle of mixed highs', and permits considerable saving in band-width without apparent loss of picture quality. Further band-width reduction is being explored by interleaving the colour signals with the monochrome signal, by a method which was originally a 'dot interlaced' system and more recently a 'colour sub-carrier' system. Two other American developments were referred to—the 'constant luminance' system and 'colour phase alternation'—which are refinements directed towards the reduction of spurious patterns produced by interfering signals and reduction of colour distortion.

Mr. Horner concluded his remarks by describing various solutions to the problem of changing the colours at the very high frequency necessitated by the dot sequential method. This problem is much less serious in the transmitter than in the receiver, where the question of initial cost and maintenance of the viewers' equipment is obviously an important economic factor. So far, the most successful solution appears to be the RCA tricolour cathode-ray tube. This tube contains three guns, the electron beams of which are brought into coincidence on a fluorescent screen consisting of a mosaic of triangular groups of red, green and blue phosphor dots, a total of some six hundred thousand being contained in the picture area. Between this and the electron guns, an apertured mask is accurately positioned. Each aperture centres on a group of three phosphor dots, the direction of arrival of the three beams being such that, after they have passed through the aperture mask, each beam can only excite one set of colour phosphor dots. This solution obviously involves the problem of the correct registration of the three electronic pictures on the screen of the tube. The experimental manufacture of these tubes by RCA is a major technical triumph, but many people feel that it is likely to be a very expensive design for production.

Following Mr. Horner's description of the various colour television systems, Mr. L. C. Jesty described and demonstrated some of the visual problems arising. First, with the field sequential system, the field scanning-rate has to be sufficiently high to eliminate flicker and 'colour break-up'. This was demonstrated by means of a variable-speed colour-filter disk rotating in front of a projector. With the disk running sufficiently fast to eliminate flicker, 'colour break-up' still remained and showed itself in two ways. If the viewer inadvertently moved his eyes, he saw a sequence of partially overlapping red, green and blue images. Experience has shown that the average person quickly learns to ignore this, and it is not considered to be a serious defect in the system. If an object in the picture moves rapidly across the screen, however, an effect is produced which cannot so easily be ignored. An exaggerated example of this was demonstrated by illuminating a wheel having white spokes with the projector and rotating colour-filter disk. In addition to the contrary rotation effect occurring at certain critical speeds of the wheel (as commonly seen on cinema pictures), some very striking colour patterns were produced by the spokes. A 'Kodachrome' transparency photograph of an actual field sequential colour-television picture of the wheel was then projected. This showed the same brilliantly coloured spokes, thus confirming the demonstration.

With the compatible colour sub-carrier system at present being investigated in the United States, the method of signal compression results in the appearance of a 'dot crawling' pattern on parts of the picture under certain conditions. In earlier experiments the band-width compression was achieved by simple dot-interlacing, which gave a theoretical improvement equal to halving the band-width for the same picture-detail, but at the expense of four scanning fields instead of two for the transmission of all picture elements. The resulting dot crawling or 'twinkle' on the picture and the production of additional spurious patterns from objects containing certain types of fine detail were demonstrated to the meeting in an exaggerated form by a 16-mm. film which had been recorded from the receiver screen of an experimental dot-interlaced monochrome television system. In the latest American experimental colour receivers dot patterns are now practically invisible over large areas of uniform brightness and colour, due to improvements in the method of coding the colour information.

As a final demonstration Mr. Jesty showed some colour pictures which had been kindly prepared for him by Ilford Limited (Mr. Horner), demonstrating the principles of 'by-passed monochrome' and 'mixed highs'. Two colour pictures were shown side by side for comparison, one being a normal colour transparency projected on to a screen; the other consisted of a black-and-white photographic enlargement from the original colour picture, which was illuminated by projection from a special colour transparency. The latter had been prepared by re-photographing the original colour picture with colour-sensitive material, using a black-and-white negative 'mask' of suitable quality to cancel out the greater part of the brightness differences in the colour picture. It was seen that, when this second transparency was in focus and registered with the black-and-white enlargement, it was almost indistinguishable from the normal picture alongside it. The special transparency was then progressively defocused by adjustment of its projector lens, and with certain types of picture it could be thrown badly out of focus with no noticeable loss of picture quality. The projector lens mount had been previously calibrated in Mc./s. on the basis of the B.B.C. 405-line 3-Mc./s. picture standard. The demonstration showed that the colour components of the image could be defocused well below 1 Mc./s., so long as the brightness (black-and-white) component of the image remained sharp.

Mr. Jesty concluded his remarks by stressing the necessity for a proper appraisal of alternative systems by a team of average observers, due care being taken to ensure they do not become especially skilful in their judgment, thus losing their average status.

Prof. Wright then reported on his American visit. Of the various colour television demonstrations he had seen, the field sequential system is in the most advanced state, and has given the best picture quality. He felt, however, that the potentialities of the dot sequential system are greater, particularly with regard to band-saving techniques such as in the application of the 'mixed highs' principle and, of course, in 'compatibility'. He was inclined to query if any loss in absolute definition could be tolerated in exchange for the addition of colour. He was very impressed with the technical achievement in preparing the phosphor mosaics, and in locating the mosaics, aperture mask and the three gun electrodes in correct alignment in the manufacture of the RCA tricolour cathode-ray tube.

The American television engineers have completely absorbed the C.I.E. colour triangle and are applying it with ingenuity to their colorimetry problems. Doubts are, however, beginning to arise as to the relevance of the C.I.E. data to all their problems, and colorimetrists are already becoming aware of the impact of the ideas of electronic engineers. Much remains to be learned on the subjective aspects, and the work already done in colour photography is being carefully studied. The use of an illuminated surround to the picture is being actively investigated in one laboratory. An example of the direct application of trichromatic theory to colour television is to be found in the 'low flicker primaries' used in the Columbia Broadcasting System field sequential demonstrations. By the choice of a desaturated blue primary in the receiver, they have been able to increase picture brightness without increasing flicker. The range of reproducible colours is thereby diminished, but this does not appear to give any noticeable reduction in picture quality. Again, it is possible in principle to make colour transformations from one trichromatic system to another, by means of suitable electrical circuits, and it is proposed to take advantage of this by transforming the output signals of the red-, green- and blue-sensitive cameras at the transmitter, to give correct red, green and blue modulating signals at the receiver, without the need for devising cameras having partly negative spectral sensitivity curves.

A recent American development is the Lawrence-Paramount tricolour tube. The screen of the tube consists of a fine grid of coloured phosphor lines, and close to this and accurately registered to it is a mesh of parallel wires, alternate wires being connected together. There are in effect, therefore, two interlaced grids. By applying suitable potentials to these, it is possible to deflect the electron beam on arrival so that it excites the required set of colour lines.

Following the three introductory papers, the meeting was thrown open for general discussion. Several speakers raised points relating to methods of exchanging picture-sharpness for colour. The general conclusion seemed to be that the eye is more sensitive to luminance differences than colour differences in regions of fine detail, particularly in actual television programmes, where other overriding distractions are present. If it is necessary to show detail colour as, for example, in a woven fabric, the technique of the 'close up' is available and would deal very adequately with any such requirement.

Dr. J. A. Darbyshire discussed the secondary advantages arising from the addition of colour to a picture, and demonstrated these by projecting some of his own colour transparencies. Colour can add materially to the impression of depth in a picture. For example, the colour of distant objects is often modified by atmospheric effects. Colour differences make small objects in the picture more visible, thus giving an impression of greater sharpness, not directly related to 'resolving power'. It can produce an atmosphere or mood which increases the viewers' appreciation, as, for example, the difference in the same scene viewed in the daytime and at sunset. The effect of adapting conditions on the choice of white in a picture was discussed by Mr. H. G. W. Harding. With a colour television receiver it would be possible to adjust this for viewing by daylight and by artificial light. Mr. G. T. Winch described his binocular viewing experiments for the appraisal of artificial illuminants. This technique might be applied to determining the best colour balance for television pictures. It was certain that faithful reproduction would not be acceptable. Dr. W. S. Stiles directed attention to the latest American proposals for a compatible system, where the reduced-definition red and blue colour-difference signals are equal in band-width. Further economies could be effected if the blue colour-difference signal were reduced in definition still further. The meeting having exceeded its time limit, the chairman was forced to bring to a conclusion a still lively discussion of an obviously interesting topic. L. C. JESTY

OBITUARIES

Sir Charles Peers, C.B.E., F.B.A.

SIR CHARLES REED PEERS, born in 1868, will be principally remembered as chief inspector of ancient monuments in the Office of Works. Educated at Charterhouse and King's College, Cambridge, he received his architectural training in the office of Sir T. G. Jackson. Peers's principal interest lay in the historical side of his profession, and he was for many years architectural editor of the "Victoria County Histories". As such he was responsible for the description of a number of important buildings, among which the scholarly and lucid accounts of the cathedrals at Winchester and Peterborough may be noted. With this experience he was an obvious choice when an inspector of ancient monuments in the Office of Works was appointed in 1910. Three years later the Act of 1913 was passed and Peers became chief inspector. The next twenty years, apart from the interruption caused by the First World War, were spent in building up and directing the services required to give effect to the provisions of the Act.

The Act of 1913 empowered the Office of Works to take over buildings, other than churches in use and inhabited houses, in order to ensure their preservation. In carrying out this work, Peers's aim was to preserve what time had left without unnecessary additions or conjectural restoration. The success with which he pursued this conservative objective may be judged both from the numerous abbeys and castles for which the Ministry became responsible during his period of office, and also from the virtual cessation of the bitter controversy between the different schools of preservation, which had vexed the end of the nineteenth and the early years of the twentieth century. While it would be too much to claim that there is no criticism of the work carried out under his guidance, it is essentially a criticism of details; the main tradition which he founded is unchallenged.

Research was not a primary duty of the service established by the Act of 1913, but throughout his tenure of office Peers strove to promote the publication of works that would rouse interest in the buildings under his care. For specialists there were learned articles in scientific journals such as *Archæologia*, the *Antiquaries Journal*, and many others. For the wider public there was the admirable series of official guides to the monuments in charge of the Ministry, a series of which the larger part were from the hand of the chief inspector himself. On retirement from the Civil Service in 1933, his experience was made available to other bodies. He became surveyor of Westminster Abbey, and consulting architect to a number of important buildings such as York Minster and the Cathedral and Castle of Durham.

Peers was associated from the beginning with the work of the Royal Commission on Historical Monuments and became a commissioner in 1921. His connexion with the Society of Antiquaries was long and intimate; he served successively as secretary, director and president, and was continuously an officer from 1908 until 1934. His death has come at a time when the cause in which he spent his working life is firmly established and in good hands, a result largely due to the excellence of the foundations which he laid. C. A. RALEGH RADFORD

Mr. S. R. Roget

SAMUEL ROMILLY ROGET died on November 17 in the way he would have wished, suddenly and while in full harness. In spite of his seventy-seven years, he was actively engaged, on a full-time basis, in work dear to his heart—the preparation of national and international glossaries on electrical and other technical subjects. His keen interest in this sort of work is, of course, well known; not only did he publish a "Dictionary of Electrical Terms", but also he kept up to date the famous "Thesaurus of English Words and Phrases" which was compiled by his grandfather, Dr. P. M. Roget, and first published in 1852.

Born in London in 1875, the great-grandson of a Genevese Protestant minister who came to England to be the pastor of a London Huguenot Church, Samuel Roget was educated at University College School. He studied mechanical sciences at Cambridge, and after a further year of experimental work at Cambridge went to the Woolwich works of Siemens Brothers. He remained there for seven years and then turned his attention to technical journalism. He was for a time assistant editor of the *Electrician* and afterwards of *Electrical Engineering* (of which he was part-proprietor) from 1906 until 1917, when publication ceased. Between the two World Wars he was a 'free lance' and occasionally contributed to *Nature* and other journals. He also did abstracting work for the Institution of Civil Engineers and the Institution of Electrical Engineers.

As befitted his Huguenot descent, he was a member of the Huguenot Society of London and became its honorary secretary in 1923, a post which he held until he was elected president in 1951.

In 1938 he joined the temporary part-time staff of the British Electrical and Allied Industries Research Association, and his services were placed at the disposal of the British Standards Institution to supervise the revision of the British Standard Glossary of Terms used in Electrical Engineering. In 1941 he joined the staff of the British Standards Institution, and when the revision of the glossary was completed he agreed to remain with the Institution to assist with the preparation of other glossaries and related work.

In his latter years Roget had no hobby other than his work at the British Standards Institution. After a full day at his desk or at a committee meeting, he would often work on at the hotel in which he lived, producing documents which a less enthusiastic person would have dictated next day at the office. In this way he kept up with the work of the thirty or so committees of the Institution of which he acted as secretary, in a way which amazed his colleagues and at a pace which would have done credit to a man of half his age. With his industry he combined a quiet sense of humour and a charm of manner which endeared him to all with whom he came into contact.

Understanding between individuals and between nations depends upon the correct use of language, and much of Roget's life was devoted to the means towards such understanding. Few people possess the patience, the wide knowledge, the love of words and the clarity of expression which are so essential to this task and which were possessed in such abundance by Roget.

He leaves a son and a daughter.

J. F. STANLEY

WE regret to announce the following deaths:

Sir Charles Arden-Close, K.B.E., C.B., C.M.G., F.R.S., formerly director-general of the Ordnance Survey, on December 19, aged eighty-seven.

Mr. J. G. Robb, recently deputy engineer-in-chief of Marconi's Wireless Telegraph Co., Ltd., on December 16, aged sixty-two.

Dr. W. C. Sillar, formerly lecturer in experimental pharmacology in the University of Edinburgh, on October 23, aged eighty-eight.

NEWS and VIEWS

Division of Biochemistry, Massachusetts Institute of Technology: Prof. J. M. Buchanan

A DIVISION of Biochemistry in the Department of Biology has recently been started at the Massachusetts Institute of Technology, and Prof. John M. Buchanan, professor of physiological chemistry in the University of Pennsylvania, has been appointed the first professor and head of the Division as from July 1, 1953. The new Division will operate as an autonomous unit within the Biology Department, closely correlated with the other activities of the Department, particularly in the fields of general physiology and biophysics, and will be responsible for teaching and research in biochemistry at all levels—undergraduate, graduate and post-doctoral—in the Institute. All undergraduate students in the Biology Department will take at least one course in the Division of Biochemistry, and graduate degrees in biochemistry will be offered in connexion with the Division's research activities, which will mainly be concerned with the growth, structure and reproduction of cells. Housing for the Division will be provided on the sixth floor of the new John Thompson Dorrance Laboratories of Biology and Food Technology.

Prof. Buchanan graduated from De Pauw University, Greencastle, Ind., in 1939, and then took his M.Sc. at the University of Michigan and his Ph.D. at Harvard University. Except for two years at the Medical Nobel Institute, Stockholm, his subsequent career has been entirely at the University of Pennsylvania. He is widely known for his researches in the biosynthesis of biological compounds, particularly the purines and glycogen, and he has also made important contributions in the isolation and purification of enzymes. In 1951 Prof. Buchanan received the Eli Lilly Award in Biological Chemistry of the American Chemical Society.

Geological Society: Awards

THE Council of the Geological Society announces the following awards for 1953: *Wollaston Medal:* Prof. Erik Stensio, keeper of the Palæozoological Department in the Swedish Natural History Museum, Stockholm, for his fundamental researches on the lower vertebrates and for his remarkable techniques in palæontological research; *Murchison Medal:* Dr. F. Dixey, for his outstanding contributions to the geology of Africa and his distinguished services as director of the Colonial Geological Surveys; *Lyell Medal:* Dr. M. B. Bulman, for his important contributions to palæontology, particularly on the morphology of the Graptoloidea and to Lower Palæozoic stratigraphy; *Bigsby Medal:* Prof. K. C. Dunham, for his contributions to petrology and to the study of mineral deposits; *Wollaston Fund:* Mr. P. C. Sylvester-Bradley, for his researches on fossil Ostracoda and on Jurassic stratigraphy; *Murchison Fund:* Mr. C. D. Ovey, for his researches on fossil Foraminifera; a moiety of the *Lyell Fund* to Dr. Gilbert Wilson, for his works on structural geology, notably in Cornwall and the Highlands, and his studies of granitization and coastal geomorphology; another moiety of the *Lyell Fund* to Dr. D. A. Brown, for his contributions to the structural geology and palæontology of New Zealand, and particularly the Tertiary Polyzoa of that Dominion.

Institute of Metals: Awards

THE Council of the Institute of Metals has made the following awards: *Institute of Metals (Platinum) Medal* for 1953 to Prof. Georg Masing, of the Institut für Allgemeine Metallkunde, University of Göttingen, in recognition of his outstanding contributions in the field of metallography; *Rosenhain Medal* for 1953 to Dr. C. E. Ransley, of the Research Laboratories, British Aluminium Co., Ltd., in recognition of his outstanding experimental and theoretical work on gas-metal equilibria.

Manchester College of Technology: Jubilee Brochure

IN connexion with the jubilee of the Manchester College of Technology, an illustrated brochure has been issued (pp. 36; from the College) giving an excellent account of the origin of the College and its development since the opening of the present building in 1902. Up to 1918 the institution was known as the Municipal School of Technology; but it had already, in 1905, concluded arrangements with the Victoria University of Manchester for the institution, within the School of Technology, of the Faculty of Technology, which in its first session included 522 university students. In 1912 the School of Technology was for the first time listed with universities and university colleges in Great Britain which were in receipt of grants from the Board of Education. This was prior to the establishment of the University Grants Committee, and the Manchester Municipal School of Technology was the first municipal institution to be thus listed with university institutions. Although the brochure does not trace the earlier development to 1902 of the original Mechanics' Institute of 1824, it gives some indication of the research work carried out by the College, particularly during the two World Wars. Some account of the co-operation with industry which led first, during October 1917, to a course of lectures in scientific management and later, in 1926, to the establishment of the Department of Industrial Administration is included, and also of the post-war developments and the new buildings. Besides the thousand undergraduate university students for whom accommodation was planned for the three sessions following 1946–47, the non-university registrations reached a peak of 8,558 in 1949, of whom 7,943 were part-time students, while in 1950 more than nine hundred students were attending post-advanced classes. According to a recent estimate, the extensions originally commenced in 1938 will almost double the present accommodation. Since 1924 the number of volumes and pamphlets in the library has increased from 12,000 to 33,500, and the number of periodicals taken from 130 to 420.

Technical Education in the North of England

A PAMPHLET entitled "Technical Education in the Northern Region", giving a summary list of courses which are available in the technical, commercial and art colleges and institutes of Cumberland, Durham, the North Riding of Yorkshire, Northumberland and Westmorland, has been issued by a subcommittee of the Northern Productivity Exhibition Planning Committee, organized by the Northern Regional Board for Industry in association with the Information Division of the Treasury and others. Since 1938–39 the number of full-time students in senior and advanced courses in the region has grown from 635 to 2,152, of part-time day students from 909 to 10,552 and of evening students from 19,714 to 26,836 (1950–51), though part-time day release remains below the average for Great Britain as a whole. The Exhibition itself, which was held in the City Baths Hall, Newcastle upon Tyne, during October 30–November 6, 1952, included a technical college exhibit.

German Hydrographic Institute, Hamburg: Report for 1951

THE German Hydrographic Institute's report for 1951, its sixth year of activity (pp. 72+12 pl.; from the Institute, Hamburg 11; 1952), includes some retrospective statistics which go back to its foundation in 1946. On the whole, the Institute's work has been continued and progressively extended as in the years before, especially in the departments for nautical books and charts. Some events are mentioned which have a special importance for the Institute's further development. With regard to the work for the direct benefit of practical navigation, a committee has been established which includes representatives of all nautical and technical institutions, organizations and firms which are interested in the Institute's activities. This committee is to meet at suitable intervals in order to lodge requirements and make suggestions bearing upon the work of the Institute. As for the resumed participation in international scientific work, members of the Institute's staff took part in the meeting of the International Geophysical and Geodetic Union held in Brussels in August and September 1951, and in that of the International Council for the Exploration of the Sea held in Amsterdam in October 1951. Moreover, the Institute has been able to continue its research work in the North Sea from its vessel *Gauss*. In June 1951 a cruise was made in the Southern Bight of the North Sea for physical, chemical and plankton observations in association with contemporaneous British and Dutch fishery investigations, and a call was made at Lowestoft for discussions with British oceanographers there. During an autumn cruise in the German Bight and the Skagerrak, some methods and apparatus designed for practical marine seismology were tested, and several echograms of the deepest part of the Norwegian Trench were obtained. Following upon the Brussels and Amsterdam meetings referred to, the Institute was visited by many foreign scientific workers who had attended them.

Franklin's 'Philadelphia Experiment' on Lightning

THE May 1952 number of the *Journal of the Franklin Institute* (253, No. 5) is devoted to the subject of lightning protection in commemoration of the two hundredth anniversary of the 'Philadelphia experiment' (May 10, 1752) on the identity of laboratory and thunderstorm electrification which was proposed by Benjamin Franklin. It contains a reproduction of the first photograph of lightning, believed to have been taken by W. N. Jennings on September 2, 1882, and four articles, by B. F. J. Schonland, I. B. Cohen, K. B. McEachron and H. Norinder, respectively. The first two deal with the historical background. Prof. Schonland gives an account of the experiments and hypotheses which led Franklin to propose the famous experiment and the lightning rod as a protective device, and Prof. Cohen describes the considerable prejudice which was aroused against the introduction of lightning rods. He quotes Prof. Schonland's conclusion from his recent book that "lightning still takes a considerable toll of unprotected property in the country from which the rod came", and points out that, although lightning was given the sixth place in importance among the causes of fire during 1921 by the United States National Board of Fire Underwriters, the number of buildings with adequate lightning protection is still but a small fraction of those that require rods. Dr. McEachron, of the General Electric Co., discusses lightning protection since Franklin's day, in particular with respect to communication systems, transportation and the electrical industry. Finally, Dr. Norrinder, of the Institutet för Högspänningsforskning, University of Uppsala, deals with experimental research into lightning discharges and effects in their vicinity. Meteorological aspects and the long-distance effects—atmospherics—are not considered. Optical methods, photographic methods and high-speed cathode-ray oscillograph methods of recording lightning discharges are described, and some of the results obtained, revealing the leader stroke mechanism, are discussed and illustrated.

Handbook of the New Zealand Department of Scientific and Industrial Research

THE Department of Scientific and Industrial Research, New Zealand, has issued an illustrated and well-produced Departmental Handbook (pp. 68. Wellington: Govt. Printer, 1952) collecting much information previously only available from separate sources. An organization chart and brief account of the organization and administration of the Department is supplemented by some historical notes on its development and by maps indicating the geographical location of the units. The bulk of the Handbook consists of brief accounts of the functions and organization of the several divisions, laboratories, sections, etc., and of the incorporated research associations, including lists of staff. There is also a list of committees and their membership and of organizations in receipt of grants from the Department. The Handbook is completed with an index.

New Light on Gnetales and Ephedrales

PROF. A. J. EAMES has considered in some detail, and in the light of modern knowledge, the relationships of that much-discussed plant group, the

Gnetales—comprising *Gnetum*, *Welwitschia* and *Ephedra* (*Phytomorph.*, 2, 1, 79; 1952). These plants have long been prominent because of their very curious morphology and diverse habit, and because they appear to occupy a position intermediate between gymnosperms and angiosperms. The evidence now available points to the need for an extensive taxonomic revision. As a result, the three families are separated and raised to ordinate rank. Moreover, it is recognized that the Ephedrales have no phylogenetic relationship to the Welwitschiales and Gnetales. They are, however, closely related to the Cordaitales, both having similar appendicular ovules. *Ephedra*, in fact, is regarded as a derivative of ancient cordaite-conifer stock.

Papers from the Arcetri Astrophysical Observatory

Publication No. 67 of the Faculty of Mathematical, Physical and Natural Sciences of the University of Florence, entitled "Osservazioni e Memorie dell' Osservatorio Astrofisico di Arcetri" (pp. 141, 1952), consists of eleven papers contributed by seven authors. These papers deal with a variety of subjects: correlation coefficients between areas of sunspots and areas of calcium and bright *Hα*-flocculi; results of the examination of the mean heliographic latitude of sunspots and that of bright flocculi, from which it appears that the former are smaller than the latter; relative photometric intensities of chromospheric flares, measured monochromatically in *Hα* and *K*2·3 lines, on 258 spectroheliograms recorded during 1950 with the solar tower of Arcetri Observatory; study of the eleven-year cycle of solar prominences, without taking into consideration the distinction between those in high and low latitudes, and comparing prominences with filaments, some differences in their behaviour being detected; photometric measurements of the ghosts given by the grating of the Arcetri solar tower; relative intensities of flares and bright flocculi observed in *Hα* light on spectroheliograms taken at Meudon, and a comparison with those taken at Arcetri, etc.

The Night Sky in January

Full moon occurs on Jan. 0d. 05h. 05m., U.T., and also on Jan. 29d. 23h. 44m., and new moon on Jan. 15d. 14h. 08m. The following conjunctions with the moon take place: Jan. 9d. 09h., Saturn 8° N.; Jan. 19d. 01h., Mars 4° S.; Jan. 19d. 01h., Venus 4° S.; Jan. 23d. 02h., Jupiter 7° S. In addition to these conjunctions with the moon, Venus is in conjunction with Mars on Jan. 18d. 02h., Venus being 0·2° N. Mercury, a morning star, rises at 6h. 50m. on January 1, but later in the month it draws too close to the sun for favourable observation. Venus, an evening star, sets at 19h. 50m., 20h. 30m. and 21h. 10m. on January 1, 15 and 31, respectively, stellar magnitude averaging − 3·9 and the visible portion of the illuminated disk varying between 0·65 and 0·52. Mars is an evening star, setting about 20h. 35m. throughout the month; its stellar magnitude varies between 1·2 and 1·3. Jupiter sets at 3h. 10m., 2h. 10m. and 1h. 15m. at the beginning, middle and end of the month, respectively, its stellar magnitude averaging − 2·1. Saturn, a morning star, rises at 1h. 40m., 0h. 45m. and 23h. 45m. on January 1, 15 and 31, respectively; its stellar magnitude is about 0·9, and it lies a little north-east of α Virginis (Spica). There is only one occultation of stars brighter than magnitude 6 in January, namely, π Canc., which reappears at 6h. 18·3m., assuming that observations are made at Greenwich. A total eclipse of the moon takes place on January 29/30 and is visible in the British Isles. The circumstances of the eclipse are as follows:

Moon enters penumbra	Jan.	29d.	20h.	40·1m.
Moon enters umbra		29	21	54·1
Total eclipse begins		29	23	04·6
Middle of eclipse		29	23	47·3
Total eclipse ends		30	00	29·9
Moon leaves umbra		30	01	40·4
Moon leaves penumbra		30	01	54·5

The earth is at perihelion on January 2.

Announcements

Prof. J. F. Baker, professor of mechanical sciences and head of the Department of Engineering, University of Cambridge, has been awarded the Ewing Gold Medal of the Institution of Civil Engineers, in recognition of his contributions to engineering research.

In reply to a question in the House of Commons, the Minister of Works stated that the planning of the Government Science Centre has had to be deferred in view of the need for economy. When the economic situation improves, it is hoped to lease a site on the South Bank immediately below Waterloo Bridge.

The annual exhibition of the Television Society, dealing with television engineering or production or with the production of television programmes, will be held during January 23–24, 1953, at 155 Charing Cross Road, London, W.C.2, by invitation of the Edison Swan Electric Co., Ltd. The exhibition will be open as follows: January 23, 6–9.30 p.m., members and friends; January 24, 10.30 a.m.–6 p.m., members. Public admission is by invitation card, obtainable from members of the Society, patron members or from the lecture secretary, G. T. Clack, 43 Mandeville House, Worsopp Drive, London, S.W.4.

A symposium on anticholinesterases, arranged jointly by the British Pharmacological Society and the Fine Chemicals Group of the Society of Chemical Industry, will be held during March 27–28, 1953, at the Wellcome Research Institution, Euston Road, London, N.W.1. The symposium will be in four sections: chemical features which confer inhibition; mode of action *in vitro*; mode of action *in vivo* (acute effects); mode of action *in vivo* (chronic effects). Further information can be obtained from the honorary secretary of the British Pharmacological Society, Mr. George Brownlee, at the Physiology Department, King's College, Strand, London, W.C.2.

An International Congress on Electroacoustics will be held in the Netherlands during June 16–24, 1953, under the auspices of the International Commission on Acoustics of the International Union of Pure and Applied Physics. Lectures and invited short contributions will be read covering the following sections: (1) sound recording, (2) public-address systems, (3) acoustic measurements, (4) hearing-aids and audiometers, (5) electroacoustics in ultrasonics, and (6) electroacoustics applied to musical instruments. These will be followed by a symposium on the sound insulation of lightweight structures. Further details can be obtained from the secretary, Dr. P. A. de Lange, Mijnbouwplein 11, Delft.

The lectures delivered at the vacation school on the "Insulation of Electrical Equipment" held at the Imperial College, London, in September (see *Nature*, Dec. 13, p. 1006) are being published in book form by Chapman and Hall, Ltd., 37 Essex Street, London, W.C.2, under the editorship of Prof. Willis Jackson.

UNIVERSITY COLLEGE, IBADAN

FORMAL OPENING

ON November 17, Marshal of the Royal Air Force Lord Tedder, Chancellor of the University of Cambridge, formally opened the buildings of what in a few years time will be the University of Nigeria. This was the fourth anniversary of the ceremony when the then Secretary of State for the Colonies, Mr. Arthur Creech Jones, cut the first sod and inaugurated the building programme; the Soil Science Laboratory of the Department of Agriculture appropriately stands on the spot. Less than six years ago a commission appointed by the Inter-University Council for Higher Education in the Colonies, under the chairmanship of Sir William Hamilton Fyfe, selected the site, which was then a tract of unsurveyed and almost impenetrable bush.

The capital cost of the new buildings has been provided by a grant from the British Exchequer under the Colonial Development and Welfare Act. The sum of £1,500,000 was set aside in 1947, and on November 17 Sir Christopher Cox, educational adviser at the Colonial Office, announced, on behalf of the Secretary of State, that a further £200,000 had been added, to offset increased prices and to allow the whole of the first phase of the scheme to be completed. The whole of the recurrent costs of the College, which now amount to about £400,000 per annum, come from Nigerian sources, either as a direct subvention from the Government or as interest from endowments from the same source or from the marketing boards (for example, the Cocoa Marketing Board has endowed the School of Agriculture to the extent of £1,000,000).

The site of nearly 3,000 acres was acquired for the College by the Nigerian Government and lies some three miles north of Ibadan. Ibadan is the largest town in tropical Africa, with an estimated population of half a million inhabitants, mostly Yoruba, but with substantial numbers of settlers from other parts of Nigeria, and a few hundred European, Syrian, Indian and other expatriates.

The site, as well as containing the main academic buildings, houses more than a hundred members of the academic staff, and several hundred junior employees. The greater part of the 3,000 acres will, however, be developed as experimental farms by the Department of Agriculture.

The buildings, designed by Mr. Maxwell Fry and Miss Jane Drew, comprise residential accommodation for nearly six hundred student in halls of residence and teaching blocks for the departments in the Faculty of Arts, including a theatre, library, administration building and an assembly hall; this last is a gift from the United Africa Company, and is to be called Trenchard Hall, after Lord Trenchard, chairman of the Company, who during 1903–10 saw service with the Army in Nigeria.

There are at this stage four halls of residence, in each of which the plan follows the general recommendations of the committee set up by the vice-chancellors and principals of universities in Britain. Each undergraduate has a separate study-bedroom, and there are a communal dining hall and recreation rooms in each hall of about 150 students. The buildings have been planned for tropical conditions, and although they are built around courtyards, most of the residential blocks run east and west to avoid direct sun shining into the rooms. Each room has through ventilation, and each study-bedroom a private veranda.

The laboratories, for the Departments of Chemistry, Physics, Botany and Zoology in the Faculty of Science, for Agriculture, for Anatomy, Physiology and Pharmacology in the Faculty of Medicine, have been planned for construction with the maximum economy, and so as to be easily adapted and converted to meet changing needs. These buildings have been designed by Mr. J. Hoskins, of the College staff, collaborating where necessary with the architects to ensure that the façade conforms with the general layout plan. These laboratories are of one story only (this is much cheaper to construct under Nigerian conditions than loftier buildings), and they are planned to be able to house a much larger number of students and of staff than will immediately be necessary. Thus the Departments both of Chemistry and of Physics have each about 18,000 sq. ft. of laboratory space.

The buildings now constructed are intended to house the College in the first phase of its development; but the site has been planned so that a great expansion is possible. More halls of residence are likely to be the first necessity, and sites for at least six more are scheduled. The teaching departments can be easily extended to take several thousand students,

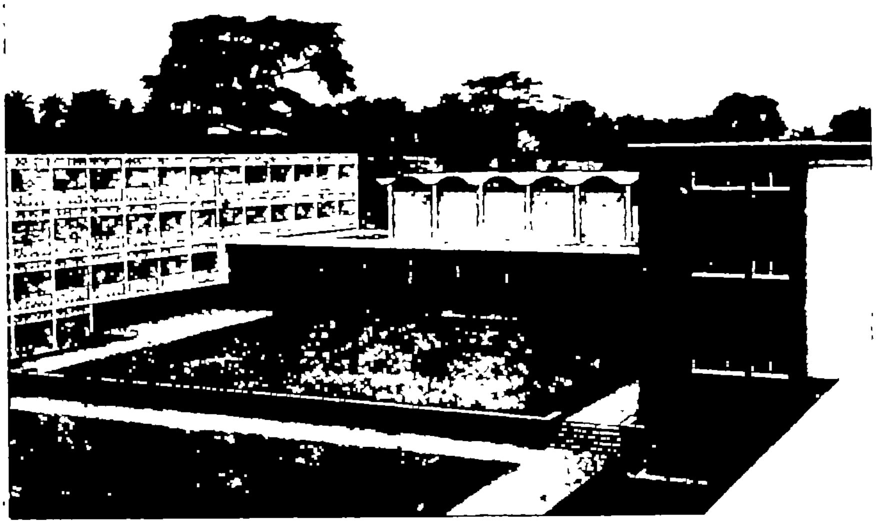

Fig. 1. Part of the court inside a hall of residence; students' study-bedrooms on the left, dining hall centre

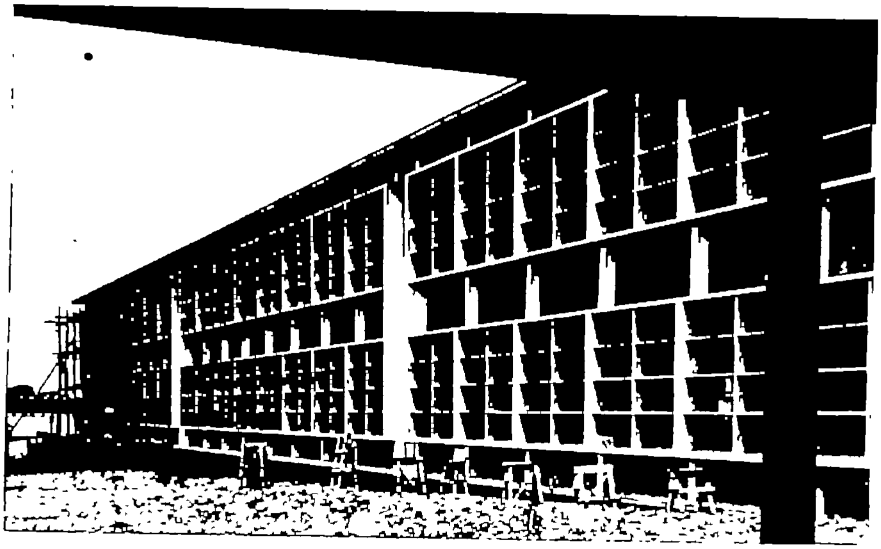

Fig. 2. North wing of the arts building, containing Departments of Geography, Mathematics and Phonetics

though those at present responsible for planning the College think that when the undergraduate community reaches about 2,500 a start should be made with a second Nigerian university in another part of the territory.

The College has already been working for more than four years in temporary buildings in a converted military hospital. The preclinical and agricultural students have now moved into their permanent quarters; but the Faculties of Arts and Science will not be able to move for some months. There are at present in residence in Ibadan nearly 400 undergraduates, and an academic staff of more than a hundred.

Ibadan students work for degrees of the University of London. The College is in a "special relationship" with the University; this means that, while academic standards are guaranteed, there is some latitude in adapting the syllabus to meet local needs. Thus in the biological sciences, geography and history, for example, special courses have been evolved. The preparation of these syllabuses, which will develop as the appropriate research work into African problems progresses, gives useful experience which will be of value when the College becomes an independent university.

The whole course leading to general or honours degrees in a wide range of arts and science subjects, and in agriculture, can be completed in Ibadan. In medicine, teaching at present only extends to the end of the preclinical course; for clinical studies, students proceed overseas, but work is proceeding on the Teaching Hospital (for which the Nigerian Government has granted £2,250,000) and soon it is hoped that the final London M.B., B.S., may be taken in Ibadan. At present there are no hospitals in Nigeria suitable to obtain recognition for teaching of the appropriate standards.

Nigeria, with a population estimated at not far short of 30,000,000, will require far more graduates than the College can at present produce, but the size of the entry is at the moment largely dependent on the production of suitable freshmen by the secondary schools. So far, few suitable candidates have failed to secure entry. An attempt is being made to maintain a proper balance of the different faculties, and notwithstanding the obvious demand for well-qualified scientists and technicians, arts subjects are by no means neglected.

Academic work in the tropics often suffers from the lack of library facilities. The library at Ibadan already contains more than 70,000 volumes, and receives about a thousand current periodicals. The new building will take, without extension, more than a quarter of a million volumes. Microfilms are extensively used, being frequently flown out from Europe for the urgent use of readers, and the library can make its own microfilms and photostat copies for the use of readers elsewhere. Many back-numbers of otherwise unobtainable scientific journals are available on microcards; Ibadan was the first Commonwealth library to use this technique.

Everyone at Ibadan realizes that the future standing of the University College will depend on the quality of the original work carried out there, both by the staff and by visiting investigators using the College's facilities. All departments are planned not only to allow for an increase in student numbers, but also to accommodate visitors from overseas. Several such workers have spent considerable periods at Ibadan. Fulbright Scholars from the United States have, for example, studied primate physiology, poultry husbandry, indigenous songs and other cultural problems. A Medical Research Council team investigated vegetable precursors of cortisone. But the main research must always be done by the College itself, and a good start has been made in all faculties; in medicine, where no clinical teaching will take place for a few years, research will largely determine the details of the courses which will eventually be given.

At this stage it is impossible to foretell the exact future development of the College. This depends only in part on the College itself. The political situation in Nigeria is changing rapidly, and it is the more

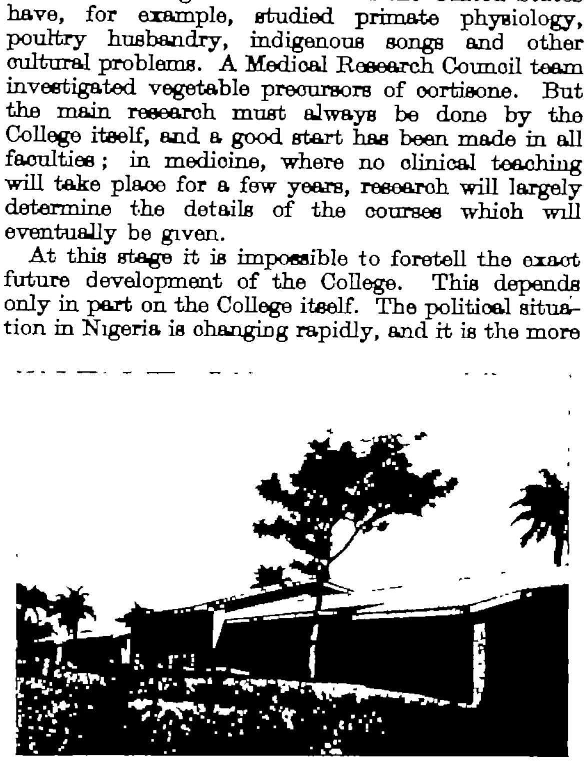

Fig. 3. Elementary chemistry laboratory; the Department of Chemistry includes three similar parallel buildings

moderate politicians who speak of "Dominion status in 1956". The College is a fully autonomous institution, and so far there have been few attempts, save by the less responsible organs of the popular press, to interfere with this autonomy. Nevertheless, until the College and its standards are firmly established the danger of outside political pressure will remain, and will impose an added strain on those responsible for the well-being of an institution on which the future of Nigeria itself depends so greatly.

INTERNATIONAL FEDERATION FOR DOCUMENTATION

CONFERENCE IN COPENHAGEN

THE International Federation for Documentation held one of its 'restricted' conferences in Copenhagen during September 28–October 4, which was attended by representatives of some sixteen countries. These conferences consist of a number of meetings of the council and of the active specialist committees of the Federation. Among the committees which met on this occasion were those on universal classification, mechanical selection, technical means of documentation, abstracting, training, and information services. Meetings were also held between members of the staff of the United Nations Educational, Scientific and Cultural Organization and representatives of the council of the International Federation for Documentation, the International Federation of Library Associations and other international bodies concerned with documentation, archives and librarianship. As a step towards closer collaboration, it was agreed that both the International Federation for Documentation and the International Federation of Library Associations should become members of the other's organization and that the next conferences of the two bodies should take place simultaneously in Vienna in 1953. It was also agreed with the representatives of Unesco that a joint consultation committee of international non-governmental organizations in the field of librarianship, documentation and archives be established, and that this committee should arrange the next world conference on these subjects to be held in 1954 or 1955.

One of the main items discussed by the council of the Federation was the report of its committee on reorganization, which was set up at the end of the conference held in Rome in 1951. This report, which was accepted after minor modification, restated the aims of the Federation in terms suitable for the present; in particular, it made clear that such a body should restrict its activities to those which are truly international in character, leaving studies of a more general nature to its national constituent bodies. Similarly, it was agreed that international technical studies should not necessarily be carried out by the general secretariat but allocated to appropriate national members who would undertake them for the benefit of the Federation as a whole. It also recommended that international specialist bodies should be accepted as members of the Federation in addition to the national co-operating bodies (Aslib in the case of Great Britain). It was recognized that, with the increased amount of research undertaken, especially in the pure and applied sciences, and the consequent volume of publication, special problems of documentation are arising in many scientific and technical fields. As a result, a number of specialist international bodies have already been established, such as the International Council on Building Documentation which was meeting at Copenhagen at the same time as the International Federation for Documentation. The Federation felt itself to be in a position to give advice to international bodies for specialized topics, such as the various international scientific unions, on documentary aspects of their work, and decided to create facilities for such bodies to join the Federation and participate fully in its work.

Among the technical matters agreed as appropriate to the programme of the Federation for 1953, priority was given to the proposals for a guide to centres for microfilm and photocopying services, and centres for international loans and translation services; the production of manuals for instruction in documentation; a directory of the effective members of the Federation, with a description of their activities; a study of auxiliary publications, including 'unpublished' reports of scientific work; a study of costing and economics in the preparation and sale of photocopies; and a manual of documentary reproduction.

This conference, with its wide scope of technical interest, demonstrated clearly the need for improved services of documentation and information as well as the interest of scientific and technological workers in problems resulting from the mounting pressure of publication. Although a number of international organizations are operative in this and neighbouring fields, the International Federation of Documentation, in encouraging co-operation with other bodies while at the same time improving its own organization and procedures, is showing real leadership and finding a useful continuing function.

ADVISORY COMMITTEE ON ARID ZONE RESEARCH

MEETING IN LONDON

THE Advisory Committee on Arid Zone Research set up by the United Nations Educational, Scientific and Cultural Organization held its fourth meeting in the Royal Society's rooms, Burlington House, London, during September 29–October 1. Following its former policy, the Committee's recommendations were concerned to a large extent with the dissemination and exchange of information by means of reports and symposia. Reports have already been obtained and circulated on arid zone hydrology, on plant ecology, on the climatic history of arid regions and on the utilization of salt water. A successful symposium on arid zone hydrology organized jointly by Unesco and the Turkish Government was held in Ankara last April. The Committee recommended that qualified experts be commissioned to prepare reports reviewing research on energy sources, including wind and solar energy and their utilization in arid and semi-arid regions, and also on the general characteristics of arid zone soils and their modification. It also recommended that a survey of current research in the field of arid zone plant ecology be prepared. The symposium planned to be held in 1953 will deal with this field of plant ecology in arid regions, and the Committee considered its programme and plans for holding it in a Latin-American country in the autumn.

Plans were also discussed for the production of a handbook to assist those confronted with the task of collecting basic data required before schemes can be prepared to develop an arid or semi-arid area. Such a handbook would aim at serving two purposes. It would first direct the attention of persons concerned with organizing development to the various and interrelated fields in which data are needed before satisfactory plans for such development can be made. Secondly, it should give information as to the best methods of collecting and presenting basic data in a form that supplies the information needed for their practical application.

A scheme is now in operation in which certain institutions carrying out research relating to arid zone problems may be designated as suitable for the exchange of personnel and information and for the reception of visiting scientific workers. A number of applications for designation under this scheme were considered by the Committee, which recommended that the following institutions be added to those already designated at earlier meetings:

Commonwealth Research Station (Murray Irrigation Areas), Merbein, Victoria.
Division of Plant Industry (C.S.I.R.O.), Black Mountain, Canberra.
Irrigation Research Station (C.S.I.R.O.), Private Mail Bag, Griffith 58, New South Wales.
Katherine Research Station, Katherine, Northern Territory.
National Field Station, "Gilruth Plains", Cunnamulla, Queensland.
Information on Regional Pastoral Laboratory, Deniliquin, Box 26, P.O., New South Wales.
Laboratorium voor Grondmechanica, Oostplantsoen 25, Delft.
Waterloopkundig Laboratorium (Hydraulic Laboratory), Raam 61, Delft.
Amarillo Conservation Experiment Station, Box 2160, Amarillo, Texas.
Department of Geology, University of Southern California, 3518 University Avenue, Los Angeles 7, California.
Inter-Mountain Forest and Range Experiment Station, U.S. Forest Service Building, Ogden, Utah.
Information on Reclamation Engineering Centre, Denver, Colorado.
South-western Forest and Range Experiment Station, Tucson, Arizona.
University of Arizona, Tucson, Arizona.
University of California Citrus Experiment Station, Riverside, California.

Particulars of these institutions and of the facilities available at each can be obtained from Unesco (19 Avenue Kléber, Paris 16e). The Committee also recommended that member States be reminded of this scheme and be supplied with a full list of institutions at present associated under it.

As a result of an earlier recommendation by the Committee, a survey has been conducted by Unesco of institutions engaged in research on arid zone problems, and the Committee recommended that the information thus collected should be made use of to compile a directory of institutions engaged in arid zone research.

On the research side the Committee recommended that assistance be given to the following projects. (1) A project proposed by the Institut Français d'Afrique Noire to study the effects on plant cover of natural factors, mainly climatic, and of human intervention such as grazing, trampling and wood cutting. Data on this subject are much needed, especially since they bear on the deterioration of natural pastures. (2) A project proposed by Dr. F. W. Went, of the Earhart Plant Research Laboratory, California Institute of Technology, to study the role of dew in plant growth in arid regions. (3) A project proposed by Dr. K. Smidt Nielsen, of Duke University, North Carolina, to study the physiology of the camel and of other desert mammals. This work would extend that already carried out by Dr. and Mrs. Smidt Nielsen on the physiological mechanisms which enable certain desert rodents to live on dry food without drinking water. (4) A project proposed by Prof. L. Picard, Geological Institute, Jerusalem, Israel, to investigate the climatic changes that have taken place during the Quaternary in the arid and semi-arid region of the south-east Mediterranean, initially by means of a study of the peat deposits of northern Galilee.

EUROPEAN COUNCIL FOR NUCLEAR RESEARCH

SESSION IN AMSTERDAM

THE third session of the European Council for Nuclear Research was presided over by Prof. P. Scherrer when it met at the Academy of Sciences, Amsterdam, during October 4–6. The main work before the Council was to consider the offers which had been made by various member States for the site of the proposed laboratory, to hear reports of progress made by its four study groups, and to consider a report from its secretary-general, Prof. E. Amaldi, on the organization and financial implications of future European co-operation in nuclear research. Last June the Council sponsored a scientific conference at Copenhagen to promote a broad exchange of views upon the problems of nuclear research which could be most profitably dealt with by international co-operation. As a result of this conference, it has been decided that the study of mesons and the other new particles which have recently been found in the cosmic rays should be developed by international co-operation, and by the construction of high-energy machines in a suitable centre so that these particles might be created artificially. Four working-groups were formed by the Council to carry out the following respective tasks: the first to design a 600-MeV. synchrocyclotron; the second to design a proton synchrotron of not less than 10 GeV. (10^{10} eV.) energy; the third to study theoretical and experimental developments having a bearing on the aims of the Council and to promote other forms of European co-operation in nuclear physics; and the fourth to explore the organization and structure of a suitable laboratory.

Rapid progress with the design study of the 600-MeV. synchrocyclotron was reported by Prof. C. J. Bakker. The main features of the magnet design have been settled, and also the layout of the vacuum chamber and radio-frequency system. At one stage it had been intended to use a rotary condenser to provide the necessary radio-frequency tuning, but as a result of a recent visit to the Radiation Laboratory of the University of California, the use of a vibrating-reed method of tuning is now being studied. The general design has advanced to the stage where it is necessary to start considering the manufacture of the various components.

Prof. O. Dahl reported that, since the last Council meeting in Copenhagen in June, an event of considerable scientific interest has occurred which has profoundly affected the work of the Proton Synchrotron Group. Drs. E. D. Courant, M. S. Livingston and H. S. Snyder, of the Brookhaven National Laboratory, have proposed a new focusing principle applicable to a high-energy proton synchrotron.

This principle splits the magnetic guiding field into sectors that are alternately strongly focusing and defocusing. The net effect of a combination of sectors in this way is a strongly focusing action such that any oscillations about the equilibrium orbit induced in the motions of the particles are kept small in amplitude. This is of outstanding importance since, for a given energy, the particles may be constrained within an annulus of much smaller dimensions than is the case with a machine of conventional design. Preliminary study has suggested that it should be quite practical to design a machine for 30 GeV. in which the energy to be stored in the magnetic field is not more than that required for the present 3-GeV. machine at Brookhaven. The work of the Proton Synchrotron Group has been changed to take advantage of this new idea. The Council expressed its approval of this.

One part of the work of the Council's Group directed by Prof. Niels Bohr is to promote forms of European co-operation in nuclear physics other than the creation of the laboratory. Sweden has offered to the Council facilities on the 200-MeV. cyclotron which is now working at the University of Uppsala, and Prof. Bohr reported that he has arranged on the Council's behalf for two or three young nuclear physicists from other European countries to take part in work with the machine. Great Britain also has offered facilities on the 400-MeV. cyclotron now nearing completion at the University of Liverpool, and this, too, has been accepted. Prof. Bohr also described an experiment carried out at the Institute of Theoretical Physics, Copenhagen, by Prof. J. C. Jakobsen, which was of interest to the Council because it illustrated the new focusing principle proposed for proton synchrotrons. Four sections of a magnet were used, being constructed so as to provide focusing and defocusing fields in alternate sections. Particles were injected from an alpha-particle source into these fields, and it has been shown by the use of a photographic plate that they were brought to a focus at the end of the fourth section. This experiment has provided confirmation of the first-order theory of the new focusing method. While it was recognized that the experiment still left unanswered important questions about particle stability under practical operating conditions, the Council expressed its appreciation of the work.

In a report by Dr. I. L. Kowarski, it was stated that the main work of the Laboratory Group since the Council's last meeting has been concerned with obtaining the relevant technical information about the sites offered for the laboratory and with the preparation of a draft convention for the building stage. Four member States had made formal applications to the Council to have the laboratory built in their territory, namely, France, Denmark, Holland and Switzerland ; each country had supplied detailed information about its site and had been invited to make the case for it to the Council. From the information given, it appeared that any of the four sites would be satisfactory on purely technical grounds. It was generally recognized that the choice would also take into account other considerations, such as the balance between international common good, plus the national benefit from it, on one side, and the necessary sacrifice of national resources, on the other. Competition between each of the four member States to have the laboratory within its territory was keen, but the subject was debated in a courteous atmosphere, and when all but Switzerland had withdrawn their offers, however reluctantly Geneva was unanimously chosen as the site for the future laboratories.

Since the Council had decided at its second meeting to give support to cosmic-ray research, the secretary-general reported to it the results of an international expedition which had been independently organized and operated in the Mediterranean area to carry out research in the high atmosphere using balloons. A total of thirteen balloons has been launched, and 1,300 c.c. of emulsion exposed to radiation at 70,000 ft. for an average time of 6½ hours has been recovered. This is approximately ten times more emulsion than has previously been exposed. It was considered that, besides providing a considerable amount of material for research work, the expedition has been very useful for improving the technique of balloon launching.

In his draft of an interim report for the governments of member States, the secretary-general outlined how the Council came into being, its present stage of development and its plans for the future. At the present time studies concerning the equipment and organization of a laboratory are in full progress. It is hoped that by the spring of 1953 these studies will have advanced sufficiently to allow member States to take final decisions regarding the construction of an international nuclear research laboratory, and the organization of other forms of co-operation in nuclear research. It is estimated that the next stage of development will last seven years and cost a total of 27 million dollars, after which the estimated annual running cost of the laboratory would be a maximum of 1½ million dollars. Very preliminary consideration was given to questions of organization which will arise in the third stage and to the form of the convention which will set out the constitution of the organization. This report is to be studied again by the Council before it is submitted to the governments.

TERCENTENARY OF THE LEOPOLDINA ACADEMY, SCHWEINFURT

THE tercentenary of the foundation of the Leopoldina Academy in Schweinfurt, Bavaria, in the West Zone of Germany, was commemorated during July 13–15 under the auspices of the civic authorities and Historical Society of the town. This was in the nature of a *Nachfeier* to the main celebrations at Halle in the East Zone of Germany (see *Nature*, April 5, p. 576), at which the Schweinfurt delegate was Dr. Josef Helfrich. Prior to the zonal split, the late president of the Academy, Prof. Emil Abderhalden, who died in Zurich in 1950, had hoped for the tercentenary celebration to be held in Schweinfurt.

The Senate of the Academy at Halle, under its newly elected president, Prof. Otto Schluter, and new senior vice-president, Prof. Heinrich Brandt, was represented by the secretary, Prof. Rudolph Zaunick, of Dresden (East Zone), who placed a wreath on the grave of the founder, Dr. Johann Lorenz Bausch (1605–65), reported on the present activity and projects of the Academy, and held a business meeting of members. The Martin-Luther University of Halle was represented by the rector, Prof. Rudolf Agricola. Prof. Michele Gortani brought greetings from the University and Academy of Bologna. A telegram was read from the veteran member, (the late) Sven Hedin, the Swedish explorer.

Prof. Zaunick spoke at the opening session on "Idee, Form und Inhalt der Akademie in der Antike". He showed how the modern idea of a scientific academy goes back not to the Ακαδημεια of Plato, which excluded and explicitly ridiculed experimentation, but to Ptolemy's Μουσειον.

At the scientific session, Prof. Wilhelm Lorey, of Frankfurt, spoke on "Persönliche Erinnerungen an Mathematiker unter den einstigen Akademie-Mitglieder". The Leopoldina Academy, which started as a medical society, took in no pure mathematicians as such until 1876. But some members, such as Werneburg, Goethe's contemporary, like him hostile to Newton's colour theory, and a fanatical protagonist of the duodecimal system, had started life as mathematicians, and many more, like Goethe, recognized the great educative value of mathematics. A pupil of Georg Cantor at Halle and of Felix Klein at Göttingen, Prof. Lorey recalled that he was often the sole audience at Cantor's lectures; and as one of the very few surviving contemporaries of Grace Chisholm (afterwards Mrs. W. H. Young) at Klein's seminar, he told the story behind her 'unforgettable' first appearance in the famous armchair at Klein's house. An enlightened Prussian Minister for Education, who thought mathematics the best subject to use as a guinea pig in testing whether women could or should be admitted to the universities, but wished to create no precedent for German women, entrusted to Klein the task of making suitable inquiries on his professional travels abroad. Grace Chisholm came from Cambridge and Mary Winston from the United States, and by their success opened up university careers to German women. The talk was illustrated by lantern-slide portraits of many eminent mathematicians whom the speaker had known personally.

Dr. Steck, of Nuremberg, under the title "Albrecht Dürer als Mathematiker und Kunsthistoriker", claimed that Durer had made a thorough study of mathematics and expressed life-long ideas on the unity of beauty and truth in his last three written works, "Unterweisung der Messung . . ." (1525), "Befestigungslehre" (1527) and "Proportionslehre", published posthumously (1528).

Prof. Hans Gallwitz, director of the Geological Institute at Halle, gave a talk of the greatest interest on "Ausgrabungen von Wirbeltieren und Insekten in der Eozänen Braunkohle". Unique palæontological discoveries have been made in the open-cast coal-mines in the Geiselthal near Halle. Excavations started by J. Weigelt in 1928 have only since the Second World War been successfully resumed, and praise is due to the mine-management and workers for their consistent co-operation. A film taken on the spot showed how specimens are detached and treated for preservation. The finds are unusually complete: not only whole skeletons, but also some skin, muscle and other soft-tissue remains are found, and even colours have been preserved in some green plant leaves and iridescent beetles. It is clear that the rate of sedimentation was rapid enough to prevent the attack of organic substances by atmospheric oxygen. Moreover, large desert tracts surrounded the district, isolating it and its inhabitants. The coal strata have an extensive surface area and attain a thickness of up to 100 m. on the southern rim. Tectonic movements, and particularly subsidence due to salt-leaching in the underlying Permian, can be clearly traced in the profiles; the formation of deep water-holes produced by the aforementioned process was particularly favourable to the concentration of specimens; others are found closely scattered over certain areas, called *Leichenfelder*, which were subject to recurrent flooding and which must have been formed as the result of periodically recurrent catastrophes.

The period, about forty million years ago, to which the finds belong lies near the beginning of the mass-development of the mammalian order. Plant remains clearly indicate a tropical and sub-tropical climate, and a dual rainy season is evidenced both by the two-fold lamination in the coal profile and by the otoliths of fish. In fishes and frogs, the shape of cutaneous pigment-carriers as seen under the microscope points to asphyxiation. Minute specimens of insect larvæ, pollen grains of the order of 10^{-6} gm. in weight, and even bacteria in the tracheæ of insects have been discovered. Among the finds are giant serpents, long-legged alligators, crocodiles with partially incubated eggs, a mammal transitional between insectivores and prosimians (with both hairs and spines), and one of the early prototypes of the horse, one foot high, with three toes on the hind-feet and four on the fore-feet.

Prof. H. Burgeff, of Würzburg, fresh from a visit to the United States, spoke on "Samenkeimung, Entwicklung und Kultur deutscher Orchideen", elucidating by diagrams and lantern-slides his method of cultivation in a double flower-pot, the seeds being planted individually in a net or weft of fungus-threads. The method has succeeded for all indigenous orchids, after guarding against the danger of destruction by mice, whereas the usual method has always failed except for the Platanthera.

Several speakers, notably Prof. Hämel, of the two-hundred year old Bavarian Academy of Sciences, Prof. D. Ackermann, of Würzburg, and Dr. F. Gademann, of Schweinfurt, did justice to the life-history and supra-national aims of the Leopoldina and of its foundation members—Brausch, Fehr, Metzger and Wohlfarth. These last-named were the first to put into practice the precepts, set out in the "New Atlantis" by Francis Bacon, for a scientific academy such as every principal city of Europe was soon to possess (London 1662, Paris 1666, Berlin 1711, Madrid 1713, St. Petersburg 1725, etc.). It is remarkable that this occurred in a small market-town, with a strong industrial background, in times of disruption rather like our own. A quotation that mystified some of the audience was from the curious charter that Kaiser Leopold I granted the Academy in 1687, when also it acquired its full name, conferring, as one of the normal privileges due to the Court rank bestowed on the president by the charter, the right to "legitimize illegitimate children" and to "declare dishonourable persons honourable".

Schweinfurt has preserved intact the fine library of more than a thousand volumes left to it by Dr. Bausch, chiefly on medical and botanical subjects; a large part was on view, together with works by other local Academy members—notably that on Japan by Philipp Franz von Siebold (1832), and with it his "Life" by the Japanese, Prof. Shuzo Kuro (Tokyo, 1926), the largest biography of a European ever written by an Asiatic.

An impersonation of the native poet Friedrich Rückert (1788–1866), a Haydn serenade in the courtyard of Mainberg Castle and a visit to the exhibition of medieval Franconian church art at

Würzburg Castle—the most striking feature of which was a large collection of the sculptures of Tilman Riemenschneider (1460–1531)—were the main social items in the proceedings, which were essentially informal. As in the case of the Halle celebrations, detailed reports will be published in the *Nova Acta Leopoldina*, including a full account of Prof. Gallwitz's researches. But, as yet, no copies of the current year's issue have reached the British bodies who were recipients before the War (and whose publications have been received up to date by the Academy), although at the time of the Halle meeting it was hoped to make up the deficiency forthwith.

R. C. H. Young

FARM WATER SUPPLIES

On October 21, under the auspices of the Society for Applied Bacteriology, a series of papers were read on various aspects of "Farm Water Supplies". The introductory paper was given by Mr. G. T. Morgan (Ministry of Agriculture and Fisheries), who at the outset emphasized the great importance of cleanliness in milk production and the significance of water supplies in this connexion. Of the 158,000 milk producers in Great Britain, 40 per cent own less than ten cows, and a large proportion still have inadequate and unsatisfactory water supplies to meet the estimated daily requirement of some 30–35 gallons per animal. With so many small units it is difficult to effect immediate improvements, particularly when so many of them have been producing satisfactory milk for many years. Information is being collected continuously, supplies are checked, and advice is given for improving their quality; reasonable time being allowed to correct faults and to effect the desired improvements.

Sir William Savage (Taunton), the eminent authority on public health matters, emphasized the need for a practical approach to the problem, since it is clear that piped supplies for all agricultural purposes are not possible, first on economic grounds and, secondly, because there is not sufficient water available. The quantities and qualities required must, therefore, be related to their uses. On only rare occasions have water supplies been incriminated in epidemics of bacterial infection, and in these cases the *Salmonella* and enteric organisms have been involved. Moreover, for most dairying purposes, the standards of water supplies need not be as high as those for general domestic supplies. Well and stream waters are quite satisfactory for animal drinking and for byre washing. Pure supplies are essential for washing all surfaces which come into direct contact with the milk. Sir William was sceptical of chemical disinfection, since this is usually carried out by unskilled farm hands.

Mr. W. A. Cuthbert (Leeds) said that 97 per cent of farm water supplies are from wells, usually shallow ones, or from springs. By means of a series of lantern slides he illustrated the unsatisfactory nature of many such wells and the difficulties of tracing the real sources of some of the springs. Infection in these waters are mainly found to be due to human pollution, which can be eliminated by appropriate protective measures, although these often involve reconstruction. Chlorination should also be employed, but this cannot be relied upon entirely to render a bad water safe. In farm water supplies, the counts of *Bact. coli* and *coli-aerogenes* groups vary independently, so that differentiation of fæcal and non-fæcal organisms is of little value for diagnostic purposes. Topographical examination of all supplies is essential and should be considered along with bacteriological findings before expressing judgment on any supply. Numerical standards for bacterial content are in themselves of no value in assessing farm water supplies because of the considerable seasonal variations encountered. Investigation has shown that factors responsible for this variation include soil temperature and, to a less extent, rainfall.

Dr. J. H. McCoy (Hull), considering the significance of polluted farm water supplies in relation to human infection, said that standard bacteriological tests cannot of themselves guarantee the non-pathogenicity of any supply. Topographical examination is a first essential to eliminate obvious faults. Epidemics of milk-borne enteric infections are traceable mainly to carriers, but a small number is undoubtedly attributed to the water supply, for example, the Croydon epidemic of 1937. Dr. McCoy also directed attention to organisms likely to cause spoilage in dairy products, such as lipolytic and proteolytic bacteria in cheeses, but said that these should not be present in large numbers in properly handled milks. Mr. T. C. Ketchen (Ministry of Agriculture and Fisheries), again emphasizing the practical and financial aspects, described in detail several ways in which the design and maintenance of farm water systems could be improved. Examples were given of how these could be effected by fencing off springs and wells from animal contact, by substituting bore-holes for shallow wells, by re-directing and piping flows from springs, or by proper walling and fencing of well-mouths.

The discussion was opened by Dr. Windle Taylor, who emphasized the importance of chemical tests on waters, and expanded further the significance of the *Bact. coli/coliform* ratio, stating that fæcal *Bact. coli* appears to survive much longer in water than was originally thought.

INTERNATIONAL SANITARY REGULATIONS

For more than a hundred years the progressive nations of the world have endeavoured to arrange a uniform sanitary code to govern international traffic and to utilize the best preventive measures against the importation of infectious diseases, especially cholera, plague and yellow fever. Important work to this end was done by the Pan-American Sanitary Bureau, the Office International d'Hygiène Publique, and the Health Organization of the League of Nations[1]. The development of air travel led to the International Sanitary Convention for Aerial Navigation, afterwards modified in 1944, like the convention of 1926 for maritime traffic.

During the first half of the present century there were as many as thirteen conventions or diplomatic arrangements relating to health control measures to be taken at frontiers. None of these conventions completely superseded all its predecessors, nor were all the States parties to these arrangements, some participating in certain of them and not in others. This disunity caused trouble and confusion in international traffic. Further defects were the delay in ratification, which prevented the application of the agreed measures rapidly and simultaneously; and the difficulty of revising them expeditiously in the light of scientific and technical progress, experience gained and new epidemiological knowledge.

The United Nations World Health Organization was established in 1946, and in its constitution was given authority to adopt international sanitary regulations. Without delay, the Interim Commission of the Organization appointed expert committees to prepare a revision of existing sanitary conventions. They studied such questions as the sanitary control of the Mecca Pilgrimage, modern advances in epidemiology and methods of preventing transmission of disease by insect vectors. The technical documentation thus produced enabled the Expert Committee on International Epidemiology and Quarantine, with the help of its legal sub-committee, to prepare preliminary draft international sanitary regulations. In April–May 1951 these regulations were considered by the special committee appointed by the Third World Health Assembly at thirty-six plenary meetings held in the Palais des Nations, Geneva, under the chairmanship of Dr. M. T. Morgan (Great Britain). After receiving comments and suggestions from the delegates of the member States, a final draft was prepared which the special committee submitted to the Fourth World Health Assembly. The text of the Regulations was adopted unanimously on May 25, 1951, by the representatives of the sixty governments present[2].

The first part of the official record of the International Sanitary Regulations consists of the proceedings of the special committee, appointed by the Third World Health Assembly, and of the plenary session of the Fourth World Health Assembly. The second part of the volume contains the text of the Regulations with an explanatory memorandum, a table of comparison between the provisions of the Regulations and those of previous sanitary conventions and similar agreements, and an index to the Regulations. The Regulations are a revision and a consolidation of the text of the numerous previous conventions and agreements; they came into force for all member States of the World Health Organization (and also for those non-member States which so signify) on October 1, 1952.

Turning to the Regulations themselves, they are framed in the endeavour to secure maximum security against international spread of disease with minimum interference with world traffic. They revise and consolidate previous provisions on plague, cholera, yellow fever and typhus, including the Pan-American Sanitary Code, Havana, 1924. Relapsing fever, being suitable for control in ports, airports and at international frontiers, has been added. Supplementary regulations dealing with measures for preventing the spread of other epidemic diseases may be added from time to time, and already are envisaged as regards malaria.

It is required that the appearance of a quarantinable disease in a territory, and, if necessary, its continued existence, shall be notified to the Organization, which will report the information to all health administrations to which the Regulations apply. Thus health administrations will have a world-wide knowledge of the epidemiological situation of quarantinable diseases. In measures for the prevention of the importation of pestilential disease, it is intended that a State shall chiefly rely on its own public health service. The Regulations concerning plague, cholera, yellow fever, typhus and smallpox include all modern scientific methods of prevention. Vaccination is advised in the case of yellow fever; but not as regards typhus, because modern insecticides, properly applied, and disinfection where appropriate, afford adequate security. Rules governing the health control of the Mecca Pilgrimage have been added.

After reading the Regulations, including the procedure for acceptance, reservations and rejections, one obtains the impression that a great step forward has been made in the international control of epidemic disease. When all the governments of the world adopt the Regulations and implement them, they will protect not only their own frontiers from pestilence, but will also materially contribute to the health of all nations.

A. S. MacNalty

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[1] MacNalty, Sir Arthur, *Nature*, 170, 108 (1952).

[2] World Health Organization. Official Records of the W.H.O., No. 37 International Sanitary Regulations; Proceedings of the Special Committee and of the Fourth World Health Assembly on WHO Regulations No. 2. Pp. iv+442. (Geneva: World Health Organization; London: H.M. Stationery Office, 1952.) 16s. 3d.; 2.25 dollars; 9 Sw. francs.

COPYRIGHT AND THE SCIENTIST

To the scientific man, nurtured in the tradition of the greatest possible freedom for the circulation and interplay of new scientific knowledge, anything that tends to restrict that freedom is liable to be irksome. If the Copyright Act of 1911 was guilty of causing (or more accurately of perpetuating) uncertainty among the general public as to the extent to which published works might be reproduced, it is not surprising that it should have appeared to the scientific worker to be something of a maze, any tortuous path of which might lead him to wrongdoing. Apart from such general uneasiness, three specific factors have in recent years given added point to the problem. First, and probably the least troublesome, the growth in the use made of review literature has brought out the need for some clearer definition of the degree to which a work might be quoted without infringement of the "fair dealing" provisions of the Act. Secondly, the copious increase in scientific and technical literature during the present century has brought with it a corresponding need for digests and summaries for convenient record by the research worker. Thirdly, advances in photo-copying and microphotography have simplified the reproduction of tables of results, technical reports and periodical articles and virtually removed the principal "disincentive" to copying, namely, the laborious process of manual transcription. If the Report of the Copyright Committee* set up by Mr. Harold Wilson, then President of the Board of Trade, in April 1951 does not entirely resolve these problems, it does provide a reasoned commentary on them and its recommendations will doubtless form the basis of any new legislation that may be introduced.

It says much for the good sense of scholars, authors and publishers alike that no test case has so far been brought in British courts. Yet it is virtually certain that the law of copyright, as it now stands in relation to the limited copying permissible of any work "for the purpose of private study, research, criticism, review or newspaper summary" has been frequently infringed in the scientific field. The facts that, first, infringement has probably taken place either in ignorance of the law or from a lack of understanding of the conception of published work as property; secondly, that no author or publisher has yet felt able to seek issue at law; and thirdly, that evidence of unlawful copying in cases of private study or research must be extremely difficult to obtain, only serve to emphasize that the present position is founded on fundamentally bad law. Two conflicting interests must be reconciled. On one hand, the scholar's interest demands that reasonable freedom to profit from the speed and cheapness of modern photographic methods of copying should be enjoyed, especially where original works are scarce or out of print. On the other, the author or his publisher—neither of whom may be responsible in these days for a work going out of print—quite reasonably foresees that indiscriminate and cheap photographic copying may substantially affect his own income.

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* Report of the Copyright Committee, Cmd. 8662. (London: H.M.S.O. 4s. 6d. net.)

The Copyright Committee's diagnosis of this general problem is not at fault. What is debatable is whether the formula which it puts forward as machinery for the reconciliation of these two sets of interests rests upon a proper assessment of the nature of scientific communication. Broadly speaking, the Committee attempts to differentiate between the copying of periodical literature, books and manuscripts, a distinction of form rather than of content. The assumption is made—and for the purposes of science rightly made—that considerations of speed and currency lend the greatest importance to copying from periodical publications. Here it is proposed that, subject to certain statutory rules to be drawn up in consultation with organizations directly interested, any periodical literature should be available for copying. The minimum provisions of these rules which the Committee suggests is that copying should be done only by certain specified non-profit-making bodies, that the responsible librarian should satisfy himself that copies are genuinely required for private study or research, that one copy only of any one excerpt should be supplied to any one person and the excerpt restricted to one article, that the copy should not be supplied at less than cost price and that the applicant should give a written undertaking that the excerpt will not be used for other than its declared purpose. Apart from the question of designating the bodies under which such copying would be permitted, the proposals probably recognize, and are doubtless envisaged as giving force of law to, a procedure that is already not uncommonly adopted by learned societies and research libraries. Copying from books would be treated similarly except that the rules, since speed would not seem to be so essential, would enjoin some attempt to secure the author's or his publisher's permission before any "substantial" extract was copied.

It is not, however, sufficient to distinguish only between the various forms of printed publication. A more fundamental distinction lies between types of material published and, particularly, between works of creative imagination and papers or articles which bring scientific research data to public notice. While, on one hand, the author of a creative work expects to receive payment, and indiscriminate copying would be against his interests, for the scientific man, on the other hand, publication is rarely a matter of commercial reward. The scientific man's financial return is often nil, or a merely nominal sum. His real profit is in the form of an increase in professional reputation. Indeed, his interest, like that of scientific progress, demands that his work should be circulated as widely and as freely as possible. Some such notion doubtless lies behind the common practice among learned journals of making reprints of their papers readily available to contributors; and since this indicates acceptance by a considerable body of publishers of the advantages of the system, it is difficult to see that an extension of freedom to copy from scientific papers could do material harm. It should, of course, be required that every copy so made should bear a full reference to the original publication, and re-sale should be prohibited by law.

Needless to say, a general arrangement such as this would still be open to objections. Is it certain, for example, that works of creative imagination will not occasionally come near to being properly regarded as of scientific value? Is it reasonable to give the force of law to a permissive arrangement embodied in the Royal Society's "Fair Copying Declaration", and extend its application to all commercial scientific publishers in addition to those who have already accepted its provisions, together with many learned societies and other publishing agencies? How, if at all, would any general relaxation of copyright law in relation to scientific works affect British interests abroad under existing or contemplated international copyright conventions? Awkward as they are, it should not prove impossible to reach a fair solution of these problems. At the moment, it appears as though the Committee, in trying to please research worker, author and publisher alike and in treating all publication as a commercial investment, may have fallen into the trap of proposing statutory authority for a piece of cumbersome protective machinery which was created in self-defence against an anomalous and outmoded law. LESLIE WILSON

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

REPORT FOR 1951

A PUBLICATION bearing the general title "Chemistry Research 1951"* includes the report of the Chemistry Research Board, signed by the chairman, Prof. E. L. Hirst, and the report of the Chemical Research Laboratory, Teddington, over the signature of the director, Dr. D. D. Pratt, together with the customary lists of publications during the year, standard substances and staff, and an alphabetical list of species in the National Collection of Industrial Bacteria, which now includes more than five hundred strains. Following a special review by the Board of the research programme and distribution of effort in the Laboratory, increased effort has been assigned to the purification of organic compounds and the precise measurement of physical properties, and to the microbiological production of sulphur. Work on the precise measurement of the vapour pressures and boiling points of bases of the pyridine series has been resumed, and greater effort has been given to the chemical side of the joint programme with the Physics Division of the National Physical Laboratory on accurate bomb calorimetry. A team from the Chemical Research Laboratory is now using for the microbiological reduction of sulphate the continuous process developed by the Ministry of Supply's Experimental Station at Porton.

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* Department of Scientific and Industrial Research. Report of the Chemistry Research Board with the Report of the Director of the Chemical Research Laboratory for the Year 1951. Pp. iv+120+4 plates. (London: H.M. Stationery Office, 1952.) 4s. 6d. net.

Although the new Radiochemical Building of the Laboratory was expected to be ready for occupation, this would not suffice to meet the lack of accommodation stressed in the report for 1950; but that position should be alleviated by the new prefabricated building, specially designed for microbiological work, which was to be completed by the middle of 1952. (Both buildings have now been completed, see *Nature*, October 18, p. 648.) The Board's report stresses the extent to which fundamental work on corrosion is contributing to the solution of practical problems. Four model Scotch marine boilers have been installed on behalf of the British Shipbuilding Research Association for the Corrosion Group to investigate the corrosion produced in boiler tubes by the infiltration of salt water, and the Group is also advising the British Electricity Authority on the corrosion of boiler tubes in its generating stations. Use of potassium chromate containing chromium-51 in the study of corrosion inhibitors has indicated that the role of the inhibitor is not solely that of an oxidant keeping the iron oxide film in repair, and the radioactive tracer technique has already furnished information on the amount of chromium in the protective film and the distribution of the chromium over the surface. The use of electrode potential decay-curves has thrown further light on the mechanism by which sodium benzoate and potassium chromate inhibit corrosion, while good progress is reported in the fundamental work on the oxidation of massive metal surfaces. Other work has shown that sodium salts of the three nitrocinnamic acids and of *o*-nitrohydrocinnamic acid, at 0·5–1·0 per cent, inhibit the corrosion of cast iron as well as of zinc in distilled and mains water; the electrochemical investigation of the behaviour of painted steel panels in the solutions of various osmotic pressures continued, and electrochemical studies of anaerobic microbiological corrosion were started, as well as preliminary work on the effect of the cooling fluid on the turning of mild steel and on the application of vapour phase inhibitors for arresting corrosion in closed installations.

In the production and analysis of pure germanium for the Radio Research Board, the Inorganic Group has succeeded in reducing to about 1 part in 10^8 the arsenic content of germanium dioxide, produced from the tetrachloride, by distilling germanium tetrachloride in the presence of hydrochloric acid and chlorine. Further work on phosphatic fertilizers has been directed largely to the production of dicalcium phosphate and the recovery of the nitric acid used in attacking the phosphate rock. Besides a literature survey of the recovery of sulphur from calcium sulphate, the Group has continued to study the spectrophotometric determination of arsenic by the 'molybdenum blue' method; its spectrographic laboratories have been equipped with a 'multiservice unit' and a Beckman spectrophotometer with flame-photometer attachment, while efforts have been made to increase the speed of microchemical analyses of samples and to place on a sound basis the inorganic techniques required to deal with the increasing number of inorganic materials presented for analysis.

In the Radiochemical Group the scope of chromatographic methods has been extended to a wider range of metals, including tantalum and niobium, which are difficult to separate in other ways. Further improvements have been made in physical methods of analysis, and a polarographic method has been developed for continuously recording the variation in concentration of metal ions in solution, and a method devised for the measurement of carbon-14 operating in solution, based on a scintillation technique. Studies were carried out on the adsorption of gold, copper and iron from cyanide solutions by 'Amberlite I.R.A. 400' resin and of nickel, cobalt and zinc by 'ZeoKarb 225' cation-exchange resin, as well as on the precipitation of uranium and other metals from solution.

Much of the work of the Organic Group has been concerned with the provision of services to other organizations, and its preparative work has included, for example, the supply to the Medical Research Council for field trials in Africa of a sample of N_1N_3-*bis*-(4-aminocinnalyl-6-)guanidine, which has shown promising trypanocidal activity, a new synthesis of 2 : 6-hydroxybenzoic acid, the preparation and investigation of 2 : 3 : 5 : 6-tetrahydroxyterephthalic acid and its diethyl ester and attempts to prepare phloroglucinoltricarboxylic acid for investigation of its anti-rheumatic properties. Nearly five hundred samples of pure low-boiling hydrocarbons have been supplied to industrial and other laboratories in Britain for use as standards in calibrating mass spectrometers; α-picoline has been hydrogenated at 120–140° C. in the presence of *W*-6 Raney nickel catalyst, and benzene containing carbon-14 atoms has been synthesized, as well as ethylene oxide containing carbon-14 for use in insecticide studies.

The unique properties of polyvinyl alcohol membranes are being studied by the High Polymer Section for studies in osmometry and the exchange behaviour of large quaternary ammonium cations. A second series of sulphonated polystyrenes of different degrees of cross-linking has been prepared from a divinylbenzene solution supplied by the Dow Chemical Co., and the relative affinity coefficients are in general consistent with theories of ion-exchange equilibria which emphasize the importance of the size of the hydrated cation in the resin. Work has been commenced on the preparation of strongly basic resins by the chloromethylation of styrene, and, in work on the application of ion-exchange resins, β- and γ-resorcylic acids have been separated on an anion-exchange resin.

Fundamental studies in the Microbiological Section indicate that reducing agents enhance the viability of sulphate-reducing bacteria, and this finding has led to the development of a method for the accurate counting of live organisms. Work on the breakdown of organic compounds by these organisms has demonstrated the importance of pyruvic acid in their metabolism, and certain strains have been found which require no reducible sulphur when grown with pyruvates. Investigations on the inhibition of hydrogen absorption have continued, and those sulphate analogues found to be active inhibitors in manometric studies have been tested as inhibitors of the growth of the Hildenborough strain in sulphate-deficient *GPYS* medium; culture filtrates of this strain grown in *GPYS* and *LYS* media showed no trace of antibiotic activity against a wide variety of organisms. Further experiments have shown that elemental sulphur can be produced by the combined action of pure cultures of sulphate-reducing bacteria and the photosynthetic green or purple sulphide-oxidizing bacteria in a common medium and provide strong evidence that some of the sulphur in the Cyrenaican lakes was produced from sulphate by a similar combined action.

ROYAL GREENWICH OBSERVATORY

ANNUAL REPORT FOR 1951–52

THE annual report of the Astronomer Royal for the period May 1, 1951–April 30, 1952[*], deals with the three separate sections of the Royal Greenwich Observatory at Herstmonceux (including H.M. Nautical Almanac Office), Greenwich and Abinger, and provides an account of the work carried out at each place as well as a short description of the condition of the buildings. In some cases the progress of repair and reconstruction leaves much to be desired.

Approval has been given to the recommendation of the Board of Visitors that the old buildings of the Royal Observatory at Greenwich should be used as an astronomical and navigational annexe to the National Maritime Museum, and the trustees of the latter have received official intimation of this recommendation. The Astronomer Royal proposes leaving the historic instruments belonging to the Observatory in the old buildings at Greenwich—a decision which will give wide public satisfaction. The progress of the work with the 36-in. Yapp reflector at Greenwich has been disappointing, owing to further deterioration in the sky since the end of the Second World War, largely due to street lighting with mercury-vapour lamps, recently installed; a further reduction in the output of the telescope has been caused by illness among the observers. The programme of examining *K*0 sub-giants for luminosity effects correlated with anomalous trigonometric parallaxes is now directed towards fainter stars, and this, with the other factors, is responsible for the fact that only forty-six spectra of thirty stars have been obtained with the main reflector.

Time service throughout the year has been based upon astronomical observations made with the small transit *B* at Greenwich and the Bamberg broken-transit instrument at Abinger. A total of 509 observations at both places was made in the twelve months covered by the report, and an analysis of the performance of the clocks suggests that considerable changes occur in phase and amplitude of the annual fluctuations in the rate of rotation of the earth. The values obtained for 1950–51 are smaller than those given by many previous concordant analyses, and hence it is not practicable to apply corrections month by month to the time determined astronomically so as to produce a uniform time system. A time system that is approximately uniform is defined by the best quartz clocks, while the astronomical determinations of time over two or three years are used for giving the error and the rate for each clock.

Preliminary work has been started on the preparation of the Admiralty magnetic charts for the epoch 1955; the unfortunate dearth of recent observational data over many parts of the earth, particularly in central Asia and in the oceans, renders it extremely difficult to construct reliable current charts of secular variation. The employment of spherical harmonic analysis to improve the charts in regions where no observations have been made cannot be regarded as very satisfactory; the process is one of distributing the inaccuracies and is a poor substitute for the deplorable lack of observational data.

An important collaboration between H.M. Nautical Almanac Office and the Nautical Almanac Office, United States Naval Observatory, has resulted in the British "Air Almanac" and the "American Air Almanac" becoming a single publication bearing the title "The Air Almanac". Although printed separately in Great Britain and the United States, the two editions are printed photographically from identical material. This production represents a very important step in international co-operation, and the United States authorities have agreed to supply, at nominal cost, specially pulled proofs on glossy paper suitable for photographic reproduction to the official almanac-producing agency in any country. The International Civil Aviation Organization has recently directed the attention of contracting States to the availability of this Almanac for reproduction in other countries, with or without language changes, and it is hoped that it may eventually become international.

Some disappointment is expressed in the report at the slow progress in the removal of the Observatory from Greenwich to Herstmonceux. Nearly four years have passed since the first sections of the staff were moved to Herstmonceux; but the only instruments that have been installed are the spectroheliograph and spectrohelioscope, and the 26-in. and 28-in. refractors still remain dismantled at Herstmonceux. The Cook reversible transit circle is still at Greenwich, but no large programme of observations will be started with it until it has been installed at Herstmonceux. Increased industrial staff and, in consequence, increased expenditure attend the separation of the Observatory into three separate sections at Herstmonceux, Greenwich and Abinger, and, in addition, there is loss of flexibility and much administrative inconvenience. The most serious disadvantages of the division are the loss of observations and the lack of training in observing by many junior members of the staff. The meridian group, which is already far behind schedule, is to be proceeded with, but the financial cuts imposed this year have prevented a start on the construction of the equatorial group. The general situation is summed up by the Astronomer Royal towards the end of the report in the following words: "The slow progress in the removal from Greenwich to Herstmonceux is the cause of great disappointment and of a deep sense of frustration".

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[*] Report of the Astronomer Royal to the Board of Visitors of the Royal Greenwich Observatory, read at the Annual Visitation of the Royal Observatory, June 7, 1952. Pp. 30. (Greenwich: the Observatory, 1952.)

STANDING LIGHT WAVES

THE Rumford Medals awarded biennially by the American Academy of Arts and Sciences to the outstanding American contributors to the science of heat and light were established in 1796 by a gift of Benjamin Thompson, Count Rumford. It is customary for the recipient to present a communication to the Academy at the time of the receipt of the Medal, and in recent years he has usually reviewed significant aspects of his own work. The Academy, believing that the communications constitute a noteworthy record of American achievement in heat and light, has decided to publish a new series of the biennial Rumford Lectures, and the first of this series[*], entitled "Adventures with Standing Light Waves", is by Prof. H. E. Ives, who was awarded the Rumford Medal for 1951.

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[*] *Proc. Amer. Acad. Arts Sci.*, 81, No. 1 (1951); "Adventures with Standing Light Waves" (Rumford Medal Lecture, 1951) (pp. 32; from the Academy, Boston, Mass., 1951).

The phenomenon of standing waves of light in the form of the Lippmann process was the subject of Prof. Ives's doctoral thesis some forty years ago. He then turned, during the First World War, to work on aerial photography, and after the War at the Bell Telephone Laboratories he was occupied at first with electrical contacts and then with the photoelectric effect, of which he made a close study. The various problems in the nature of the photoelectric effect, particularly the effect of the state of polarization of the exciting light on the photoelectric emission and the spectral distribution of the photoelectric emission from the alkalis, occupied his attention and led him to give an explanation in terms of the existence of a system of standing waves above the metal surfaces. This required for its test a knowledge of the optical constants of the alkali metals. Details of the experimental results obtained and their significance are discussed briefly by Prof. Ives. He stresses that it is the optical properties of the materials and the optical conditions of the region in which the phenomena occur which explain the outstanding effects, and that the various quantum mechanical explanations have almost uniformly neglected or ignored the optical factors.

Another experiment with standing waves of light referred to by Prof. Ives is a modification of Wiener's experiment, with a photoelectric film replacing the photographic film used by Wiener. Prof. Ives asserts that the verification of the electromagnetic wave theory of light furnished by this experiment considerably transcends that of Wiener's original simple experiment.

Finally, Prof. Ives discusses what contribution the results of these photoelectric experiments can make to the elucidation of the old question of the nature of light, waves versus corpuscles. Wiener's modified experiment, he claims, comes very close to showing both types of phenomena in combination. Wave mechanics is a way out of the dilemma. It avoids the unacceptable idea of photons by putting the quantum h in the atom and not in the radiation, and Prof. Ives concludes by predicting that the photon will go the way of the 'caloric' that Rumford demolished.

X-RAY AND NEUTRON MUTAGENIC EFFECTS ON CEREAL SEEDS

THE biological action of X-rays and fast neutrons on cereal seeds is the subject of detailed investigation in the Mutation Laboratory of the Swedish Seed Association at Svalöf, Sweden, use being made of the cyclotron equipment and other facilities of the Nobel Institute for Physics and of the Institute of Radiophysics at Stockholm (J. Mackey, *Arkiv. for Botanik*, **1**, 16, 545; L. Ehrenberg, A. Gustafsson and N. Nybom, *ibid.*, 557, 1952).

Both dry dormant and soaked seeds of wheat and barley were irradiated with X-rays and fast neutrons and the treated materials followed through two generations for observation of the frequency of primary chromosome disturbances, the retarding effect on sprouting, the death-rate, the induced degree of sterility in the first generation, and the frequency of certain types of mutation in the second. For the production of genetically interesting and useful materials, neutrons are many times more effective than X-rays; at high neutron dosages the mutation-rate reaches a very high level. Cells with low water content (and low metabolic activity) are highly resistant to the killing effects of neutrons as compared with X-rays, but actively dividing cells are more sensitive to neutrons; after neutron irradiation, about five times as many cells show chromosome disturbances in pre-soaked as compared with dry seed.

Different radiations may act in different ways because of differences in ionization density, distribution of ionizing rays within the object, and the duration of the time of action of isotopes. The general result so far obtained is that neutrons are about ten times as effective as X-rays of equivalent energy dissipation in causing chromosome disturbances and from fifty to one hundred times as effective in causing first-generation sterility and in increasing the rate of mutation. This higher effectiveness is attributed to the difference in ion density. While the results reported are not regarded as final, they constitute an important advance in the planned and controlled induction of mutations in agricultural and horticultural plants by ionizing agents.

CYTOCHROME COMPONENTS IN CHLOROPLASTS

By H. E. DAVENPORT

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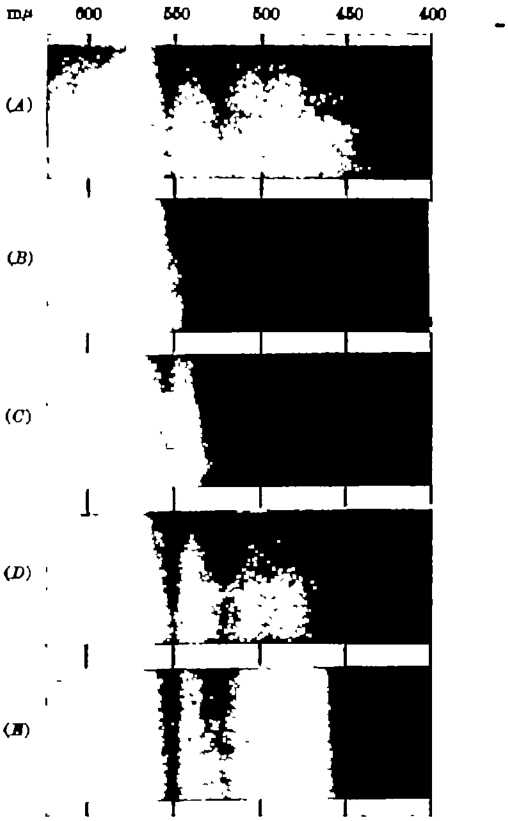
LITTLE was known of the distribution of components of the cytochrome system in green leaves until Hill and Scarisbrick[1] separated not only cytochrome *c* but also two new soluble components, b_6 and *f*. Cytochrome *f* appeared to be confined to chlorophyll-containing tissues where the presence of high concentrations of plastid pigments precludes the direct spectroscopic observation of the component. It was first observed in the reduced form in preparations of leaves from which plastid pigments had been removed by acetone treatment. Afterwards, Hill and Scarisbrick obtained cytochrome *f* in solution in ethanol extracts of fresh leaves. In solution it is not autoxidizable, does not combine with carbon monoxide and has, in the reduced form, a characteristic spectrum with the α-band at 555 mμ. Further properties of the purified cytochrome have been described in greater detail[2] and evidence presented for supposing that it may play an important part in the electron transfers occurring in photosynthesis. Hitherto, however, cytochrome *f* has been observed only in preparations which had been treated with organic solvents, and the possibility therefore remained that it was an artefact arising from some other hæmatin compound as a result of that treatment. It has now been found that the absorption spectrum of cytochrome *f* can be observed directly in intact plastids prepared from etiolated barley leaves.

Barley seedlings were grown on John Innes seedling compost in a darkened incubator at about 20° C. After nine days, the yellow leaves were harvested and 10-gm. amounts were ground in a chilled mortar with 10 ml. of cold 0·5 *M* glucose in 0·03 *M* phosphate buffer of *p*H 7·4. The material was squeezed through muslin and centrifuged for 1 min. at 3,000 r.p.m. to remove intact cells and vascular debris. The turbid yellow supernatant fluid was centrifuged at 4,000 r.p.m. at 2° C. for a further 5 min. This gave a yellowish brown sediment which when viewed with the Zeiss microspectroscope against a strong light showed the spectra of carotenoids, protochlorophyll and a little chlorophyll *a* and also a sharp band at 555 mμ, the position of the α-band of ferrocytochrome *f*. The cloudy supernatant fluid was recentrifuged at 12,000 r.p.m. for 10 min. to give a second precipitate showing a similar spectrum.

The two precipitates were suspended separately in about two volumes of the cold glucose solution and examined microscopically. The second precipitate appeared to be mainly fragments of plastids, whereas the first precipitate consisted of intact plastids similar in form to the chloroplasts extracted from normal green barley leaves by the same procedure. The latter have been found to have high activities in the photochemical chloroplast reaction described by Davenport, Hill and Whatley[3]. Similarly[4] it has been shown that etiolated barley plastids will reduce an indophenol dye in light, and that this activity increases progressively with the development of chlorophyll when the leaves are greened by exposure to light. For further examination and the photography of spectra, the suspended precipitates were combined in a cell 0·5 cm. thick. The photographs of absorption spectra were made in collaboration with Dr. R. Hill, using a diffraction-grating camera arrangement designed by him[5].

Immediately after resuspension of the precipitates, the band at 555 mμ is relatively faint; but at room temperature it slowly increases to a maximum density in about 30 min. (Fig. *B*). Shaking then again results in an immediate decrease in density, suggesting that systems are present which can catalyse the oxidation of cytochrome *f* by oxygen. On the addition to the suspension of a trace of ferricyanide, the band at 555 mμ disappears as the cytochrome is completely oxidized. If, on the other hand, a trace of a reducing agent (sodium hyposulphite) is added there is no change in the band of ferrocytochrome *f*, but two additional bands then appear (Fig. *C*) : a faint band at 605 mμ corresponding to cytochrome *a* of yeast and a strong band at 563 mμ in the position of the *b* group of cytochromes. Cytochrome *c* could not be detected visually in the preparations. To facilitate comparison of the spectrum of the reduced plastids with more typical cytochrome systems, the spectra of reduced yeast cells and muscle granules[6] are shown in Figs. *D* and *E*. By comparing visually the intensities of the α-bands of the components in the reduced plastid suspension with those in a variable thickness of compressed baker's yeast, it was possible to obtain an approximate measure of the relative concentrations of the components in the two types of material. Here it was necessary to compare the band of cytochrome *f* in the plastids with that of cytochrome *c* in the yeast. On the basis of the absorption spectra of the two cytochromes in solution this comparison is valid[6]. These measurements gave the following concentration ratios : *a* (yeast)/*a* (plastids) = 10 ; *b* (yeast)/*b* (plastids) = 1·6 ; *c* (yeast)/*f* (plastids) = 4. The concentration (v/v) of plastids in the suspension used was similar to that estimated for the living cell. Moreover, Hill and Scarisbrick[1] have shown that leaf hæmatin is concentrated largely in the plastids and is not distributed evenly through the cell. These ratios may therefore be held to represent a direct comparison of the concentrations of the components in the living cells of leaves and yeast.



Absorption spectra of cytochrome components. (*A*) Dilute solution of cytochrome *f*. (*B*) Suspension of etiolated barley plastids in air. (*C*) Suspension of etiolated barley plastids + sodium hyposulphite. (*D*) Compressed baker's yeast, 1 mm. thickness. (*E*) Granule preparation from pigeon breast muscle

The spectrum of the reduced plastid preparation does not change in an atmosphere of carbon monoxide. By adding an equal volume of pyridine to the reduced suspension, bands of the corresponding pyridine hæmochromogens appear with centres at 585 mμ (*a*), 558 mμ (protohæmochromogen = *b*) and 551 mμ (*f*). The presence of large concentrations of carotenoid pigments in the preparations entirely prevented observation of the β- and γ-bands of the cytochrome components.

It was confirmed that cytochrome *f* can be extracted by ethanol from both etiolated and normal barley leaves. Leaves (10 gm.) were ground in a chilled mortar with 9 ml. of 96 per cent ethanol containing 0·06 ml. of ammonia solution (spec. grav. 0·88). The material was squeezed through muslin and centrifuged. When viewed with the microspectroscope in a layer 2 cm. thick, the characteristic band at 555 mμ was visible in the clear supernatant fluid.

The above preliminary observations appear to confirm that cytochrome *f* is a normal constituent of the chloroplast. Its abundance in the intact plastids and the relative absence of cytochrome *c* is in marked contrast to the considerable uniformity shown by the cytochrome systems of animal tissues and yeast and also by the colourless, non-photosynthesizing portions of higher plants[7,8]. There is still no direct evidence of the role of the component in the metabolism of the chloroplast; but it is hoped that further work with partially etiolated material may throw light on this problem.

I have to express my gratitude to Dr. R. Hill for his interest in this work. I am indebted to Mr. J. B. Chappell for a preparation of muscle granules. Thanks are also due to the Agricultural Research Council for providing the special facilities for this work.

[June 4.

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OCCURRENCE OF GAMMA-AMINO-BUTYRIC ACID IN EXTRACTS OF *PISUM SATIVUM* (L.) AND IN THE HONEYDEW OF *MYZUS CIRCUMFLEXUS* (BUCK.)

By J. L. AUCLAIR and J. B. MALTAIS

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THE occurrence of gamma-amino-butyric acid in biological material has been reported occasionally. Dent[1] mentioned its possible occurrence in human blood and urine. Steward *et al.*[2] definitely identified it as a constituent of the potato tuber; next to the amides glutamine and asparagine, it was the most abundant soluble nitrogen constituent in the potato, amounting to 540 µgm. per gm. of fresh tuber. Awapara *et al.*[3] and Roberts *et al.*[4] reported the occurrence of free gamma-amino-butyric acid in the human brain. Reed[5] also found this compound in yeast.

In investigations on the factors of plant resistance to insects, analyses of free amino-acids in pea-plant extracts were carried out by paper partition chromatography. Two-dimensional chromatograms yielded a large number of amino-acid spots, one of which appeared at the position usually occupied by methionine sulphoxide (Fig. 1, No. 14). Before a further test, a few plant extract samples were oxidized at mild heat with hydrogen peroxide and a catalyst in order to convert methionine sulphoxide quantitatively into methionine sulphone. The test revealed only a trace of the sulphone on the two-dimensional chromatograms. The large methionine sulphoxide spot remained mostly unchanged. This observation led to some uncertainty as to the identity of the methionine sulphoxide spot. The R_F values of this particular spot were 0·73 in phenol – water and 0·21 in collidine – lutidine – water by the method of capillary ascent. Other samples were run with the following solvent system: phenol – water in the first dimension and *n*-butanol, 300 ml.; glacial acetic acid, 60 ml.; and water, 140 ml., in the second dimension. This procedure resulted in the separation of the 'methionine sulphoxide' spot into two components: a faint spot that remained at the methionine sulphoxide position with an R_F of 0·31 in butanol – acetic acid – water (Fig. 2, No. 14), and a large dense spot that appeared just below the valine spot with an R_F of 0·50 (Fig. 2, No. 20). The position of this new spot did not correspond with that of any of the well-known amino-acids.

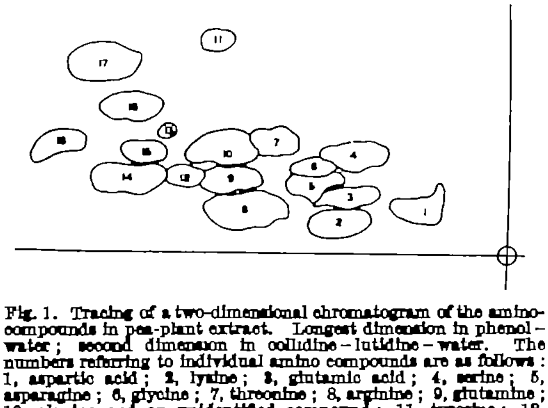

Fig. 1. Tracing of a two-dimensional chromatogram of the amino-compounds in pea-plant extract. Longest dimension in phenol – water; second dimension in collidine – lutidine – water. The numbers referring to individual amino compounds are as follows: 1, aspartic acid; 2, lysine; 3, glutamic acid; 4, serine; 5, asparagine; 6, glycine; 7, threonine; 8, arginine; 9, glutamine; 10, alanine and an unidentified compound; 11, tyrosine; 12, β-alanine; 13, α-amino-butyric acid; 14, methionine sulphoxide and γ-amino-butyric acid; 15, possibly β-amino-isobutyric acid; 16, valine; 17, leucine and/or isoleucine and phenylalanine; 18, proline

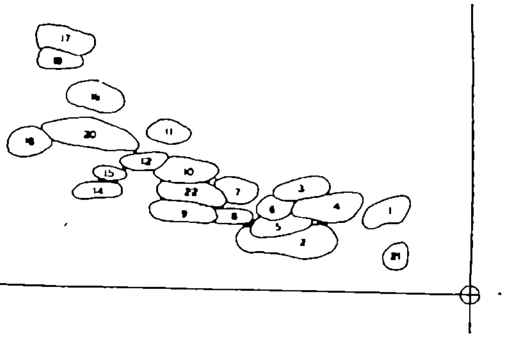

Fig. 2. Tracing of a two-dimensional chromatogram of the amino-compounds in pea-plant extract. Longest dimension in phenol – water; second dimension in butanol – acetic acid – water. The numbers referring to individual amino compounds are as follows: 1, aspartic acid; 2, lysine; 3, glutamic acid; 4, serine; 5, asparagine; 6, glycine; 7, threonine; 8, arginine, 9, glutamine; 10, alanine; 11, tyrosine; 12, β-alanine; 14, methionine sulphoxide; 15, possibly β-amino-isobutyric acid; 16, valine; 17, leucine and/or isoleucine; 18, proline; 19, phenylalanine; 20, γ-amino-butyric acid; 21, cystine; 22, an unidentified amino compound concealed by alanine in Fig. 1

The basic copper carbonate ($CuCO_3$, $Cu(OH)_2$) test described by Crumpler and Dent[6] as a distinctive test for alpha-amino-acids in paper chromatography was applied with positive results. When samples of pea-plant extracts were separated on two-dimensional chromatograms previously treated with the basic copper carbonate powder, a single spot appeared after the ninhydrin reaction. This single spot, on chromatograms irrigated with phenol – water in the first dimension and collidine – lutidine – water in the second dimension, was situated at the methionine sulphoxide position. The results obtained with the basic copper carbonate test indicated that the unidentified compound is not an alpha-amino-acid.

Of the new amino-compounds other than alpha-amino-acids recently reported as occurring in biological material, gamma-amino-butyric acid and beta-amino-isobutyric acid were those having the R_F values closest to the methionine sulphoxide position. Pure samples of the two compounds were secured, and the above experiments were repeated; gamma-amino-butyric acid matched exactly the R_F of the methionine sulphoxide spot in phenol – water and collidine – lutidine – water chromatograms. Moreover, upon the addition of a small amount of gamma-amino-butyric acid to pea-plant extracts before chromatographic analysis, there was a significant increase of the 'methionine sulphoxide' in the first solvent system and of the 'below valine' spot in the second solvent system. These results, together with the evidence given by the basic copper carbonate test, leave no doubt as to the presence of gamma-amino-butyric acid in the pea plant. This amino-acid is an addition to the list of those identified in peas by Auclair and Maltais[7].

Gamma-amino-butyric acid was also identified in the honeydew excreted by *M. circumflexus* feeding on potato plants. It is very likely that the aphids take this compound from the host plant, which contains a relatively large amount of it. A complete chromatographic analysis of amino-acids in the honeydew of this insect feeding on potato has been effected by Maltais and Auclair[8].

A quantitative estimation of gamma-amino-butyric acid in pea-plant extracts was made by the method of quantitative paper chromatography developed by Auclair and Dubreuil[9]. On a dry-weight basis, the quantity of gamma-amino-butyric acid is approximately 11 mgm. per gm. of pea-plant sample. On a fresh-weight basis, the amount is approximately 1,680 μgm. per gm. The amount found in the potato tuber, as given by Steward *et al.*[2], is 540 μgm. per gm. In the honeydew of *M. circumflexus* feeding on potato, the quantity of gamma-amino-butyric acid is estimated at 0·6 mgm. per gm. of dry matter. The significance of the occurrence of this compound in relation to plant resistance to insects is being studied.

It is probable that another spot appearing above methionine sulphoxide, not as yet identified on chromatograms of pea-plant extracts, may be beta-amino-isobutyric acid. The R_F of this compound corresponds to the spot above methionine sulphoxide (Fig. 2, No. 15). Further tests are being carried out on its identification.

We are grateful to Dr. F. C. Steward and Dr. J. F. Thompson, Department of Botany, Cornell University, for their generous supply of pure gamma-amino-butyric acid. Thanks are also extended to Dr. Lester J. Reed, Department of Chemistry, University of Texas, for a gift of pure synthetic beta-amino-isobutyric acid. [Feb. 14.

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PEPSINOGEN IN HUMAN SEMINAL FLUID

By Dr. FRANK LUNDQUIST and Dr. HANS HENRIK SEEDORFF

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EARLIER investigations have shown the presence in human semen of proteolytic enzymes responsible for the degradation of the fibrin-like material which causes the clotting of semen (Lundquist[1]). The presence of at least two different proteolytic enzymes, an amino peptidase hydrolysing leucinamide, glycylglycine, triglycine and glycyl-leucine, and a 'protease' has been established[2].

We have now been able to show that apart from these enzymes, with a pH optimum around 7·5, there is also present in seminal fluid an enzyme which has optimal activity at very acid reaction, namely, about 2·5. As it was considered unusual for a cathepsin to show activity at such high hydrogen-ion concentration, the possibility was investigated that the enzyme in question was pepsin, or some closely related proteolytic enzyme.

Figs. 1 and 2 show a comparison of the pH-activity curves for the seminal enzyme preparation and ordinary swine pepsin, using as substrates serum proteins (as described by Bucher[3]), and edestin (prepared from hemp seed according to Bailey[4]). The hydrolysis was followed colorimetrically with phenol reagent and copper sulphate[5]. The very close relationship with pepsin was confirmed by the fact that coagulation of milk was produced by enzyme preparations that had been acidified and neutralized again.

The enzyme preparations employed in these experiments were purified in the following way: pooled samples (50–70 ml.) of seminal plasma (we are indebted to "Sygekasselægernes organisations centrallaboratorium" for considerable quantities of human semen) are precipitated between 40 and 70 per cent saturation with ammonium sulphate at pH 6. The precipitate is dialysed thoroughly against distilled water for at least 24 hr. The residue, after centrifugation, contains practically all the pepsinase activity present in the original semen and no activity at neutral pH, whereas the supernatant contains the other proteolytic enzymes. Extracts of the precipitate with 0·9 per cent sodium chloride are used for further experiments. Extracts prepared in this way contain the enzyme as a proenzyme, which is converted to pepsin when the pH is lowered to 3–4. This was shown by the following experiments:

(*A*) ***Milk coagulation test.*** When the solution is mixed with skim milk at pH 5·4 (0·1 ml. enzyme + 1 ml. milk) no coagulation takes place. If the enzyme solution is acidified to pH 2 and carefully readjusted to pH 5·4 after a few minutes, coagulation takes place 2 min. after mixing with milk.

(*B*) ***Instability in alkaline solution.*** When the extract prepared as described above is kept at room temperature for 18 hr. at a pH of 8·5, no appreciable reduction in activity takes place. If, however, before

ENZYMATIC ACTIVITY OF HUMAN SEMINAL ENZYME, HUMAN GASTRIC JUICE PEPSIN AND CRYSTALLINE SWINE PEPSIN TOWARDS DIFFERENT SUBSTRATES

Substrate	Seminal enzyme (0·34 mgm. nitrogen/ml.)	Human gastric enzyme	Crystalline swine pepsin (0·0029 mgm. nitrogen/ml.)	Ratio : $\frac{\text{gastric enz.}}{\text{seminal enz.}}$
Serum protein (extinction)	0·206 average 0·208 0·209	0·212 average 0·217 0·222	0·215 average 0·218 0·221	1·04
Edestin (extinction)	0·174 0·178 0·181	0·185 0·184 0·183	0·195 0·198 0·201	1·035
Milk (1,000/clot. time)	8·02 7·71 7·85 7·62	8·32 8·29 8·25	8·40 8·45 8·50	1·055
Carbo-benzoxy-glutamyl-tyrosine (per cent hydrolysis)	60	62	60	1·03

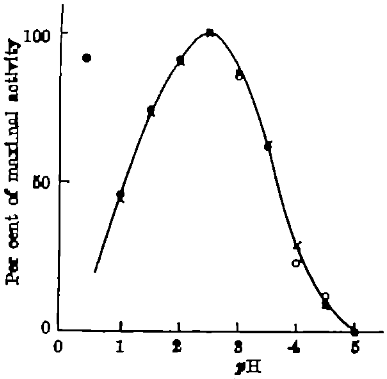

Fig. 1

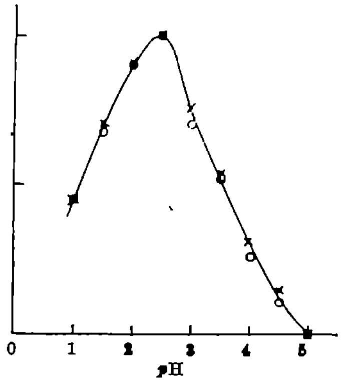

Fig. 2

Fig. 1. Activity of seminal enzyme (circles) and swine pepsin (crosses) as a function of pH. Substrate, 10 per cent dialysed dry serum; 2 ml. substrate + 0·5 ml. enzyme. Temperature, 37° C. Time, 60 min. Citrate buffer. Activity expressed as per cent of the maximal value

Fig. 2. Activity of seminal enzyme (circles) and swine pepsin (crosses) as a function of pH. Substrate, 2 per cent edestin in citrate; 2 ml. substrate + 0·5 ml. enzyme. Temperature, 37° C. Time, 60 min. Activity expressed as per cent of the maximal value

incubation the *p*H has been brought to 2·5 and back to 8·5, practically all activity has disappeared. This instability at faintly alkaline and even neutral reaction is a characteristic property of pepsin.

The accompanying table shows the results of experimental comparison of the activity towards various substrates of seminal pepsinase, crystalline swine pepsin and human pepsin made from gastric juice. The enzymes were diluted to approximately the same strength towards serum protein. For the serum protein, 2 ml. of a 10 per cent dialysed solution of dry serum at *p*H 2·5 was incubated with 1 ml. enzyme for 1 hr., followed by precipitation of proteins with trichloroacetic acid and phenol reagent and addition of copper sulphate and sodium carbonate to an aliquot of the filtrate. Edestin was used in the same way, but the concentration of protein was only 2 per cent; colour was developed in the same way as for serum proteins. For the milk test, 0·1 ml. of enzyme was added to 1 ml. of skim milk at *p*H 5·4, and the time was measured for the first sign of flocculation. In the test with carbobenzoxy-glutamyl-tyrosine, the substrate concentration was 0·0015 *M* and the *p*H 2·5; the samples were incubated at 37° C. for 18 hr. and deproteinized with tungstic acid; the hydrolysis in this case was measured by the ninhydrin method as described recently by Baker[6]. The close similarity in the rates of hydrolysis is best seen when the ratio between human gastric pepsin and seminal pepsin for the four substrates are compared (last column).

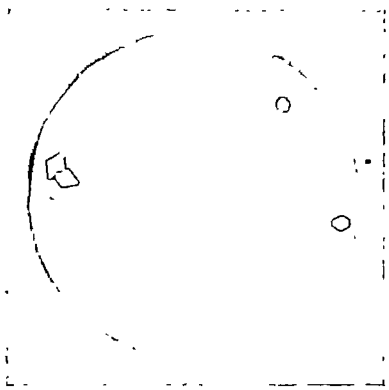

Fig. 3. Pepsin crystals obtained from human seminal plasma

The activity of pepsinogen in normal semen corresponds to 0·002 mgm. pepsin per ml., which is of the same order of magnitude as that found in gastric juice.

As pepsin was one of the first enzymes to be prepared in the crystalline state, we tried to crystallize the enzyme from human semen. The methods described by Northrop[7] were not applicable in our case, because they require very concentrated solutions; but the following procedure led to the crystallization of seminal pepsin. The saline extract (already described) was dialysed against distilled water for 36 hr. The precipitate was extracted with isotonic saline and centrifuged for 20 min. at 25,000 *g*. The supernatant was again dialysed, and the small amount of precipitate extracted with 0·05 *N* hydrochloric acid. The clear supernatant after centrifugation for 30 min. at 25,000 *g* was dialysed for 24–48 hr. at 5° C. against distilled water. By this procedure crystals were obtained. They have not been isolated free of amorphous material, and the quantities of crystalline enzyme are exceedingly small, so that we have not so far been able to make analyses and to tackle the question of the identity of pepsin from semen and gastric juice. The crystals are, however, indistinguishable both as regards appearance and size from those prepared from pure swine pepsin using the same procedure, and correspond well with the description given by Northrop (compare Fig. 3).

Concerning the site of formation of pepsinogen, our preliminary experiments indicate that it is formed in the vesicular glands. The function of pepsinogen in semen presents a very puzzling problem, the main difficulty being how activation takes place. It must be considered very improbable that the *p*H of semen at any time after ejaculation into the female genital tract can be exposed to *p*H values low enough to bring about activation. If, on the other hand, activation has taken place, one might imagine some process analogous to milk coagulation, which takes place at more physiological *p*H values.

One possibility has appealed to us, namely, that pepsinogen is adsorbed to the surface of the sperm cells, and that the acid metabolic products excreted by the cells might bring about a local high acidity, enabling the proenzyme to be converted into pepsin. Experiments with epididymal bull spermatozoa have shown, however, that less than one thousandth of the cell surface is covered with pepsinogen when a dense suspension of living cells is mixed with pepsinogen solution. Work on this problem will be continued on other animal species.

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LETTERS TO THE EDITORS

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Determination of Neutron Resonance Parameters from Measurements of the Absorption Integral : Application to the Main Resonance of Uranium-238

THE resonance absorption of neutrons has been extensively studied by the time-of-flight technique[1]. If the resolution is insufficient to resolve the true shape of the resonance curve, it is sometimes possible to determine the absorption cross-section σ_0 at exact resonance and the width Γ of the Breit–Wigner resonance formula from a study of the variations with absorber thickness of the absorption integral :

$$A(n) = \int (1 - T)\mathrm{d}E = \int (1 - \exp - n\sigma(E))\mathrm{d}E, \quad (1)$$

where $\sigma(E)$ is the cross-section of the absorbing nuclei and n the number of nuclei/cm.^{2}. Experimentally, the absorption integral is found as the area of the dip in the measured curve of transmission against neutron energy. This area is independent of the resolution.

If the resonance is sharp, that is, the width is small compared to the resonance energy, the asymptotic behaviour of $A(n)$ for large n has been shown to be

$$A_{as} = (\pi n\sigma_0\Gamma^2)^{1/2}. \quad (2)$$

In treating the results of absorption integral measurements, it is convenient to express them in the form :

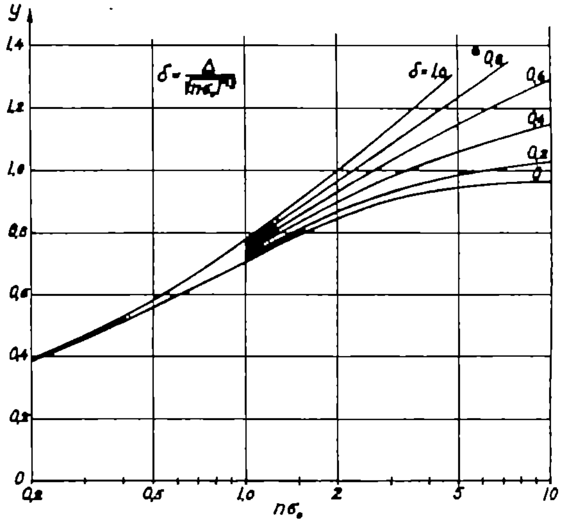
$$y = (A/A_\infty)\,(n_\infty/n)^{1/2}, \quad (3)$$

where A_∞ results from the measurement on an infinitely thick absorber. If the Breit–Wigner formula is assumed to hold and the resonance is sharp, we have for atoms at rest :

$$\begin{aligned} y_0 &= (4\pi n\sigma_0)^{-1/2}\int_{-\infty}^{+\infty} [1 - \{\exp - n\sigma_0/(1 + x^2)\}]\,\mathrm{d}x \\ &= (\pi n\sigma_0)^{-1/2}\int_0^z\int_{-\infty}^{+\infty} \{\exp - 2t/(1+x^2)\}\,(1+x^2)^{-1}\,\mathrm{d}x\mathrm{d}t \\ &= (\pi/2z)^{1/2}\int_0^z (\exp - t)\,I_0(t)\mathrm{d}t \\ &= (\pi z/2)^{1/2}\,(\exp - z)\,[I_0(z) + I_1(z)], \end{aligned} \quad (4)$$

where $z = n\sigma_0/2$.

The intermediate step leading to the introduction of a Bessel function $I_0(z)$ of imaginary argument makes use of the integral expression quoted by Bethe[2]. The final result is obtained by partial integration[3]. The function y_0 has previously been calculated by numerical integrations by Havens and Taylor[4]. If the width Γ of the resonance cannot be regarded as large compared with the Doppler width Δ, the Breit–Wigner cross-section curve has to be averaged over the velocity distribution of the scattering atoms.



We have :

$$y = (4\pi n\sigma_0)^{-1/2}\int_{-\infty}^{+\infty} [1 - \{\exp - n\sigma_0\psi(\Gamma/\Delta,x)\}]\mathrm{d}x, \quad (5)$$

where[2]

$$\psi(\Gamma/\Delta,x) = \pi^{-1/2}\,(\Gamma/2\Delta)\int_{-\infty}^{+\infty} [\exp - \{(\Gamma/2\Delta)(x-y)\}^2]\,(1+y^2)^{-1}\,\mathrm{d}y. \quad (6)$$

The integrations (5) and (6) can no longer be carried out analytically, but it is possible by series expansion of the integrands of (5) and (6), and subsequent integration term by term, to obtain y in the form of a power series of δ^2, where

$$\delta = \Delta/(n\sigma_0\Gamma^2)^{1/2}. \quad (7)$$

This power expansion will converge only as long as $\Delta/\Gamma < 1$. For larger values of Δ/Γ the integrations (5) and (6) have been performed numerically. In the accompanying graph, y is plotted as a function of $n\sigma_0$ with δ as a parameter.

For very thick samples ($n\sigma_0 \gg 1$) the expansion

$$y_{as} = 1 - \frac{1}{4}(2z)^{-1} - \frac{3}{32}(2z)^{-2}\ldots + \frac{3}{2}\delta^2\left(1 - \frac{5}{4}(2z)^{-1}\ldots\right) - 45/8\,\delta^4\ldots \quad (8)$$

is obtained.

To determine the resonance parameters from measurements of the resonance integral for a thin and a thick sample, the thick sample is first assumed to be infinitely thick and δ and y for the thin sample calculated. The graph then gives a first approximation to σ_0. From this the function y for the thick sample is calculated using (8) and is applied as a correction factor to δ and y for the thin sample, yielding a second approximation for σ_0.

For optimum accuracy the thickness of the thin sample should be chosen roughly in the region of

Sample (gm./cm.^{2})	n (cm.$^{-2}\times10^{24}$)	A (eV.)	y	δ	$n\sigma_0$	σ_0 (cm.$^2\times10^{-24}$)
5·46	0 0115	0 670 ± 0 050	1 00	0·14	(53)	
3·45	0 00727	0 560 ± 0 040	1 05	0·17	(34)	
0 67	0 00144	0·265 ± 0·030	1·12	0·39	> 3 3	> 2,000
0·27	0·00051	0·170 ± 0·025	1 14	0 62	2·3 – 10 5	4,000–18,000
0·092	0·000194	0 065 ± 0·010	0 75	1·06	0·60–1·30	3,100–6,700

maximum slope of the graph, if it is assumed that the absorption integral measurements have the same absolute accuracy. For atoms at rest this corresponds to a value of $n\sigma_0$ of about 1·0, while the Doppler effect tends to increase the optimum thickness. If the thin sample is made very thin, the result becomes independent of the Doppler effect, but the accuracy is low.

The procedure has been applied to measurements on the main resonance of uranium described elsewhere[5]. The samples were uranium oxide of thicknesses listed in column 1 of the table. Uranium oxide has a Debye temperature of about 140° K.[6], and the effective temperature[7] of the sample is thus almost equal to the room temperature, the Doppler width Δ being 0·052 eV., assuming a resonance energy of 6·6 eV.[4,8]. The value of σ_0 has been given in the last column as an upper and lower limit resulting from estimated mean square errors of the absorption integral measurements. While the accuracy of the measurements is rather low, it is seen that the results are quite consistent.

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Angular Distribution of the Neutrons from the Reaction $^7Li(d,n)^8Be$

Using 680-kV. deuterons from the Van de Graaff generator at the University of Bergen, we have measured the energy spectrum and the angular distribution of the neutrons from the reaction ^{7}Li(d,n)^{8}Be. The energy spectrum of the neutrons has been found by measuring the recoil protons in photographic emulsions for the following angles ω, between the d and n directions in the laboratory system: 0°, 20°, 50°, 90°, 110°, 120° and 140°. A total of about 10,000 proton tracks, forming a maximum angle of 10° with the incident neutrons, have been investigated.

The energy spectrum for ω = 140° is given in Fig. 1. Neutron groups are found corresponding to energy-levels in beryllium-8 at 2·9, 4·1 and 5·0 MeV. These results are in good accordance with previous measurements by Green and Gibson[1].

The energy spectra for the smallest three ω-values also indicate the existence of an energy-level at 2·2 MeV. The relative intensities of the neutron groups change with the angle ω.

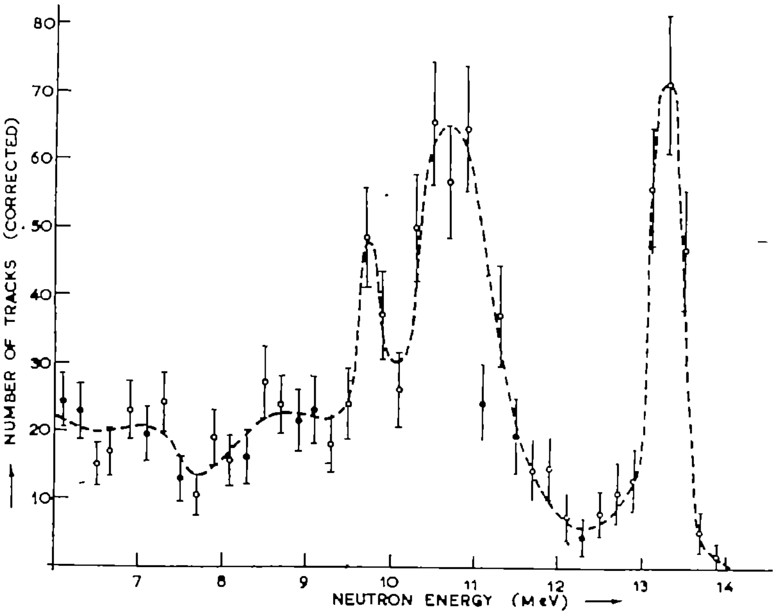

Fig. 1. 140° neutron spectrum

The angular distribution in the centre-of-mass system of the neutrons corresponding to the ground-state and the 2·9-MeV. excited state of beryllium-8 is given in Tables 1 and 2 and Figs. 2 and 3 respectively, the values in both cases being normalized to 1·00 for ω = 0°.

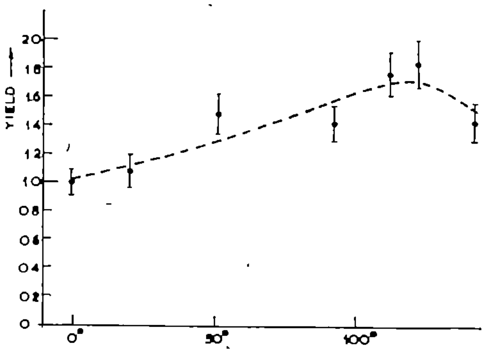

Fig. 2. Angular distribution in the centre-of-mass system of the reaction ^{7}Li(d,n)^{8}Be

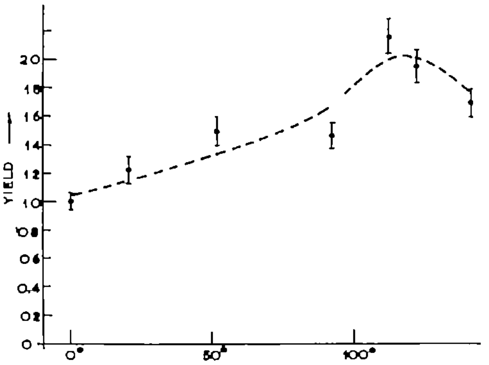

Fig. 3. Angular distribution in the centre-of-mass system of the reaction ^{7}Li(d,n)^{8}Be*

Table 1

Ground state

0°	1·00 ± 0·09
20·7°	1·08 ± 0·12
51·5°	1·48 ± 0·14
92·0°	1·42 ± 0·12
111·9°	1·76 ± 0·15
121·7°	1·83 ± 0·14
141·3°	1·43 ± 0·13

Table 2

2·9-MeV. excited state

0°	1·00 ± 0·06
20·7°	1·22 ± 0·09
51·5°	1·49 ± 0·10
92·0°	1·47 ± 0·09
111·9°	2·16 ± 0·12
121·7°	1·96 ± 0·11
141·3°	1·70 ± 0·10

No theory for the angular distribution of the neutrons from (*d*,*n*)-reactions has so far been worked out for low deuteron energies. The Butler theory[2] of a stripping process, originally worked out for deuteron energies between 7 and 15 MeV., has since been extrapolated to lower energies[3].

On the basis of this theory and the angular distribution curves in Figs. 2 and 3, we may conclude that both the stripping process and the compound nucleus formation are operative at the *d*-energy used in our experiment[4].

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Growth Spirals originating from Screw Dislocations on Electrolytically Produced Titanium Crystals

ACCORDING to the theory of Burton, Cabrera and Frank[1], crystals can only grow at supersaturations too low for two-dimensional nucleation, when dislocations are present. Where a screw dislocation terminates in a crystal face, an exposed edge is formed which, while growing, will persist and develop as a 'growth spiral' centred on the dislocation. This theory has been applied to the electrolytic production of titanium crystals.

In the course of work on the production of titanium by electrolysis of fused salt, we have obtained a number of large titanium flakes which are single crystals as revealed by X-ray examination. These hexagonal flakes have, in the main, flat (0001) basal plane surfaces. On further examination using a metallographic microscope and employing the techniques described by Griffin[2], growth spirals originating from screw dislocations have been observed on these surfaces. This is the third reported instance where direct visual evidence of screw dislocations has been obtained on metal crystals and is the first case of screw dislocations being responsible for crystal growth in electrolysis.

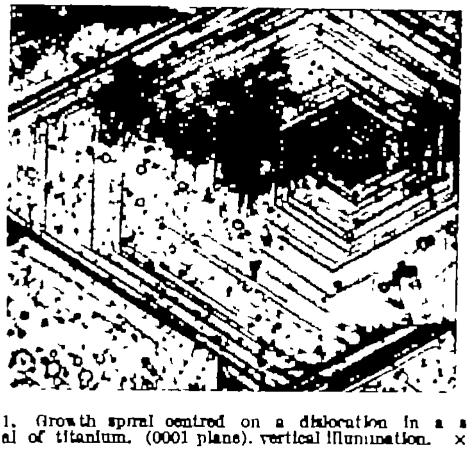

Fig. 1. Growth spiral centred on a dislocation in a single crystal of titanium. (0001 plane). vertical illumination. × 200

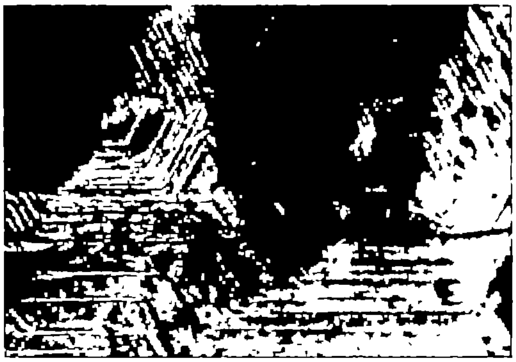

Fig. 2. Growth spirals of the opposite hand joining to form closed loops. 'In focus' technique (ref. 1). × 200. (Note mechanical twin through growth layers)

The first visual proof for the presence of dislocations in metals was obtained by Amelinckx *et al.*[3], when growth spirals originating from screw dislocations were observed on the (111) faces of gold crystals obtained by precipitation. Triangular and hexagonal growth spirals were observed and step-heights of the order of 400 ± 100 A. were measured.

More recently, Forty[4] has observed spiral growths originating from screw dislocations on the (0001) surfaces of magnesium crystals obtained in the form of thin hexagonal flakes by sublimation. The growth layers were estimated to be either one or two atoms in thickness. (The step-heights were less than 20 A.)

Growth spirals centring on multiple dislocations have been observed on our titanium single crystals (Fig. 1). The average step-height, measured by multiple-beam interference fringes of the Fizeau type, obtained with parallel, monochromatic light at normal incidence, was 240 ± 100 A. Some difficulty was experienced in making the measurements due to surface irregularities, and a technique similar to the one recently described by Tolansky and Omar[5] was used.

It is evident that most of these spirals cannot be due to dislocations of unit strength (1/2 $d_{(0001)}$ = 2·37 A.) but are generated by groups of dislocations all having the same sign and having a resultant Burgers vector with a component normal to (0001) of approximately 100 A. However, in some cases, no deviation of the fringe system could be seen, showing that the steps are less than 100 A.

Besides multiple spirals originating at the same dislocation centres, spirals of opposite sign, interacting so as to form closed loops, have been observed, in accordance with theory (Fig. 2).

In all cases, after the first few turns of these growth spirals, they became hexagonal in form, following the hexagonal outline of the crystal and denoting the strong influence of the crystal orientation on the radial growth velocity of the titanium crystals.

One other observation that should be mentioned is the following. Some crystals have been obtained which are series of built-up hexagons of which the edges (10$\bar{1}$0) show growth lamellæ of the type observed on zinc and cadmium deposited from vapour by Straumanis[6]. These layers are about 3000 A. in thickness on our electrolytically produced titanium and are not to be confused with the growth spirals observed in the centres of the (0001) faces of these crystals. When these layers are complete over the length of the crystal edge, the hexagonal type of growth spirals is obtained as shown in Figs. 1 and 2.

A complete description of the observations and techniques used will be reported elsewhere.

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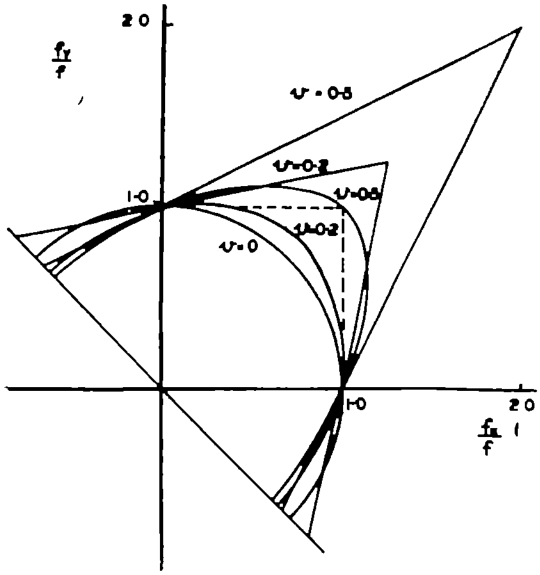
Mechanism of Fracture of Concrete

H. J. COWAN's[1] hypotheses for the fracture of concrete are very similar to those already proposed by Prof. M. Roš[2]. Such hypotheses usually rely mainly on the observations of failing loads of specimens for their justification, and proceed from the assumption that concrete may be regarded as a homogeneous isotropic material. In the Division of Building Research of the Commonwealth Scientific and Industrial Research Organization, an extensive experimental study has been made of the strain distribution in various types of concrete specimen, using one concrete mix throughout. The results suggest that in all specimens the first failures occur when the tensile strain is about 10^{-4}. In compression tests of cylinders, this strain occurs when the load is about fifty per cent of the ultimate, and in unreinforced flexural specimens at about ninety per cent of the ultimate. The measurements made here also show how widely the concrete strains may vary in a region in which they are theoretically uniform.

These results concerning maximum tensile strain and the development of tensile cracks in specimens before the maximum load is reached are confirmed by other workers[3-5]. Our tests suggest that a noticeable decrease in the gradient of the compressive stress–strain curve coincides with the formation of tensile cracks on the circumference of a cylindrical compression specimen. I believe that the so-called shear failure is a secondary development which occurs after the vertical splitting has begun. It may be of interest to note that Wästlund[6] claims to have shown that the plane of so-called shear failure in compression specimens is actually a plane perpendicular to the maximum tensile stresses.

In the accompanying graph the ratio of the stress at fracture to the uniaxial tensile strength is plotted for various hypotheses of failure for a range of stresses from $f_x = -f_y$ to $f_y = -f_x$. The hypotheses chosen are maximum normal stress (straight broken lines), maximum normal strain (straight full lines) and maximum total strain energy per unit volume (curved full lines). It is desired to show the extent to which the limit provided by each hypothesis may vary according to the value assumed for Poisson's ratio. In this graph the extremes for $\nu = 0$ and $\nu = 0 \cdot 5$ are shown (the maximum strain theory with $\nu = 0$ coincides with the maximum stress theory). These are undoubtedly extremes, but such values have been proposed for concrete under certain conditions[4,7].



Since Poisson's ratio itself may vary widely for one mix, and in the range of values most commonly accepted ($0 \cdot 1 < \nu < 0 \cdot 25$) the limiting curves for all hypotheses lie close together, the difficulty of choosing any one hypothesis, principally on an observation of the loads and hence the stresses, during the test becomes obvious. A complete set of strain measurements for the effective part of the test specimen is also essential.

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Enhancement of Auroral Hydrogen Lines towards Lower Latitudes

MANY years ago, I suggested that the bundles of solar electric rays which produce the auroræ and most magnetic disturbances are composed of electrons electrostatically neutralized by positive ions of great specific charge, mainly protons[1-4].

On this view the current density (i) of a bundle composed of electrons and protons is given by

$$i = ne\,(V_e - V_p), \qquad (1)$$

where n is the number of electrons or protons in unit volume, and V_e and V_p are the velocities of the electrons and protons respectively.

The number of electrons ν_e and protons ν_p entering unit cross-section perpendicular to the direction of the current in unit time is $\nu_e = nV_e$, and $\nu_p = nV_p$. Thus the velocity of the protons (V_p) relative to that of the electrons (V_e) essentially determines the relative intensity of the hydrogen lines in the auroral luminescence.

A bundle constituted in this way, being magnetically active, produces the magnetic fields responsible for the magnetic perturbations, and at the same time it is deviated in the earth's magnetic field.

In a magnetic field of intensity F, each unit volume is acted on by a force K given by the equation :

$$K = F.en\,(V_e - V_p)\sin\varphi, \qquad (2)$$

where φ is the angle between F and the direction of the current density in the point, and K is perpendicular to the vectors F and i.

The correctness of this view regarding the constitution of the solar ray bundles was proved when, in the years 1939–41, it was found that hydrogen lines occasionally appeared with considerable intensity in the auroral luminescence, and that they showed a pronounced Doppler displacement corresponding to velocities of the order of 10^8 cm./sec. [5-8].

Thus the proton velocities may vary from very small values corresponding to extremely small intensities of the hydrogen lines to values at least up to 2,000–3,000 km./sec., while the electrons have velocities of the order of 10^{10} cm./sec., and are thus mainly responsible for the magnetic activity of the bundle.

On account of their much greater mass, the protons may have a dominating influence on the magnetic deviability of the bundle. It is easily shown that for proton velocities greater than about 10^7 cm./sec., the radius of curvature of the protons will be greater than that of the electrons, provided electrons and protons could move independently of each other.

Thus the increase of proton velocities, which means greater intensity of the hydrogen lines, will increase the magnetic stiffness of the bundle, with the result that the auroræ are driven away from the magnetic axis point and towards lower latitudes. Consequently, we should expect that the relative intensity of the auroral hydrogen lines, for a certain magnetic meridian, would increase with magnetic polar distance or towards lower latitudes.

Since the auroral hydrogen lines and their Doppler displacement were detected about twelve years ago, a considerable number of strongly exposed auroral spectrograms have been obtained both at Tromsoe and Oslo. The intensities of the H_β-lines were found relative to the negative nitrogen band 4709 and expressed by the ratio $I_{(H\beta)}/I_{(4709)}$ [10].

At Oslo we obtained twelve, and at Tromsoe eleven, spectrograms showing a quite strong band at 4709.

The mean values of the ratio $I_{(H\beta)}/I_{(4709)}$ derived from these spectrograms were: Oslo, 1·01; and Tromsoe, 0·15.

Thus the observational results, so far as they go, show a considerable increase of the relative intensity of the auroral hydrogen lines towards lower latitudes, in agreement with the consequences drawn from the proposed constitution of the solar ray bundles.

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A Microwave Vibration Wattmeter

IT has been shown[1] that mechanical forces exerted by an electromagnetic field can be employed to make absolute measurements of microwave power at levels of a few watts or more. Experiments carried out in this department by Mr. I. M. Stephenson have shown that the same method can be used to measure a few tens of milliwatts of power at a wave-length of 3·2 cm. by making use of a vibration-free table and amplifying the resulting small deflexion by means of a photo-cell and galvanometer.

However, the apparatus is rather inconvenient in use, and it is the purpose of this communication to describe a new principle which greatly increases the sensitivity. Mechanical resonance is used to increase the deflexion obtainable, but at the same time electrical resonance is employed in an unusual way. The power to be measured passes along a wave-guide terminated by a high-Q cavity. A short horizontal dipole is suspended by its mid-point by a quartz fibre inside the cavity, and tends to align itself parallel with the unperturbed electric field. When the dipole makes an angle of 45° with this direction, the cavity is resonant at the frequency at which power is to be measured, and is matched to the input wave-guide. It is arranged that a very small change in this angle detunes the cavity completely.

Consider the dipole at rest in the 45° position. Suppose microwave power is admitted to the cavity by means of a wave-guide switch. The dipole will experience a torque, tending to turn it clockwise, say. A very small clockwise rotation will suffice to reduce the torque to a negligible amount, but the dipole has then acquired some angular momentum, and it will continue its clockwise swing to an angular position $45° + \theta_1$ determined by the restoring force of the fibre and frictional forces. When this limit is reached, the oscillator is switched off, and the dipole swings anticlockwise to an angle which, if the frictional forces are small, is almost equal to $45° - \theta_1$. If the oscillator is switched on again, the dipole again experiences a torque as it passes through 45°. This time it swings to a new limiting position $45° + \theta_2$, θ_2 being greater than θ_1, and the cycle of events is repeated until a constant amplitude of mechanical oscillation is reached, from $45° + \theta_0$ to approximately $45° - \theta_0$. It can be shown that the angle θ_0 is given by:

$$\theta_0^2 \doteqdot \frac{P}{2f} \cdot \frac{M}{c} .$$

In this formula P is the power delivered to the cavity at resonance, f is the frequency, c is the specific couple of the quartz fibre, and M is the 'mechanical magnification' defined as the ratio of the initial amplitude to the decrease in amplitude per period for natural oscillations.

The remarkable feature of this result is that it is independent of the Q-factor of the cavity and of the characteristics of the dipole. This is because the increase in torque at resonance which arises from an increase in Q-factor or length of dipole is exactly compensated by the reduction in the time during which the cavity stays in tune, so that the *impulse* received is unchanged. Because of this independence, the method is particularly attractive at millimetre wave-lengths, when accurate measurements of Q-factor, etc., are not very readily accomplished.

Another feature of importance is that θ_0 is proportional to $\sqrt{(P/f)}$, whereas in the instrument described previously[1] the deflexion is proportional to P/f. It follows that the new method has the advantage that the deflexion falls off less rapidly with decreasing power and increasing frequency. However, the formula quoted above is only valid when the angular rotation of the dipole required to detune the cavity to $1/\sqrt{2}$ of the amplitude at resonance is small in comparison with θ_0. If this condition is not met, a correction including the Q-factor must be introduced.

Preliminary experiments at a wave-length of 3·2 cm. show that an adequate deflexion (~ 30 cm. at 1 metre) can be obtained easily with a power of 100 mW. or less.

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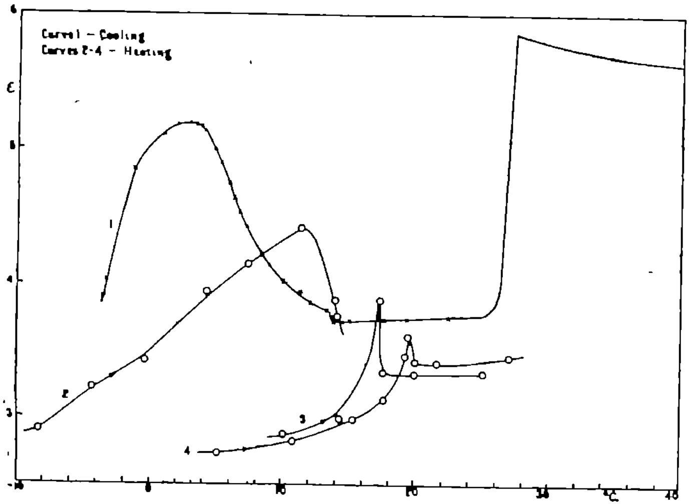
Dielectric Observations of Nucleation

Certain long-chain ketones of equal chain-lengths but different position of the keto group have such similar properties as to be reminiscent of isotopes and are yet nearly mutually immiscible in the solid state. Mixtures of equal amounts of a sufficient number of such 'equivalent' ketones are, however, stable either as a single-phase solid solution or as a multiphase mixture of the constituents[1]. Mixtures of this kind are exceptionally suitable for a study of precipitation, since all constituents are precipitated simultaneously. Recent measurements of dielectric properties carried out during the precipitation of such a mixture yield information on early stages of nucleation and on the dielectric properties of small aggregates.



Dielectric constant of a mixture of five ketones in the course of precipitation

The mixture investigated consisted of equal amounts of five equivalent ketones of the formula $C_mH_{2m+1}.CO.C_{17-m}H_{35-2m}$, with m equal to 3, 4, 5, 6 and 7. The multiphase form of the mixture is stable up to the melting point at 27·5° C., but the metastable single-phase form, which shows a polymorphic transition at 13·5–15·5° C., can be preserved indefinitely above the temperature of this transition. On cooling below this temperature, complicated phenomena occur in the mixture which find expression in its dielectric properties.

The accompanying graph shows the dielectric constant of the mixture at 800 c./s., during different heat-treatments. Curve 1 was obtained during cooling of the specimen, while curves 2, 3 and 4 were obtained on heating after the specimen had been annealed for varying times at temperatures below 4° C. The longer the time of annealing, the smaller is the peak observed and the higher the temperature at which it occurs. Specimens annealed for some weeks retain their low dielectric constant up to the melting point, and their structure, as indicated by X-ray powder photographs, is that of the multiphase form.

The experimental evidence may be interpreted as follows. On cooling below the temperature of the polymorphic transition the mixture becomes capable of precipitation, and aggregates are formed which have comparatively high dielectric constants while they are small and/or imperfect. These aggregates are thermodynamically unstable, and on annealing at low temperatures they change gradually into more stable aggregates of lower permittivity. On reheating, the aggregates are dissolved, at a temperature which is the higher the more stable they have grown, and during their dissolution they pass again through the condition connected with high dielectric constants.

The evidence indicates a sequence of intermediate stages of precipitation, depending in a complicated way on time and temperature. In this respect the mixed ketones are analogous to age-hardening alloys[2], and their study might be of interest to metallurgists. Compared with alloys, the ketones offer two advantages for the investigation of precipitation: precipitating aggregates form the bulk of the material and are not dispersed in a matrix, and their properties can be studied by very sensitive dielectric methods.

The comparatively high permittivity of the precipitating aggregates is of interest from the point of view of dielectrics: even though the permittivity of the solid mixture remains below that of the liquid, the evidence indicates a possibility of obtaining high dielectric constants with some kinds of small or imperfect aggregates. The relaxation times of dipoles in such aggregates are also of interest. From the points of view of the theories either of phase changes in solids or of dielectrics, it would obviously be interesting to correlate the physical properties of the precipitating aggregates with their structure. Work on this is in progress.

We wish to thank Mr. C. G. Garton for many helpful discussions and the Director of the Electrical Research Association for permission to publish this communication.

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A Superstructure in Spinels

IN 1935, E. Kordes[1] recognized that $LiAl_5O_8$ has nearly a spinel structure, but he observed a large number of extra lines, which he could not explain. A. Hoffman[2] prepared the corresponding compound $LiFe_5O_8$, which again was recognized as having nearly spinel structure. We found[3] that the powder diagrams of $LiFe_5O_8$ correspond with a primitive cubic lattice with a lattice constant of 8·33 A. The space group was found to be very probably $P4_33$ (or $P4_13$) and the positions of the atoms (in the notation of the International Tables, 1935) are:

$P4_33$ 4 Li at 4 (b)
12 Fe „ 12 (d) with $x = $ [illegible] $+ \Delta_1$
8 Fe „ 8 (c) „ $x = 0 + \Delta_2$
24 O „ 24 (e) „ $x = $ [illegible] $+ \Delta_3$, $y = $ [illegible] $- \Delta_4$, $z = $ [illegible] $+ \Delta_5$
8 O „ 8 (c) „ $x = $ [illegible] $+ \Delta_6$

with Δ_3, Δ_4, Δ_5 and Δ_6 approximately 0·007 and Δ_1 and Δ_2 still smaller.

For all Δ's equal to 0, this would mean an ideal spinel lattice with an ordered arrangement of lithium and iron ions in the ratio 1 : 3 over the octahedral sites. The type of the order is best described by considering only the sixteen octahedral interstices. These are occupied by four lithium and twelve iron ions in such a way that each lithium ion is surrounded by six iron ions in an octahedron elongated along a trigonal axis and each iron ion by four iron and two lithium ions.

Single crystals of $LiFe_5O_8$ have been grown and investigated and the above deductions are fully confirmed.

Below 735° C. the four lithium ions are distributed in this ordered way over the sixteen octahedral interstices. The long-range order decreases only very slowly up to this temperature. Above 755° C. the long-range order has completely disappeared and the four lithium ions are distributed over the sixteen octahedral interstices only. Up to at least 1,000° C. they do not enter to an appreciable extent into the tetrahedral interstices.

Between 735° and 755° there exists a transition region where the equilibrium long-range order vanishes within a temperature-range of a few degrees. The transition velocity above 755° C. and below 735° C. (down to 450° C.) is very high (transition within a few seconds to a minute). Between 735° and 755° there exists a region where the transition to the equilibrium is extremely slow. By rapid quenching from 950° C. we obtained the disordered phase at room temperature.

$LiAl_5O_8$ shows the same type of superstructure, but the order–disorder transition takes place at much higher temperature. We obtained the disordered phase by quenching from 1,350° C.

Some specimens of γFe_2O_3, prepared by E. W. Gorter of this laboratory, gave very nearly the same diagrams as $LiFe_5O_8$. They proved to contain some water molecules. In these γFe_2O_3 specimens the type of ordered structure described for $LiFe_5O_8$ is present, which in the ideal case would require a ratio of 1 : 3 for the ordering elements. In the description of γFe_2O_3 as a spinel with vacancies[4], $Fe_8(Fe_{13\,^1/_3}\Delta_{2\,^2/_3})O_{32}$, the ratio of vacancies to iron ions at the octahedral interstices would be at most 1 : 5. The ratio ideal for ordering would be reached by incorporating water molecules, approaching the formula HFe_5O_8 as a limiting formula.

Recently, Houben[5] has shown by absorption measurements that the compound HAl_5O_8 also exists under certain conditions. As shown by Ervin[6], the transition from boehmite to αAl_2O_3 and goethite to αFe_2O_3 through the γ oxides can be regarded as a gradual rearrangement of the aluminium and iron ions in the cubic close-packed oxygen framework. Since the products of the first transition steps are only nearly anhydrous, the very mobile protons might be expected to play an important part in these transformations. In special cases such as the γFe_2O_3 preparations mentioned, they can even give rise to a highly ordered superstructure in the γFe_2O_3 phase, thus showing that they are not merely present as absorbed water.

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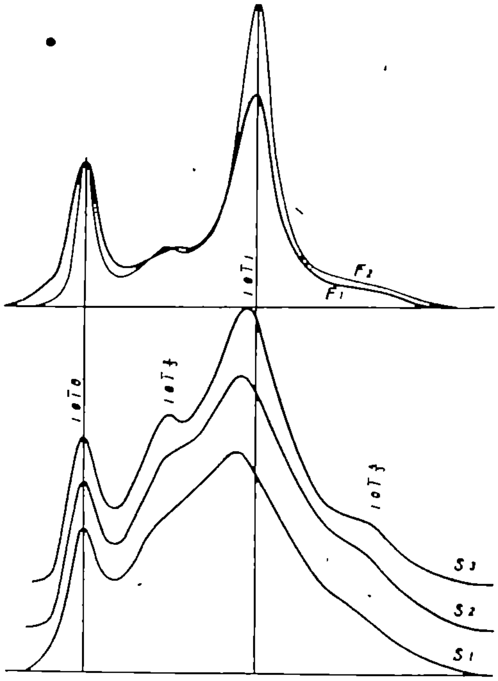
Crystal Distortion of Graphite in Cast Irons

RECENTLY, Debye–Scherrer line-breadths, the parameters of unit cells and the proportions of α- and β-modification of graphite present in cast irons, have been published by W. S. Owen and B. G. Street[1]. In connexion with this and other work, I have investigated the variation of disordered structure within a graphite grain by removing, step by step, outer layers of the grains by an oxidizing agent, since the variation seems to exist if we consider the crystal growth of irons.

The graphite samples used were a coarse flake graphite in a commercial grey cast iron, and a temper graphite in a commercial black-heart malleable cast iron of pipe fittings. The graphites were extracted from the cast irons by dissolving with hot dilute hydrochloric acid and washing with hydrofluoric acid. Then the outer layer of the grains was dissolved by wet oxidization. Many examples are known[2] of penetration of foreign atoms between the layer planes of the graphite crystal by the action of liquid agents; this results in the increase of the lattice parameter normal to the layer planes. In the present treatment it is necessary that the oxidizing agent should attack gently and uniformly over the grain surface without destroying inner structure. For this purpose, the samples were boiled in an 8 per cent solution of potassium dichromate mixed with sulphuric acid (sp. gr., 1·29) in a flask fitted with a reflux condenser. The grain size of the powder gradually decreased as the boiling continued; after 12 hr. in the case of the flake graphite, most of the grains became hexagonal in shape or fragments of hexagons, although the initial shape was irregular and only in rare cases were hexagonal figures observed on the grain surface.

The Debye–Scherrer patterns of these specimens were obtained by using copper $K\alpha$ rays and a camera



of 20-cm. radius. The intensity distribution curves of a portion of interest in the diffraction patterns are shown in the accompanying diagram, in which the curves have been reduced to the intensity scale from the microphotometer curves by using step-sector marks, the $10\bar{1}0$ line being made of constant height. The peaks of this line are arranged so as to lie on a vertical line. Curve $F1$ (thick line) was obtained with the flake graphite before the dichromate treatment, and curve $F2$ (thin line) with the same specimen oxidized for 12 hr. (weight loss 75·6 per cent). As will be seen from the latter curve, the lines are markedly sharper and the $10\bar{1}1$ line is enhanced. Curves $S1$, $S2$ and $S3$ were obtained with the temper graphite specimens oxidized for 0 hr., 2 hr. (weight loss 32·2 per cent) and 12 hr. (weight loss 74·6 per cent) respectively. It will be seen that the breadth of the lines corresponding to the α- and β-modifications of graphite decrease successively, and the peaks of the $10\bar{1}1$ line shift towards the position for the perfect crystal as the grain-sizes decrease. In addition, the increase in intensity of the $10\bar{1}\frac{1}{3}$ and $10\bar{1}\frac{2}{3}$ lines of β-graphite is noticeable. However, further sharpening of the lines was not observed after the reduction of the grain size by further oxidization up to 24 hr. (weight loss 98·2 per cent).

From these results, it can be concluded that the crystal structure is more perfect in the region of the core of the grains where the crystals were first formed. In order to examine the effect of crystal distortion which might be produced when preparing the specimen rod, a slit specimen holder with a slit width of 0·1 mm. was employed in place of the specimen rod, the powdered specimens being placed in front of the slit. X-Rays diffracted by the powder reach the photographic film after passing through the narrow slit, and hence very sharp lines are produced. With this device, a sharp 0002-line of the flake graphite was obtained, while the line broadened due to the orientation of the crystals when an extruded specimen was used. It has been confirmed that the general features of the diffraction patterns are similar to those shown in the present diagram; however, the appearance of spots on some lines of the flake graphite, due to the coarse grain, made the film inadequate for microphotometry.

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Work-hardening of Annealed Mild Steel under Static and Dynamic Conditions

IT was found by Meyer[1] that when a hard ball is pressed into the surface of a metal by a force F, thus forming an impression of diameter d, the relation

$$F = kd^n \qquad (1)$$

holds, where k is a constant depending upon the metal and ball diameter and n, the Meyer index, is a constant depending only upon the metal. The Meyer index is 2·0 for metals which do not work-harden, for example, materials already fully worked, whereas for materials which do work-harden n is greater than 2·0, the greatest value being about 2·5. It has so far only been possible to examine equation (1) under conditions of static loading, but recently a method has been described for the continuous measurement of force throughout impact[2], and this has been adapted for the measurement of the index n under dynamic conditions. The force used for this purpose is the maximum force of impact, and the diameter is the diameter of the impression left after impact.

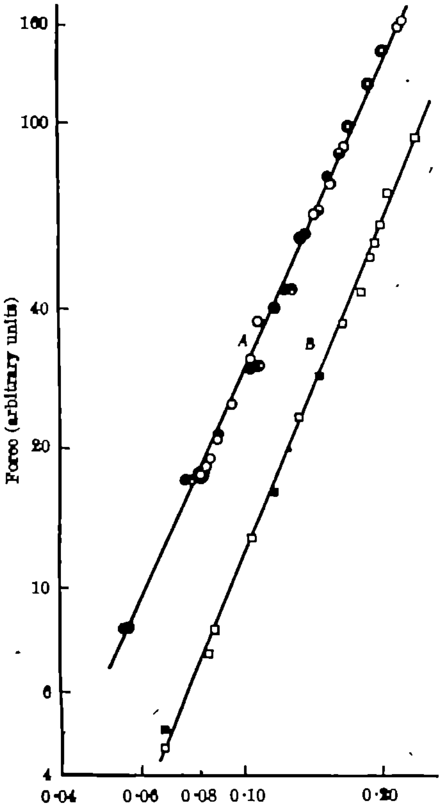
Static and dynamic measurements have been made with ⅛-in. (0·32-cm.) diameter ball-bearing indenters upon the same specimen of annealed mild steel. The diameters of both sets of impressions covered the same range, the smallest diameter being greater than 0·1 of the ball diameter, ensuring that all the measurements are in the fully plastic regime. In dynamic tests the maximum force was reached in about 300 μsec., and in static tests the maximum force was maintained for one minute.

The accompanying graph shows log–log plots of the forces as functions of the diameters of the impressions. In each case the points fall near straight lines, the slopes being the indices. The dynamic slope (2·20 ± 0·04) is less than the static slope (2·39 ± 0·05). The t test shows that the probability of this (0·19) or a greater apparent difference arising by chance is less than 0·1 per cent; the result is highly significant. The interpretation offered is that a lesser degree of work-hardening occurs under dynamic conditions than in static tests.

It is particularly important to check this interpretation, as workers with some materials have recently questioned the value of the Meyer index as a guide to work-hardening[3]. It might be expected from equation (1) that the ratio of the Vickers hardnesses (H_2/H_1) of the materials at the centres of static impressions of diameters d_2 and d_1 should be given approximately by

$$\log (H_2/H_1) = (n - 2) \log (d_2/d_1). \qquad (2)$$

This has been tested; an experimental value of the ratio was 1·43, and the calculated value 1·59. This confirms that in static tests with annealed mild steel,



The forces as functions of the diameters of impressions made in (*A*) impacts, (*B*) static tests. (The relative position of (*A*) to (*B*) is arbitrary in the vertical direction)

the work-hardening predicted by equation (1) does, in fact, occur. A further check has been made. The static and dynamic indices of the same specimens were measured after the specimens had been cold-worked by compressing them to half their original thickness. It is to be expected with fully worked material that both static and dynamic indices should be 2·0 ; the values found were 2·08 ± 0·04 for the static index and 2·09 ± 0·03 for the dynamic index. This observed equality of the indices also shows that the earlier observed difference was not simply due to instrumental effects.

It therefore appears that in impact the deformed material is not work-hardened to the same extent as in a static test. This difference might be permanent or temporary. If permanent, the difference between the indices leads to the expectation that, for impressions of diameter 0·22 cm., the Vickers hardness at the centres of those formed in impact should be about 20 per cent less than the corresponding hardness of static impressions. Forty impressions of 0·22 cm. diameter were formed statically in the annealed material and forty dynamically. The mean hardness at the centres of static impressions was 164 ± 2 kgm. mm.$^{-2}$, and at the centres of dynamic impressions, 166 ± 2 kgm. mm.$^{-2}$. (The mean hardness of the undeformed material from forty tests was 95 ± 1 kgm. mm.$^{-2}$.) Therefore, it is concluded that the lesser degree of work-hardening which occurs in impact is temporary, the mild steel changing after the impact to the same state as exists after a static test. Other materials are being examined and already similar effects have been found.

I gratefully acknowledge the help of Mr. B. Jones, who has made many of the measurements.

(All the limits quoted above are ± twice the appropriate standard errors.)

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Angular Momentum in Dirac's New Electrodynamics

TYABJI[1] recently determined the canonical and symmetrical energy momentum tensors of Dirac's[2] new theory of electrodynamics. Tyabji used the conventional definition of the canonical energy momentum tensor and symmetrized this tensor in the traditional manner[3-5]. The canonical tensor

$$T_{\rho\sigma} = \frac{\partial(kv_\lambda)}{\partial x_\sigma} F_{\rho\lambda} + \frac{\partial\xi}{\partial x_\sigma} F_{\rho\mu} \frac{\partial\eta}{\partial x_\mu} + \frac{\partial\eta}{\partial x_\sigma} F_{\mu\rho} \frac{\partial\xi}{\partial x_\mu} + \delta_{\rho\sigma} L \tag{1}$$

given by Tyabji can be written without the explicit appearance of the ξ and η variables, as follows :

$$T_{\rho\sigma} = F_{\rho\mu} F_{\sigma\mu} + F_{\rho\mu} \frac{\partial k v_\sigma}{\partial x_\mu} + \delta_{\rho\sigma} L ; \tag{2}$$

or

$$T_{\rho\sigma} = F_{\rho\mu} F_{\sigma\mu} - \lambda v_\sigma v_\rho + \delta_{\rho\sigma} L + \frac{\partial}{\partial x_\mu} (k v_\sigma F_{\rho\mu}). \tag{3}$$

The symmetrizing tensor[1], $T'_{\rho\sigma} = \frac{\partial G_{\mu\rho\sigma}}{\partial x_\mu}$, is

$$T'_{\rho\sigma} = - \frac{\partial}{\partial x_\mu} (k v_\sigma F_{\rho\mu}) \tag{4}$$

or

$$T'_{\rho\sigma} = - \lambda v_\sigma v_\rho - F_{\rho\mu} \frac{\partial k v_\sigma}{\partial x_\mu}. \tag{5}$$

(5) simply removes the unsymmetrical mixed term of (2) and adds the 'matter' contribution to the energy momentum tensor to yield[1]

$$\theta_{\rho\sigma} = T_{\rho\sigma} + T'_{\rho\sigma} = F_{\rho\mu} F_{\sigma\mu} - \lambda v_\sigma v_\rho + \delta_{\rho\sigma} L. \tag{6}$$

If (3) is added to (4), the canonical tensor contains the 'matter' term, and the symmetrizing tensor cancels the mixed last term of (3). λ is a scalar function of x_μ, and can be interpreted as the rest mass density of the streams of electrical charge.

The conservation of energy and momentum is ensured by the vanishing divergence of (6). The divergence of (6) can be written

$$\frac{\partial \theta_{\rho\sigma}}{\partial x_\rho} = \frac{\lambda}{k} \left(v_\rho F_{\rho\sigma} - k v_\rho \frac{\partial v_\sigma}{\partial x_\rho} \right), \tag{7}$$

and vanishes by virtue of Lorentz's equation

$$v_\rho F_{\rho\sigma} = k v_\rho \frac{\partial v_\sigma}{\partial x_\rho} = k \frac{d v_\sigma}{ds}, \tag{8}$$

which is a consequence of the Dirac theory.

The angular momentum, based on $\theta_{\rho\sigma}$, is equal to the sum of the 'field' angular momentum and the 'matter' angular momentum. Angular momentum is conserved, because $\theta_{\rho\sigma}$ is symmetrical and divergence free. In the usual classical formulation of the Maxwell field, the angular momentum is automatically resolved into orbital and spin components[4]. This decomposition is not justifiable on physical grounds, and, in addition, it is not gauge invariant. If one associates a spin density with $G_{omn} - G_{onm}$, customary Maxwell theory yields the non-gauge-invariant $E_m A_n - E_n A_m$, whereas Dirac's theory yields $E_m k v_n - E_n k v_m$. In space-time regions where there is electric charge, the latter expression seems to be unique. For space-time regions where there is no charge, the Dirac spin density, in the Lagrangian formulation of his theory, seems to be indeterminate, because v_μ is indeterminate[2].

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The Energy Momentum Tensor in Dirac's New Electromagnetic Theory

TYABJI[1] has shown that the energy momentum tensor in the vortical form of Dirac's new electromagnetic theory[2] has the same form as that belonging to the non-vortical theory. The method he uses of first obtaining a non-symmetrical form and then adding a suitable symmetrizing term depends on the particular definition of the electromagnetic potential A_μ and thus does not show why the two energy momentum tensors should have the same form.

The energy momentum tensor can be obtained by a different method, namely, by writing the metrical tensor $g_{\mu\nu}$ explicitly in the Lagrangian function L and then considering the variation of the integral $\int L \sqrt{-g}\, dx^1 dx^2 dx^3 dx^4$ with respect to $g_{\mu\nu}$.

In the non-vortical form of Dirac's theory, one has :

$$L = -\tfrac{1}{4} g^{\mu\sigma} g^{\nu\tau} F_{\sigma\tau} F_{\mu\nu} + \tfrac{1}{2}\lambda (g^{\mu\nu} A_\mu A_\nu - k^2), \qquad (1)$$

and in the vortical form :

$$L = -\tfrac{1}{4} g^{\mu\sigma} g^{\nu\tau} F_{\sigma\tau} F_{\mu\nu} + \tfrac{1}{2}\lambda' (g^{\mu\nu} v_\mu v_\nu - 1), \qquad (2)$$

where

$$v_\mu = k^{-1} \left(A_\mu - \xi \frac{\partial \eta}{\partial x^\mu} \right) \qquad (3)$$

and

$$\lambda' = k^2 \lambda. \qquad (4)$$

While a velocity vector is usually regarded as contravariant, the v_μ defined in Dirac's vortical theory is initially covariant, so that v_μ is independent of $g_{\mu\nu}$ and $v^\mu = g^{\mu\nu} v_\nu$. For this reason the covariant v_μ is used in (2). Variation with respect to $g_{\mu\nu}$ gives directly the symmetrical form of the energy momentum tensor obtained by Tyabji. Since the velocity vector in the non-vortical theory is defined by $v_\mu = k^{-1} A_\mu$, and since (1) and (2) contain $g_{\mu\nu}$ in the same way, it is clear that the resulting energy momentum tensors will have the same form, despite the different definitions of the electromagnetic potentials in the non-vortical and the vortical theories. Since the variables ξ, η do not enter (2) explicitly, they do not appear explicitly in the energy momentum tensor.

I take this opportunity to mention that the Schrödinger form of the non-vortical theory[3] is contained in the similarity theory of relativity, the variational principle being constructed in terms of the curvature scalar of a general symmetrical similarity tensor $S_{\sigma\tau}$. The details will shortly appear in *Physical Review*.

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Colour in Electron Microscopy

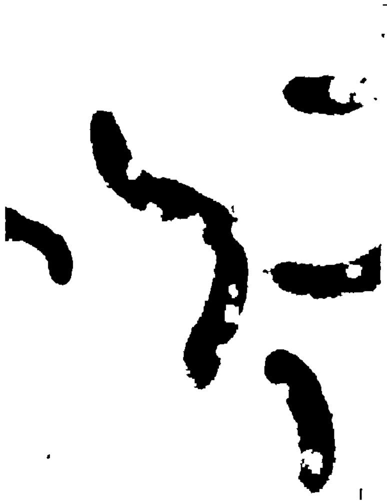
THE wave-length of the beam of an electron microscope, compared with visible light, is the property akin to colour. The beam is 'monochromatic' and it is standard practice to maintain it so within very narrow limits. The wave-length for electrons, in terms of their velocity expressed in electron volts, is given by the equation $\lambda = \sqrt{(150/V)}$ Angstrom units, where λ is the wave-length and V is the voltage accelerating the electrons. The 'colour' (wave-length) of the electron beam is varied by varying the voltage accelerating the electrons.

The image produced by the electron microscope is somewhat similar to a radiograph. The light and shade depend on the difference in the scattering and absorption of the beam by different parts of the specimen, which in turn depend on the wave-length. This is a function of the accelerating voltage, the thickness of the specimen, and the atomic numbers of the atoms composing the specimen.

The electron micrographs of the same specimen taken with electron beams of 25 kV. and 75 kV., respectively, show different detail and a certain amount of overlap. The internal detail in the higher-voltage picture shows up very well ; but very little is seen in the lower-voltage picture (see Figs. 1 and 2). The contrast of some low-density detail outside the bacteria which can be distinguished in the lower-voltage micrograph is reduced to such an extent as to render it nearly invisible in the higher-voltage picture. The similarity between micrographs taken at various voltages and X-ray pictures taken at various voltages, which is the basis of colour radiography introduced by Donovan[1,2], is obvious.

Colour electron microscopy involves the use of electron beams of two or more different voltages, and produces images in which colour is used to differentiate structure. Electron micrographs of the specimen are taken at two or more voltages (wave-lengths) selected to give the desired contrast. The images thus produced are each tagged in a visible colour such as red, green and blue, for a set of three electron micrographs, and are combined by optical superimposition or other means to form a colour electron micrograph. Such a composite colour picture shows not only variations in density but also variations in colour. Different colours in the final micrograph represent varying distribution of materials in the specimen absorbing or scattering at one or another of the wave-lengths (voltages) selected. In simplified effect, this method attempts to translate them into visible colours such as are seen in stained material used in light microscopy.

The easiest procedure is to treat the two or more electron micrographs taken at different voltages (wave-lengths) as separation negatives are in colour photography. A composite colour micrograph is assembled instantaneously by projecting in register the electron micrographs on to a viewing screen through suitable colour filters, or by means of viewing devices such as the chromoscope or 'Kromskop'. Permanent colour composite electron micrographic prints can be made with a modification of the 'Trichrome Carbro' process. Colour transparencies are made by photographing, serially and in register, the electron micrographs taken at the various voltages through appropriate colour filters on to the same frame of a colour photographic film.



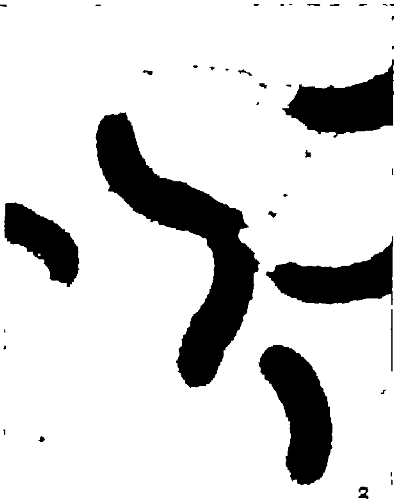


Fig. 1. Electron micrograph taken at 75 kV. Internal detail shows up, but external detail is practically invisible

Fig. 2. Electron micrograph taken at 25 kV of same specimen as Fig. 1. Internal detail shows up poorly, but external detail, such as flagella, shows up well

Satisfactory results can be obtained by using two voltages and two colours

Shadow-casting techniques are very popular in electron microscopy; they give a three-dimensional effect. The great defect of shadow casting is that only an outline of the organism shows and no internal structure is apparent. The electron microscope is capable, however, of showing great depth of focus and internal structure. A pseudo depth effect can be produced by careful choice of colours; red stands out, blue is recessive. This, allied to true stereoscopic electron microscopy, should produce very satisfactory stereoscopic electron micrographs.

We wish to thank Dr. F. T. Perkins and Dr. N. W. Preston, of the Department of Bacteriology, University of Manchester, and Messrs. Metropolitan-Vickers, Ltd., for their help.

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A Genetical System admitting of Two Stable Equilibria

It has long been known that, in a population where different genotypes possess different selective advantages, it is possible for balanced polymorphism to exist. That is to say, there is an equilibrium between the proportions of different genotypes which is stable under random mating with differential viability and fertility. I do not know, however, whether any case has been recognized in Nature, or discussed theoretically, in which it is possible for two distinct non-trivial stable equilibria to exist. (A trivial equilibrium is an extreme case when, for example, some genes or genotypes are unrepresented in the population, and is of little interest.) It may therefore be of some theoretical value to construct a genetical system admitting of two distinct stable states of balanced polymorphism.

Analogy with electrical and mechanical oscillating systems suggests that the necessary degree of complexity may be achieved by a system composed of two 'coupled' sub-systems, possessing sufficiently unlike properties. Now the random mating of the sexes can be regarded as an interaction between two sub-populations. It is therefore natural to inquire whether a population in which the same genotypes have different viabilities in the two sexes is one admitting of a multiplicity of distinct equilibria. This expectation is verified. It is easy to specify a theoretical population involving three genotypes *AA*, *Aa* and *aa* with selective advantages different within and between sexes, which has three equilibria, of which two are stable and the third unstable. For example, with the scheme of viabilities:

	AA	*Aa*	*aa*
Females	0·50	1·00	0·50
Males	2·15	1·00	2·15

we obtain three equilibria characterized as follows for gene ratios in the two sexes and for stability:

Gene ratio (*A* : *a*)

Equilibrium state	In females	In males	Character
I	0·582	0·339	Stable
II	1·000	1·000	Unstable
III	1·718	2·931	Stable

I will give elsewhere a brief discussion of systems of this type. It is shown that they may possess (*a*) no non-trivial equilibrium state; or (*b*) a unique non-trivial equilibrium which may or may not be stable; or (*c*) three non-trivial equilibria, of which as many as two may be stable, the third being unstable.

All the possibilities relating to the case of three equilibria, and the necessary conditions on the viabilities, have not been exhaustively explored numerically, but their complete examination would present no great difficulty. The analysis suggests that a necessary condition for the existence of three equilibria is that, in at least one sex, at least one homozygote must be at an advantage relative to the heterozygote. It suggests further that the difference in viability between homozygotes and the heterozygote is required to be in opposite senses in the two sexes.

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June 13.

Origin and Development of Axillary Buds in Jute (*Corchorus capsularis*)

BRANCHING characteristics of the vast majority of plants are not a desirable character in a fibre crop like jute. Some foreign varieties of *Corchorus capsularis* like Halmahera, Jap Red and Jap G, unlike the Indian varieties, do not usually branch, as the axillary buds are normally absent in the axils of the leaves. These varieties supply the gene for non-branching character to be incorporated in the high-yielding Indian varieties. Though the anatomy of normal jute plant has been investigated in detail by Kundu[1,2], the organization of the shoot apex in the non-branching plants requires study, to find whether the absence of axillary buds is merely due to dormancy or complete absence of bud meristem in the axils of leaves. Such a study will doubtless help in rigid selection for non-branching varieties. A comparative developmental anatomy of four varieties of *Corchorus capsularis*, *D*154 (a branching variety), Halmahera, Jap Red and Jap G (non-branching varieties), was taken up in order to get precise information about the nature of non-branching character.

In the branching variety, *D*154, buds develop from a portion of apical meristem detached in the axils of leaves during vacuolation and growth, as described by Wardlaw in *Matteuccia*[3] and found in a great number of plants[4,5] (Fig. 1). Such a detached meristem can be seen as 'shell zone'[6] quite early, in the axil of the third leaf primordium. This zone enlarges by further divisions and emerges out in the axil of the sixth primordial leaf (Fig. 3). Its further development and size are determined by time of sowing, spacing and other factors. In the non-branching varieties (Halmahera, Jap Red and Jap G) 'shell zone', active or dormant, is completely absent (Fig. 2), except in some cases, where buds develop at irregular intervals and their development is similar to those in *D*154. Unless they are stimulated to grow by insect or accidental damage to the main apex, these few buds remain inconspicuous and usually do not develop any further. Some tips do not show axillary buds at all, but the possibility of development of buds at still earlier or later stages cannot be excluded.

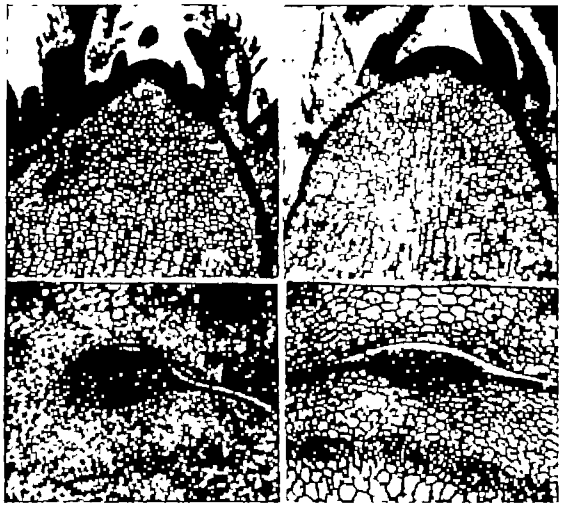

Fig. 1. L.S. of stem tip of *D*154 showing two shell zones and a portion of axillary bud
Fig. 2. L.S. of stem tip of Halmahera showing absence of shell zones
Fig. 3. T.S. of stem tip of *D*154 showing origin of axillary bud
Fig. 4. T.S. of stem tip of Halmahera showing origin of extra-axillary bud

Extra-axillary buds develop irregularly in the three non-branching varieties, but more frequently in Halmahera. In the development of extra-axillary buds, a definite zone of detached meristem exists as usual from early stages. But some previously vacuolated cells of the axis above the axil which are in continuation with the detached meristem resume meristematic activity and are responsible for the development of bud proper (Fig. 4). In all these cases the development of provascular tissues in the bud is acropetal. The development of buds is possibly checked in the non-branching varieties by production of a sort of heteroauxin[7], which is controlled by a single recessive gene; but its expression is not complete in these varieties, as is evident from the occasional production of buds.

Details will be published elsewhere.

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Barrackpore, West Bengal.
Sept. 22.

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[2] Kundu, B. C., *J. Roy. Asiatic Soc. Bengal*, 10, 27 (1944).
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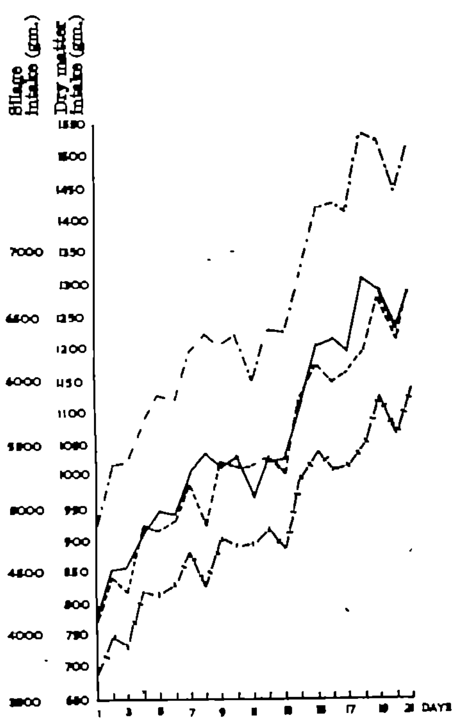
Effect of the Percentage of Dry Matter in the Diet on the Dry-Matter Intake in Ruminants

IN the course of some experiments with beef cattle, swedes and grass silage were fed, and it was observed that the appetite of the cattle, in terms of daily intake of dry matter, appeared to be inversely proportional to the percentage of moisture in these feeding-stuffs.

In order to obtain further data on this point, two sheep were fed to appetite with grass silage containing 22·66 per cent of dry matter, and a second pair of sheep received silage, from the same source, to which 300 c.c. of water had been added per kilogram of the original silage. The percentage of dry matter of this watered silage, as fed, was 16·85 per cent. All sheep were fed to appetite, and the average weight of silage eaten daily by each pair of sheep has been plotted on the accompanying graph together with the average daily dry-matter intake.

It will be noted that the weight of the daily intake of silage varied very little between the two groups of sheep, but there was a wide difference in the daily intake of dry matter, the figure being consistently higher for the sheep on the silage with a higher dry-matter percentage.



Daily intake of silage: ———, 22·66 per cent dry matter silage; – – – –, 16·85 per cent dry matter silage.
Daily intake of dry matter: —.—., from 22·66 per cent dry matter silage; —ɪ—ɪ, from 16·85 per cent dry matter silage

Although the experimental period lasted for only three weeks, these results confirm that when ruminants are fed twice daily on a diet consisting solely or mainly of succulent foods, the daily intake of dry matter is directly related to the percentage of dry matter in the diet. It follows that if ruminants are fed solely or mainly on succulent foods, maximum performance can only be expected if the dry-matter percentage of the succulent foods is maintained at a sufficiently high level to ensure that the dry-matter percentage in the diet as a whole does not fall below some critical figure—probably somewhere between 20 and 25 per cent—but this point requires further investigation.

A fuller report of this and the experiments leading up to it is in preparation for publication.

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W. H. McK. Campbell
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Agriculture Department,
Marischal College, Aberdeen. June 12.

Chromosomes of the Indian Water Buffalo

The number of chromosomes of the water buffalo (*Bubalus bubalis* L.) is a controversial issue (the names *Bubalus bubalus* L. and *B. buffelus* L. are synonyms of *B. bubalis* L.). Pchakadze[1] stated that it is $2n = 56$. Makino[2], on the contrary, reported the diploid number of chromosomes to be 48. In view of this disagreement, it was considered worth while to study the number of the Indian water buffalo.

Testicular materials, obtained by castration from 1-yr., 2½-yr. and 6-yr. old buffaloes of the Murrah breed, were fixed in Belling's modification of Nawaschin mixture, sectioned at 15 μ in thickness and stained in iodine crystal violet after overnight premordanting in 1 per cent chromic acid.

Examination revealed that the materials taken from animals aged 2½ yr. and 6 yr. were not suitable for spermatogonial chromosome count. A few good metaphase plates were, however, seen in these tissues. A large number of dividing cells were obtained in the material taken from the 1-yr. old animal. The study of the spermatogonial metaphase (Fig. 1) showed that the diploid number of chromosomes is 48. There are two types of chromosomes in respect of the position of the centromere: the first comprises four pairs with median or submedian centromere, and the second twenty pairs of rod-shaped chromosomes with terminal or nearly terminal centromere. Among the first group, there are two pairs of *J*-shaped chromosomes which are the longest in the complement. The pair next in size is also *J*-shaped, but its long arm is slightly smaller than that of the longest one, while the size of the short arm is the same as that of the longest pair. The fourth pair is a *V*-shaped one with equal arms. Among the rod-shaped chromosomes, the *X*-chromosome was found to be the longest and the *Y* seemed to be one of the smallest. Contrary to Makino, who observed that the *X*-chromosome was more deeply stained than others, no differential staining behaviour was noted in this chromosome. The number of chromosomes was also verified from the polar view of metaphase II, where there were 24 chromosomes of different sizes (Fig. 2). Our observation is in agreement with that of Makino.

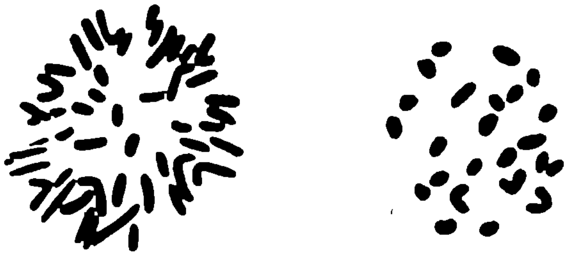
(1) (2)

Fig. 1. Spermatogonial metaphase of Indian water buffalo showing $2n = 48$ chromosomes. × 2,600

Fig. 2. Second division metaphase plate (polar view). × 2,600

This work was carried out at the Animal Genetics Section, Indian Veterinary Research Institute, Izatnagar, while one of us (M. K. D.) was a member of its staff.

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[1] Pchakadze, G., *C.R. Acad. Sci. URSS*, 24, 794 (1939).

[2] Makino, S., *Cytologia*, 13, 247 (1944).

Micro-forceps and Micro-scalpels

Some convenient glass micro-forceps are shown in Fig. 1. Type I are opened by their own resilience and closed by means of a tube fitting around them. In type II the reverse action is shown, closing being effected by resilience and opening by the force of a ball and rod. The two branches of the forceps are fixed in a tube of 1·5 mm. diameter, which is mounted on a de Fonbrune micromanipulator. A second tube, enclosing the first tube, can be made to slide around the branches of the forceps, operating it by means of a piston and a syringe. The closing movement is smooth and can be controlled within the limits of a few microns. The points remain exactly opposed.

The points of type II are useful for holding very fragile objects. Type I can hold microscopical objects of various kinds, since the points can be modified to suit several purposes.

Six modifications are shown in photograph III. The points shown are, respectively, in the form of: (1) strong pincers; (2) fine pincers; (3) eyelets (Schouten type[1], diameter 7 and 20 microns, for isolating micro-organisms); (4) ball and cup (de Fonbrune type[2]); (5) a tong-like structure; and (6) pipettes (one point is filled with fluid).

The following possible applications of these forceps may be suggested: experiments on single fibres (for example, muscle, collagen, textile fibres); clamping capillaries, partly or completely; injecting two fluids in the same place; holding small quantities of different materials (for example, radioactive chemicals); micro-dissection.

Any one of the instruments illustrated can be made with the de Fonbrune microforge within a quarter of an hour.

The micro-scalpels shown in Fig. 2 are made essentially by breaking glass rods. They have cutting edges all round, the sharpness of which is generally sufficient to cut bacteria.

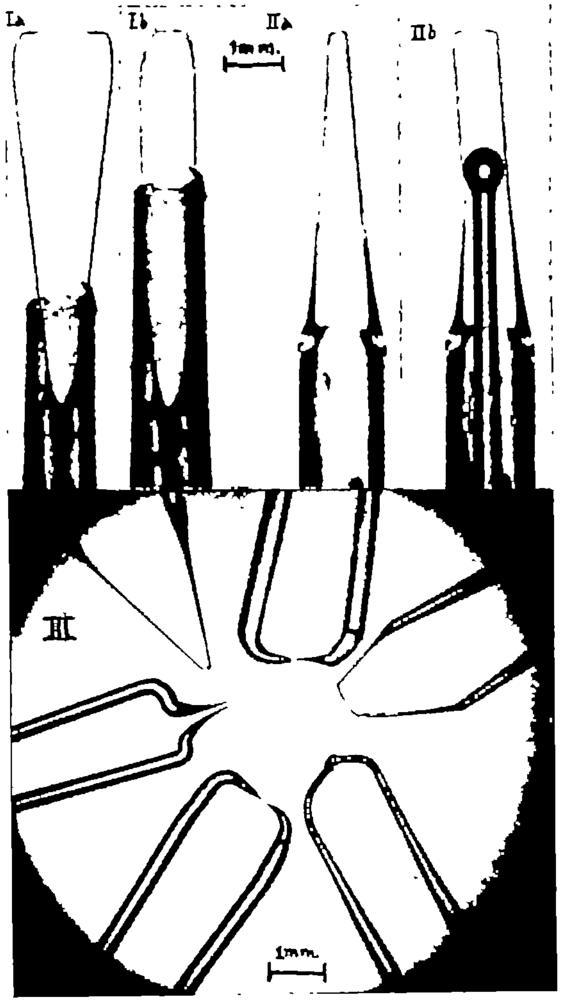

Fig. 1

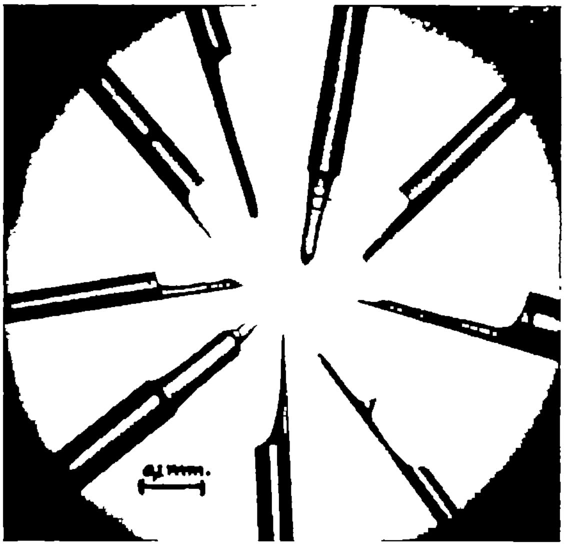

Fig. 2

J. Worst

Mozartstraat 1,
Arnhem.
Aug. 28.

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A Test for Montmorillonite

It has been shown that montmorillonite saturated with small ions, for example, lithium, is difficult to rehydrate after being dried at moderate temperatures[1-3]. This behaviour has been found to be confined to montmorillonite and forms the basis of a new test which enables the mineral to be easily distinguished from the other common montmorillonoids[4].

The hysteresis observed on drying is due to a decrease of the internal surface, which takes place in a random way and leads to the phenomenon of random inter-stratification in the re-solvated mineral. In consequence of this, the dried mineral also shows a marked decrease in exchange capacity due to the decreased rate of exchange of the interlamellar ions. The test may therefore take a number of forms, any of which may be used to identify montmorillonite.

In practice, lithium montmorillonite has been found to show the greatest effect. If the sample is either in the form of oriented flakes or powders, satisfactory saturation with lithium ions may be obtained by three washings with 3 *M* lithium chloride, the excess salt being removed with warm 80 per cent alcohol. By means of this procedure the mineral remains aggregated and the flakes retain their structure.

Lithium montmorillonite treated with glycerol, after being dried at 100° C., shows a rational series of reflexions corresponding to *d*(001) of 17·7 kX. on X-ray analysis. If the drying is carried out at 200° C., a markedly decreased rate of uptake of glycerol is observed and the X-ray diffraction pattern shows an irrational series of reflexions that would be expected for a random mixture of spacings of 9·4 and 17·7 kX. in equal proportions[5]. Heating to 300° C. leads to a rational series of reflexions corresponding to $d(001)$ of 9·4 kX.

Lithium montmorillonite dried at 200° C. shows a decreased exchange capacity to ammonium ions at *p*H 7, when compared with samples dried at 70° C. Wyoming bentonite showed a change from 90 m.equiv./100 gm. to 3 m.equiv./100 gm. Differential thermal analysis on lithium montmorillonite dried at 200° C. and rehydrated at 50 per cent relative humidity showed that the endothermic peak between 100° and 200° C., due to sorbed water, was greatly decreased when compared with samples dried[5] at 70° C.

These changes of internal surface on drying at 200° C. were not observed with authentic samples of beidellite (Black Jack Mine)[6], saponite (Cathkin Hill)[7], hectorite (California)[8] and two nontronites when saturated with lithium. It appears, therefore, that this decrease in internal surface takes place only when the mineral is dioctahedral and the charge in the silicate sheets is due predominantly to substitution in the octahedral layers. The test thus provides a useful method of distinguishing between the end members of the montmorillonite-beidellite series, which is a difficult procedure in the case of impure samples.

Grateful acknowledgment is made to the British Museum (Natural History), Geological Survey, and the Fullers Earth Union, Ltd., for gifts of minerals.

R. GREENE-KELLY

Pedology Department,
Rothamsted Experimental Station,
Harpenden, Herts. June 11.

[1] Garcia, F. Gonzalez, *Anales de Edafologia y Fisiologia Vegetal*, 9, 149 (1950).

[2] Hofmann, U., and Klemen, R., *Z. anorg. Chem.*, 262, 95 (1950).

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[4] Brindley, G. W., "X-Ray Identification and Crystal Structure of Clay Minerals", 86 (London: Min. Soc., 1951).

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Minimum Phosphate and Magnesium Requirements of Nitrifying Bacteria

THE nutrient requirements of the autotrophic nitrifying bacteria are simple, but among the elements which seem to be essential for them are phosphorus and magnesium. Bömeke[1] reported that *Nitrobacter* would not grow in media from which either phosphate or magnesium was omitted; and *Nitrosomonas* would not grow in medium with magnesium omitted. Wimmer[2] found that phosphate was necessary for the growth of both organisms, but the minimum requirement was only 0·02 mgm. phosphorus per litre for both *Nitrobacter* and *Nitrosomonas*.

To find the minimum requirements of nitrifiers for these two elements, pure cultures were grown in 5-ml. liquid medium in test-tubes covered with aluminium caps. The control medium contained $M/1,000$ phosphate and $M/1,000$ magnesium sulphate. A series of transfers was made on media from which either the phosphate or the magnesium was omitted. The bacteria used were: a strain of *Nitrosomonas europaea* from Denmark[3] and a strain of *Nitrobacter winogradskii* from Ampthill, Beds[4]. A drop from a Pasteur pipette was used as the inoculum, so that the dilution at each transfer was about a hundred times.

Phosphate. The *Nitrosomonas* survived no less than eleven successive transfers on to medium with phosphate omitted; but no special steps were taken to purify the medium from every trace of phosphate, so a very small amount (too small to give the usual drop reaction for phosphate) may have been present. In any event, the amount carried over in the inoculum was very small; after three transfers, only a fraction of a microgram would be carried over. *Nitrobacter* ceased to oxidize nitrite in the second transfer, but the bacteria survived, as transfers back on the control medium were normal. On the second transfer, the theoretical amount of phosphorus carried over in the inoculum would correspond to about 0·003 mgm. per litre.

Magnesium. Both species continued to oxidize ammonia or nitrite up to the fourth successive transfer on to medium with magnesium omitted. By this transfer, the theoretical amount of magnesium carried over in the inoculum would be about 0·0002 mgm. per litre. Both species survived, as transfers back to control medium grew.

JANE MEIKLEJOHN

Rothamsted Experimental Station,
Harpenden, Herts. June 5.

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Sir Jack Drummond, F.R.S.

THE news of the tragic death of Sir Jack Drummond came as a severe shock to his many friends in America. Only after the initial paralysing numbness associated with the sporadic news flashes of his murder had worn off could the enormity of this crime be appreciated. Although the loss to the scientific world has been great, a deep feeling of the personal loss of a friend has been experienced by many of us in Canada. Over the years Jack Drummond has made numerous Canadians his associates. His interest and hospitality was extended to many junior men of science, and all of us will remember the impact of his personality as he blended the science of nutrition and the art of entertainment into a formula as palatable as his Englishman's food. Perhaps no one has done so much to help so many Canadian medical research students attain a balanced perspective of scientific life in England. To many of us the pleasure of informal evenings, and the charm of Drummond as a host, will remain as our most vivid memory of a man who was truly more than a great man of science.

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L. CHUTE

Department of Paediatrics,
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J. F. MCCREARY

Department of Paediatrics,
University of British Columbia,
Vancouver.

R. L. NOBLE

Department of Medical Research,
University of Western Ontario,
London.

FORTHCOMING EVENTS

Tuesday, December 30—Friday, January 2

SCIENCE MASTERS' ASSOCIATION (in the Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7).—Annual Meeting: "Science in the Service of the Community".

Friday, January 2

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Capt. G. C. Adams: "Principles and Practice Governing Interchangeability and the Specification of Manufacturing Limits of Size as influenced by Statistical Considerations".

APPOINTMENTS VACANT

SENIOR LECTURER IN PHYSICS and a SENIOR LECTURER IN PHYSICAL CHEMISTRY (with a good honours degree in physics or chemistry respectively and, if possible, experience in teaching, industry and research)—The Principal, Acton Technical College, High Street, Acton, London, W.3 (January 3).

LECTURER IN PHYSIOLOGY—The Registrar, The Medical School, Birmingham 15 (January 10).

GRADUATE (male) IN BOTANY or AGRICULTURE in the Technical Advisory Section—The Director, Sports Turf Research Institute, St. Ives Research Station, Bingley, Yorks (January 15).

SENIOR ORGANIC CHEMIST to the Division of Biochemistry and General Nutrition, C.S.I.R.O., at the central laboratories in the University of Adelaide, to work on general problems involved in the introduction of isotopic carbon, nitrogen, etc., into organic compounds—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting Appointment 4078 (January 17).

CHAIR OF FUEL TECHNOLOGY—The Registrar, The University, Sheffield (January 31).

LECTURER IN BIOCHEMISTRY—The Secretary, Queen's University, Belfast (February 25).

ASSISTANT EXPERIMENTAL OFFICERS IN THE INSTRUMENTATION DEPARTMENT of the Royal Aircraft Establishment, Farnborough, for design and development of equipment for measurements in aeronautical research: ELECTRICAL ENGINEER or PHYSICIST for work on electronic circuits, and an ELECTRICAL or MECHANICAL ENGINEER for work on electro-mechanical instruments—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting D.472/52A.

ASSISTANT LECTURER (Grade B) IN CHEMISTRY at the Wolverhampton and Staffordshire Technical College—The Clerk to the Joint Education Committee, Education Offices, North Street, Wolverhampton.

HEAD OF THE SCIENCE DEPARTMENT of the Ewell Technical College—The Chief Education Officer, County Hall, Kingston-upon-Thames, Surrey.

PHYSICAL CHEMIST (with research experience) to investigate certain biophysical aspects of flour milling, and a CHEMIST for research on flour quality—The Director, Research Association of British Flour Millers, Cereals Research Station, Old London Road, St. Albans, Herts.

PHYSICIST or ENGINEER IN THE INSTRUMENTS AND AIR PHOTOGRAPHY DIVISION of the Royal Aircraft Establishment, Farnborough, for research and development on analogue computers, servo-mechanisms and similar precision electro-mechanical equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting A.312/52A.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

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Department of Scientific and Industrial Research. Report of the Radio Research Board with the Report of the Director for Radio Research for the Year 1951. Pp. iv+36. (London: H.M. Stationery Office, 1952.) 1s. 6d. net. [311

Fire Protection Association. Technical Booklet No. 11: A Comparison of the Extinguishing Effects of Chlorobromomethane, Methyl Iodide and Carbon Tetrachloride. By H. H. Coleman. Pp. 12. (London: Fire Protection Association, 1952.) [311

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Colonial Office. Colonial Research Publications, No. 13: Land Registration. By Sir Ernest Dowson and V. L. O. Sheppard. Pp. xi+212. (London: H.M. Stationery Office, 1952.) 25s. net. [411

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Ecological Crop Geography and Field Practices of the Ryukyu Islands, Natural Vegetation of the Ryukyus, and Agro-Climatic Analogues in the Northern Hemisphere. By M. Y. Nuttonson. Pp. 106. (Washington, D.C.: American Institute of Crop Ecology, 1952.) [311

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Fiskeridirektoratets Skrifter. Serie Havundersøkelser, Vol. 10, No. 2: The Lekstorfjord Herring and its Environment. By Olav Aasen. Pp. 63+3 plates. (Bergen: A/s John Griegs Boktrykkeri, 1952.) [611

Kungl. Svenska Vetenskapsakademiens Handlingar. Fjärde Serien, Band 2, No. 6: Étude complémentaire des Poissons de l'Eotrias de Madagascar. Par Jean-Pierre Lehman. Pp. 201+48 plates. (Stockholm: Almqvist and Wiksell; London: H. K. Lewis and Co., Ltd., 1952.) 75 kr. [611

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